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Assessment of Knowledge, Attitude, and Practice Toward COVID-19 in China: An Online Cross-Sectional Survey

Yaqing Fang,* Panpan Liu, and Qisheng Gao
School of Public Health, Hangzhou Medical College, Hangzhou, China

Abstract. To analyze the level of knowledge, attitude, and practice about COVID-19 among Chinese residents, noninterventional and anonymous survey was carried out with an online questionnaire. Among the survey respondents (n = 619), 59.9% were female, 61.1% were from 18 to 30 years of age, and 42.3% held an undergraduate's degree. The mean scores for each scale were as follows: perceived knowledge (36.3 ± 6.1), attitude (29.4 ± 4.7), practice (44.1 ± 4.8), total score (109.7 ± 13.2), barrier (0.2 ± 0.7), and cognition and behavior change score (8.5 ± 1.4). Perceived knowledge, attitude, practice, total score, and cognition and behavior changes were significantly and positively correlated, whereas barrier was negatively correlated with those scales ($P < 0.001$). Linear regressions revealed that those respondents who were medical professionals, civil servants, employees of state-owned enterprises and public institutions, and had relatively higher level of education were associated with a higher perceived knowledge score, attitude score, practice score, and total score. Higher mean cognition and behavior change score was associated with company employees (8.8 ± 1.3). More than half of the respondents (51.4%) were optimistic about the government's interventional measures. The respondents in China had good knowledge, positive attitude, and active practice toward COVID-19, yet, it is advisable to strengthen nationwide publicity and focus on the target undereducated population by means of We-Chat, microblog, website, and community workers for better control effect.

INTRODUCTION

COVID-19, caused by SARS-CoV-2, was declared as a global health emergency by the WHO on January 30, 2020.[1] The outbreak of COVID-19 was wreaking havoc worldwide due to strong infectiousness, virus mutation, and inadequate risk assessment regarding the urgency of the situation. It was regarded as a pandemic by the WHO on March 11, 2020.[2] The COVID-19 pandemic has made tremendous impact on the whole world, with 1,699,595 confirmed cases of COVID-19, including 106,138 deaths globally as of 2:00 AM CEST, April 12, 2020.[3] China, one of the seriously hit countries, had reported 82,160 confirmed cases, with 3,341 deaths up to April 12, 2020.[4] The clinical symptoms of COVID-19 include fever, cough, shortness of breath, muscle ache, confusion, headache, sore throat, rhinorrhea, chest pain, diarrhea, nausea, and vomiting.[5] Case fatality rates were 9.3% in Italy, 6.2% in Spain, 4.2% in France,[6] and 2.3% in China.[7]

The outbreak of COVID-19 has captured the world's attention because it has the potential to cause severe political, social, and economic upheaval; therefore, it calls for great international concern and collaborative efforts of all countries to prevent the serious spread of COVID-19. Faced with the rapid growth of cases, the Chinese authorities have implemented prompt response measures, initiating public health level 1 response of 31 provinces, strict exit screening, cancellation of mass gatherings, and postponing all kinds of school from January 23, 2020 on.[8] Meanwhile, the perceptions of communities toward this outbreak have become one of the hotspots, and several studies have been carried out, showing that the effectiveness of the government interventional measures depended a lot on people's adherence to these control measures, which was influenced by their knowledge, attitude, and practice toward COVID-19 to a great extent.[9,10] Experience from SARS and Middle East respiratory syndrome indicated that the perceived cognition toward the outbreak was associated with the behavior, thus affecting the prevention and control of the disease.[11,12] Public cooperation is crucial in containing the spread of COVID-19 and fighting against the pandemic calls for sustained efforts and constant vigilance. To promote interventional progress amid the coronavirus outbreak, there is an urgent need for assessment of the population's perceptions; hence, we investigated the perceived knowledge, attitude, and practice toward COVID-19 and the behavior changes before and after government measures in China.

METHODS

Survey design. This was a noninterventional, anonymized, self-administered, web-based survey of the knowledge, attitude, and practice of Chinese residents. This study was carried out from February 21, 2020 to March 18, 2020 using an online questionnaire.

Survey sample. To test the reliability and validity of a questionnaire that was designed by the author group, 30 participants took part in a preliminary experiment. Then, given the circumstance of strict exit screening and household quarantine of the COVID-19 outbreak, the formal online questionnaire (https://www.wjx.cn/newwjx/design/sendqstart.aspx?activity=58583407) has been sent to 800 Sina microblog users nationwide by convenience sampling,[13] among whom 619 completed it. Sina blog is one of the most popular blogs in China, and active users reach 550 million monthly, making it representative of online sampling, compared with the whole 904 million population of netizen.[14] The response rate was about 77.4%, which guaranteed for bivariate and multivariable analyses to be carried out.

* Address correspondence to Yaqing Fang, School of Public Health, Hangzhou Medical College, No. 481, Binwen Rd., Binjiang District, Hangzhou 310053, China. E-mail: colourwind1035@126.com

TABLE 1
Characteristics of the respondents (N = 619)

Characteristic	Categories	N	%
Gender	Male	248	40.1
	Female	371	59.9
Age-group (years)	< 18	38	6.1
	18–30	378	61.1
	31–40	54	8.7
	41–50	83	13.4
	51–o 60	42	6.8
	> 60	24	3.9
Living district	City	204	33.0
	Town	163	26.3
	Village	252	40.7
Occupation	Medical professionals	38	6.1
	Civil servants/employees of state-owned enterprises and public institutions	69	11.1
	Company employees	79	12.8
	Workers	44	7.1
	Farmers	49	7.9
	Self-employed	59	9.5
	Retired staff	37	6.0
	Students	211	34.1
	Others	33	5.3
Marital status	Married	311	50.2
	Unmarried	307	49.6
Level of education	Primary school or below	24	3.9
	Junior high school	61	9.9
	Senior high school/technical secondary school	79	12.8
	Junior college	169	27.3
	Undergraduate	262	42.3
	Post-undergraduate	24	3.9
Family members	1	1	0.2
	2	15	2.4
	3	161	26.0
	4	234	37.8
	≥ 5	208	33.6

Survey questionnaire. The questionnaire items were designed by the authors mainly based on the information and basic protective measures acquired from the National Health Commission of the People's Republic of China, the Chinese CDC, the WHO, and various websites of Chinese government agencies, official media, as well as some previous studies as of February 16, 2020.[15,16] In the pre-investigation, researchers screened all items and created the formal questionnaire through exploratory factor analysis using IBM SPSS Statistics for Windows version 23.0. The formal questionnaire was composed of seven different sections: 1) Sociodemographic characteristics: gender, age, province, living district, occupation, marital status, level of education, family members. 2) Questions related to perceived knowledge about COVID-19. 3) Questions related to attitude toward COVID-19. 4) Questions related to practice in preventing and controlling COVID-19. 5) Questions related to the overall evaluation of knowledge, attitude, and behavior toward COVID-19. 6) Questions related to the barriers for poor knowledge and insufficient protective measures. 7) Questions related to the cognition changes before and after government measures, and expectations about the government measures. Cronbach's alphas for the knowledge, attitudes, and clinical practice pattern scales were 0.940, 0.944, and 0.812, respectively. The overall scale had a high Cronbach's alpha coefficient (0.935).

Score measurement. Perceived knowledge score was assessed by eight questions evaluating 1) the level of knowledge regarding the possible hosts of SARS-CoV-2, 2) the level of knowledge regarding the transmission routes of COVID-19, 3) the level of knowledge regarding the infectiousness of asymptomatic COVID-19 patients, 4) the level of knowledge regarding the symptoms of COVID-19, 5) the level of knowledge regarding medical quarantine requirements for COVID-19, 6) the level of knowledge regarding susceptible population of COVID-19, 7) the level of knowledge regarding inactivation methods of SARS-CoV-2, and 8) the level of knowledge regarding the availability of specific drugs and vaccines for COVID-19.

Attitude score was evaluated by six questions assessing if respondents 1) keep themselves updated about COVID-19, 2) are willing to learn more about COVID-19, 3) are ready for strong supports and active cooperation in the prevention and control for COVID-19, 4) think the outbreak of COVID-19 should be taken seriously, 5) are aware of the designated hospitals in the area, and 6) have full confidence in the government's interventions.

Practice score was evaluated by 10 questions about 1) the frequency of wearing a mask when going out in a correct way, 2) the frequency of washing hands correctly, 3) the frequency of covering the nose and mouth with hands when sneezing or coughing, 4) the frequency of avoiding meeting and gathering, 5) the frequency of taking physical exercise, 6) the frequency of having a balanced and nutritious diet and less or no consumption of wild animals, 7) the frequency of avoiding contact with live poultry, 8) the frequency of paying attention to household hygiene and disinfection, 9) the frequency of getting enough sleep, and 10) whether or not going to the designated hospital immediately for medical treatment in case of cough, fever, dyspnea, and other suspected symptoms.

TABLE 2
Scores of perceived knowledge (N = 619)

Detailed questions about perceived knowledge	Categories	N	%	M±SD
Your level of knowledge regarding				
The possible hosts of SARS-CoV-2	Very unconfident	9	1.5	3.9 ± 0.9
	Fairly unconfident	34	5.5	
	Neutral	113	18.3	
	Fairly confident	**296**	**47.8**	
	Very confident	167	27.0	
The transmission routes of COVID-19	Very unconfident	8	1.3	4.3 ± 0.8
	Fairly unconfident	20	3.2	
	Neutral	46	7.4	
	Fairly confident	264	42.6	
	Very confident	**281**	**45.4**	
The infectiousness of asymptomatic COVID-19 patients	Very unconfident	11	1.8	4.2 ± 0.9
	Fairly unconfident	18	2.9	
	Neutral	68	11.0	
	Fairly confident	234	37.8	
	Very confident	**288**	**46.5**	
The symptoms of COVID-19	Very unconfident	10	1.6	4.1 ± 0.8
	Fairly unconfident	14	2.3	
	Neutral	61	9.9	
	Fairly confident	**329**	**53.2**	
	Very confident	205	33.1	
Medical quarantine requirements for COVID-19	Very unconfident	9	1.5	4.1 ± 0.9
	Fairly unconfident	22	3.6	
	Neutral	86	13.9	
	Fairly confident	**270**	**43.6**	
	Very confident	232	37.5	
Susceptible population of COVID-19	Very unconfident	9	1.5	4.2 ± 0.9
	Fairly unconfident	25	4.0	
	Neutral	59	9.5	
	Fairly confident	**292**	**47.2**	
	Very confident	234	37.8	
Inactivation methods of SARS-CoV-2	Very unconfident	10	1.6	4.0 ± 0.9
	Fairly unconfident	31	5.0	
	Neutral	105	17.0	
	Fairly confident	**279**	**45.1**	
	Very confident	194	31.3	
The availability of specific drugs and vaccines for COVID-19	Very unconfident	19	3.1	3.9 ± 1.0
	Fairly unconfident	37	6.0	
	Neutral	102	16.5	
	Fairly confident	**263**	**42.5**	
	Very confident	198	32.0	

Bold values represent the largest proportion in the corresponding part.

Cognition and behavior changes before and after government measures were assessed by two questions about 1) changes in cognition and behavior of the epidemic before and after the strict exit screening measures and public health level 1 response of 31 provinces from January 23, 2020 on, and 2) changes in cognition and behavior of the epidemic before and after the upgraded measures from January 30, 2020 on.

The eight items on the knowledge dimension were assessed using a five-point Likert scale ranging from 1 to 5 (1 = very unconfident, 2 = fairly unconfident, 3 = neutral, 4 = fairly confident, and 5 = very confident). Higher scores represented better knowledge. The six items on the attitude dimension were evaluated on a five-point Likert scale ranging from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree/do not know, 4 = agree, and 5 = strongly agree). Higher scores indicated a more positive attitude. The 10 items on the practice dimension were scored on a five-point Likert scale ranging from 1 to 5 (1 = never, 2 = seldom, 3 = sometimes, 4 = often, and 5 = always). The five items on the barrier dimension were scored on a two-point scale (1 = yes and 0 = no). The two items on the cognition and behavior change dimension were scored on a five-point Likert scale ranging from 1 to 5 (1 = absolutely unchanged, 2 = fairly unchanged, 3 = neutral, 4 = fairly changed, and 5 = absolutely changed).

The final score for each scale was calculated by adding up the points obtained for the corresponding questions. The total score was the sum of the perceived knowledge score, attitude score, and practice score. Higher scores represented more active behavior (Supplemental Appendix 1).

Statistical analysis. An Excel sheet was automatically generated from the online questionnaire, allowing to perform the statistical analyses. Statistical analyses were performed using IBM SPSS Statistics 23.0. Descriptive statistical analysis was used to summarize the respondents' demographic characteristics. Two-sided statistical tests were used; chi-square test was for dichotomous or multinomial qualitative variables, whereas the Student's t-test was used to check for an association between continuous and dichotomous variables. The ANOVA test was used to compare multiple group means. Linear

TABLE 3
Scores of attitude (N = 619)

Detailed questions about attitude	Categories	N	%	M±SD
Keep updated about COVID-19	Strongly disagree	10	1.6	4.2 ± 0.9
	Disagree	12	1.9	
	Neither agree nor disagree/do not know	82	13.2	
	Agree	**267**	**43.1**	
	Strongly agree	248	40.1	
Willing to learn more about COVID-19	Strongly disagree	8	1.3	4.3 ± 0.8
	Disagree	9	1.5	
	Neither agree nor disagree/do not know	73	11.8	
	Agree	245	39.6	
	Strongly agree	**284**	**45.9**	
Ready for strong supports and active cooperation in the prevention and control for COVID-19	Strongly disagree	9	1.5	4.5 ± 0.8
	Disagree	9	1.5	
	Neither agree nor disagree/do not know	33	5.3	
	Agree	193	31.2	
	Strongly agree	**375**	**60.6**	
The outbreak of COVID-19 deserves serious attention	Strongly disagree	9	1.5	4.5 ± 0.8
	Disagree	9	1.5	
	Neither agree nor disagree/do not know	29	4.7	
	Agree	173	27.9	
	Strongly agree	**399**	**64.5**	
Aware of the designated hospitals in your area	Strongly disagree	13	2.1	4.2 ± 0.9
	Disagree	21	3.4	
	Neither agree nor disagree/do not know	77	12.4	
	Agree	218	35.2	
	Strongly agree	**290**	**46.8**	
Have full confidence in the government's interventional measures	Strongly disagree	9	1.5	4.5 ± 0.8
	Disagree	7	1.1	
	Neither agree nor disagree/do not know	47	7.6	
	Agree	188	30.4	
	Strongly agree	**368**	**59.5**	

Bold values represent the largest proportion in the corresponding part.

regressions were conducted taking different scale scores as the dependent variables and sociodemographic characteristics as independent variables. $P < 0.05$ was considered as significant.

RESULTS

Sociodemographic results. Eight hundred netizens were randomly chosen via Sina microblog platform; 619 (77.4%) completed the online survey. The data of demographic characteristics (Table 1) indicated that, among the participants surveyed, 59.9% were female, 61.1% were aged from 18 to 30 years, 40.7% were living in villages, 34.1% were students, 50.2% were married, 42.3% had an undergraduate's degree, and 37.8% had a family of four members.

Scores of each scale. *Scores of perceived knowledge.* The results of Table 2 showed that 296 (47.8%) of 619 respondents were fairly confident about the level of knowledge regarding the possible hosts of SARS-CoV-2, 281 (45.4%) were very confident about the transmission routes of COVID-19, 288 (46.5%) knew well about the infectiousness of asymptomatic COVID-19 patients, 329 (53.2%) were fairly confident about the symptoms of COVID-19, 270 (43.6%) were fairly confident about medical quarantine requirements for COVID-19, 292 (47.2%) were fairly confident about susceptible population of COVID-19, 279 (45.1%) were fairly confident about the inactivation methods of SARS-CoV-2, and 263 (42.5%) were fairly confident about the availability of specific drugs and vaccines for COVID-19.

Scores of attitude. Table 3, the scores of attitude, showed that 267 (43.1%) of 619 respondents agreed to keep updated about COVID-19, 284 (45.9%) strongly agreed to be willing to learn more about COVID-19, 375 (60.6%) strongly agreed to be ready for strong supports and active cooperation in the prevention and control for COVID-19, 399 (64.5%) strongly agreed that the outbreak of COVID-19 deserved serious attention, 290 (46.8%) were fully aware of the designated hospitals in the living area, and 368 (59.5%) had full confidence in the government's interventional measures.

Scores of practice. The findings of Table 4, practice survey results, as reported by the participants, showed that 472 (76.3%) respondents always wore a mask when going out in a correct way; 351 (56.7%) always washed hands frequently and correctly; 420 (67.9%) always covered the nose and mouth with hands when sneezing or coughing; 469 (75.8%) always avoided meeting and gathering; 214 (34.6%) often took physical exercise; 271 (43.8%) often had a balanced and nutritious diet , with less or no consumption of wild animals; 427 (69.0%) always avoided contact with live poultry; 287 (46.4%) often got enough sleep; and 382 (61.7%) would always go to the designated hospital immediately for medical treatment in case of suspected symptoms.

Scores of cognition and behavior changes. The results of Table 5 revealed that 318 (51.4%) respondents had fairly changed cognition and behavior of the epidemic before and after the strict exit screening measures and public health level 1 response of 31 provinces from January 23, 2020 on; 286 (46.2%) respondents experienced fairly changed cognition and behavior of the epidemic before and after the upgraded measures from January 30, 2020 on.

Overall evaluation. The results of Figure 1 (Supplemental Appendix 2) showed that 367 (59.29%) of 619 respondents had very good knowledge, attitude, and behavior toward

TABLE 4
Scores of practice (N = 619)

Detailed questions about practice	Categories	*N*	%	M±SD
The frequency of the following behaviors after the outbreak				
Wear a mask when going out in a correct way	Never	2	0.3	4.7 ± 0.6
	Seldom	2	0.3	
	Sometimes	16	2.6	
	Often	127	20.5	
	Always	**472**	**76.3**	
Wash hands frequently and correctly	Never	2	0.3	4.5 ± 0.7
	Seldom	2	0.3	
	Sometimes	53	8.6	
	Often	211	34.1	
	Always	**351**	**56.7**	
Cover your nose and mouth with your hands when you sneeze or cough	Never	2	0.3	4.6 ± 0.6
	Seldom	3	0.5	
	Sometimes	26	4.2	
	Often	168	27.1	
	Always	**420**	**67.9**	
Avoid meeting and gathering	Never	2	0.3	4.7 ± 0.6
	Seldom	5	0.8	
	Sometimes	11	1.8	
	Often	132	21.3	
	Always	**469**	**75.8**	
Take physical exercise	Never	12	1.9	3.8 ± 1.0
	Seldom	40	6.5	
	Sometimes	185	29.9	
	Often	**214**	**34.6**	
	Always	168	27.1	
Have a balanced and nutritious diet , with less or no consumption of wild animals	Never	1	0.2	4.1 ± 0.8
	Seldom	12	1.9	
	Sometimes	117	18.9	
	Often	**271**	**43.8**	
	Always	218	35.2	
Avoid contact with live poultry	Never	3	0.5	4.6 ± 0.6
	Seldom	2	0.3	
	Sometimes	25	4.0	
	Often	162	26.2	
	Always	**427**	**69.0**	
Pay attention to household hygiene and disinfection	Never	1	0.2	4.3 ± 0.7
	Seldom	6	1.0	
	Sometimes	70	11.3	
	Often	255	41.2	
	Always	**287**	**46.4**	
Get enough sleep	Never	5	0.8	4.2 ± 0. 8
	Seldom	14	2.3	
	Sometimes	67	10.8	
	Often	**287**	**46.4**	
	Always	246	39.7	
Immediately go to the designated hospital for medical treatment in case of suspected symptoms	Never	5	0.8	4.5 ± 0.7
	Seldom	6	1.0	
	Sometimes	42	6.8	
	Often	184	29.7	
	Always	**382**	**61.7**	

Bold values represent the largest proportion in the corresponding part.

COVID-19, followed by 163 (26.33%) respondents with excellent, 79 (12.76%) good, six (0.97%) fair, and four (0.65%) poor.

Barrier. For those who did not reach the very good or excellent level (89 participants), the main reasons included limited knowledge (44, 49.4%), influenced by the surrounding population (36, 40.4%), limited or no access to COVID-19 information (31, 34.8%), and attaching little importance to the outbreak (29, 32.6%), as is shown in Table 6.

Score calculations and correlation. The calculated scores are summarized in Table 7. The mean scores for each scale were as follows: perceived knowledge (36.3 ± 6.1), attitude (29.4 ± 4.7), practice (44.1 ± 4.8), total score (109.7 ± 13.2), barrier (0.2 ± 0.7), and cognition and behavior change score (8.5 ± 1.4).

Based on Table 8, better perceived knowledge was significantly associated with better attitude (r = 0.8), practice (r = 0.5), total score (r = 0.9), cognition and behavior change score (r = 0. 3), and lower barrier score (r = –0.2). Better attitude was significantly associated with better practice (r = 0.5), better total score (r = 0.9), cognition and behavior change score (r = 0.3), and lower barrier score (r = –0.2). Better practice was significantly associated with better total score (r = 0.7), cognition and behavior change score (r = 0.3), and lower barrier score (r = –0.2). Better total score was significantly associated with better cognition and behavior change score (r = 0.4) and lower barrier score (r = –0.2). Better cognition and behavior change score was significantly associated with lower barrier score(r = –0.3).

TABLE 5
Scores of cognition and behavior changes (N = 619)

Detailed questions about cognition and behavior changes	Categories	N	%	M±SD
Changes in cognition and behavior of the epidemic before and after the strict exit screening measures and public health level 1 response of 31 provinces from January 23, 2020 on	Absolutely unchanged	0	0	4.2 ± 0.7
	Fairly unchanged	21	3.4	
	Neutral	48	7.8	
	Fairly changed	**318**	**51.4**	
	Absolutely changed	232	37.5	
Changes in cognition and behavior of the epidemic before and after the upgraded measures from January 30, 2020 on	Absolutely unchanged	1	0.2	4.3 ± 0.8
	Fairly unchanged	21	3.4	
	Neutral	46	7.4	
	Fairly changed	**286**	**46.2**	
	Absolutely changed	265	42.8	

Bold values represent the largest proportion in the corresponding part.

Bivariate analysis of factors associated with scores. The results of the bivariate analyses of factors associated with each score are shown in Table 9. A higher mean perceived knowledge score was associated with medical professionals and post-undergraduate degree, so was the attitude score and the total score. For the practice score, a higher mean practice score was associated with age < 18 years, living in city, medical professionals, and post-undergraduate degree. For the barrier score, a higher mean practice score was associated with male and farmers. A higher mean cognition and behavior change score was associated with company employees.

Multivariable linear regressions. Multivariable linear regressions took each scale score as the dependent variable and the sociodemographic characteristics as independent variables. Dummy variables were used non-dichotomously in the linear regressions. For age, > 60 years was set as the control group; for living district, village was set as the control group; for occupation, others was set as the control group; and for level of education, primary school or below was set as the control group.

Table 10, consisting of five linear regressions, summarized the factors associated with the same dependent variables, taking the sociodemographic variables as independent variables.

Linear regression 1, taking the perceived knowledge score as the dependent variable, showed that medical professionals (standardized beta 0.1), civil servants, employees of state-owned enterprises and public institutions, and company employees were associated with a higher perceived knowledge score. Junior college, undergraduate, and post-undergraduate (standardized beta 0.6) were associated with a higher perceived knowledge score.

Linear regression 2, taking the attitude score as the dependent variable, suggested that medical professionals (standardized beta 0.1), civil servants, employees of state-owned enterprises and public institutions, and company employees were associated with a higher attitude score. Senior high school/technical secondary school, junior college, undergraduate, and post-undergraduate (standardized beta 0.6) were associated with a higher attitude score.

Linear regression 3, taking the practice score as the dependent variable, indicated that age < 18, 18–30 (standardized beta 0.5), 31–40, 41–50, and 51–60 years were associated with a higher practice score. City and town (standardized beta 0.0) were associated with higher practice scores. Medical professionals, civil servants, employees of state-owned enterprises and public institutions, self-employed, retired staff (standardized beta 0.1), and students were associated with higher practice scores. Senior high school/technical secondary school, junior college (standardized beta 0.2), and undergraduate were associated with a higher practice score.

Linear regression 4, taking the total score as the dependent variable, indicated that medical professionals (standardized beta 0.1), civil servants, employees of state-owned enterprises and public institutions, company employees, and retired staff were associated with a higher total score. Senior high school/technical secondary school, junior college, undergraduate, and post-undergraduate (standardized beta 0.6) were associated with a higher total score.

Linear regression 5, taking the barrier score as the dependent variable, showed that males (standardized beta 0.2) and farmers (standardized beta 0.2) were associated with a higher barrier score.

Ways for obtaining information of COVID-19. The results of Supplemental Appendix 3 showed that the ways for obtaining information of COVID-19 included We-Chat and microblog (565, 28.3%); radio and television (451, 22.6%); family, friends, villagers, and community workers (415, 20.8%); websites (395, 19.8%); newspaper and periodicals (149, 7.5%); and others (19, 1.0%).

Expectation about government measures. The results of residents' expectation about government measures (Supplemental Appendix 4) showed that 234 participants (37.8%) believed the epidemic could be controlled in 2–3 months (excluding 3 months), and 160 participants (25.8%) believed the epidemic could be controlled in 3–4 months (excluding 4 months).

DISCUSSION

As suggested by the WHO, public cooperation is crucial in containing the spread of the outbreak and fighting against the pandemic calls for sustained efforts and constant vigilance.[17,18] Therefore, the evaluation of public awareness and behavior is of great importance. Our investigation involved the perceived knowledge, attitude, practice, cognition, and behavior changes; overall evaluation; barrier; expectation about the government interventions; and ways of obtaining information about COVID-19.

First, the results showed that the majority of respondents (74.8–88.0%) were fairly or very confident about the level of knowledge. As for the attitude scale, the majority of respondents (82.0–92.4%) agreed or strongly agreed to hold a positive attitude toward the COVID-19 pandemic. They held the

TABLE 6
Barriers

		Responses		
		N	Percent	Percent of cases
Barriers	S1. Limited knowledge	44	29.9	49.4
	S2. Attaching little importance to the outbreak	29	19.7	32.6
	S3. Limited or no access to COVID-19 information	31	21.1	34.8
	S4. Influenced by the surrounding population (family, friends, colleagues, classmates, etc.)	36	24.5	40.4
	S5. Others	7	4.8	7.9
Total		147	100.0	165.2

opinion that the outbreak deserved serious attention and had full confidence in the government's interventions. For the practice scale, there was also a majority of respondents (79.0–97.1%) reporting to be cautious in the prevention. Yet, there was a relatively low response rate of taking physical exercise (61.7%), probably due to the social distancing and household quarantine policy. For the scale of cognition and behavior changes, a majority of respondents (88.9%, 89.0%) had fair or absolute changes before and after the initial strict control measures and the upgraded measures; 85.6% respondents had excellent or very good overall evaluation toward COVID-19. The main reasons for barrier lay in limited knowledge (49.4%), influenced by the surrounding population(40.4%), limited or no access to COVID-19 information (34.8%), and attaching little importance to the outbreak (32.6%). The findings of a high knowledge, attitude, and practice rate of COVID-19 in Chinese residents were expected, because four-phase stringent measures were implemented by Chinese health authorities, starting on January 23, 2020.[8] Faced with the massive public health crisis, overwhelming news reports were delivered to the public by all kinds of media such as We-Chat, microblog, website, TV, and radio. According to the 45th China Statistical Report on Internet Development,[19] of the total population of 1.4 billion, the number of netizens in China has exceeded 900 million, with an average of 30.8 online hours per week, so most people could get timely access to the updates about the disease and had a clear understanding of the information. The series of measures included public health level 1 response of 31 provinces, strict exit screening, larger scale of cancellation of mass gatherings, postponing schools, social distancing, and spontaneous household quarantine by citizens. During the time of spontaneous household quarantine, instead of going out as usual, people stayed at home as much as possible in case of being infected, which may account for the relatively low response rate of taking physical exercise.

Moreover, our analyses revealed that perceived knowledge, attitude, practice, total score, and cognition and behavior changes were significantly and positively correlated, whereas barrier was negatively correlated with those scales. Higher perceived knowledge was proved to be significantly associated with positive attitude and behavior. These findings clearly demonstrated the importance of improving residents' knowledge of COVID-19 through health education, which may also lead to an improvement in their attitudes and practices toward COVID-19. Besides, our findings revealed that the main ways for obtaining information of COVID-19 included We-Chat and microblog; radio and television; family, friends, villagers, and community workers; and websites. This could be used as evidence for the publicity routes for the government. Furthermore, the study also showed that those respondents who were medical professionals, civil servants, employees of state-owned enterprises and public institutions, and had higher level of education were associated with a higher perceived knowledge score, attitude score, practice score and total score, whereas those who had a lower level of education were associated with a higher barrier score; this was particularly true for male farmers. This could be explained by the facts that highly educated people tend to seek information more intuitively and have a better understanding of knowledge, whereas those who are less educated are more likely to meet with difficulties in equipping themselves with up-to-date information. Therefore, it is urgent to carry out health education for people with low education background. This can be enlightening and exploited as useful evidence for the guidance for health education of epidemic—both nationwide publicity and focusing on the target undereducated population by means of We-Chat, microblog, website, community workers, and so on.

TABLE 7
Description of the generated scores

	Perceived knowledge score	Attitude score	Practice score	Total score	Barrier score	Cognition and behavior change score
Mean	36.3	29.4	44.1	109.7	0.2	8.5
Median	37.0	30.0	45.0	111.0	0.0	8.0
SD	6.2	4.7	4.8	13.2	0.7	1.4
Variance	37.7	21.8	22.7	174.2	0.5	2.0
Minimum	11.0	8.0	26.0	60.0	0.0	3.0
Maximum	45.0	35.0	50.0	130.0	4.0	10.0

TABLE 8
Pearson's correlation between each score

		Perceived knowledge score	Attitude score	Practice score	Total score	Barrier score	Cognition and behavior change score
Perceived knowledge score	r	1	0.8*	0.5*	0.9*	–0.2*	0.3*
	P-value	–	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
Attitude score	*R*	–	1	0.5*	0.9*	–0.2*	0.3*
	P-value	–	–	**<0.001**	**<0.001**	**<0.001**	**<0.001**
Practice score	r	–	–	1	0.7*	–0.2*	0.3*
	P-value	–	–	–	**<0.001**	**<0.001**	**<0.001**
Total score	r	–	–	–	1	–0.2*	0.4*
	P-value	–	–	–	–	**<0.001**	**<0.001**
Barrier score	r	–	–	–		1	–0.3*
	P-value	–	–	–	–	–	**<0.001**
Cognition and behavior	r	–	–	–	–	–	–
change score	*P*-value	–	–	–	–	–	–
	–	–	–	–	–	–	–

Bold values represent the largest proportion in the corresponding part.
* Correlation is significant at the 0.01 level (2-tailed).

What is more, it was interesting to identify that a higher mean cognition and behavior change score was associated with company employees. For this population, they were able to be well aware of the outbreak, but without the all-round publicity and initiative, they may not be supportive and spontaneously adherent to the desired health behaviors. The publicity of national prevention and control measures had the greatest impact on enterprise personnel. The second biggest impact was on the group of medical professionals, civil servants, and employees of state-owned enterprises and public institutions because they had the career awareness or professional literacy to fully understand the intervention policy

TABLE 9
Bivariate analysis of factors associated with scores

	Perceived knowledge score	Attitude score	Practice score	Total score	Barrier score	Cognition and behavior change score
Gender						
Male	35.9 ± 6.3	29.1 ± 4.7	44.2 ± 5.0	109.2 ± 13.7	0.3 ± 0.8	8.5 ± 1.4
Female	36.5 ± 6.0	29.5 ± 4.6	44.1 ± 4.6	110.1 ± 12.8	0.2 ± 0.6	8.5 ± 1.4
P-value	0.213	0.303	0.824	0.388	**0.022**	0.798
Age-group (years)						
< 18	35.7 ± 7.1	29.4 ± 4.7	45.3 ± 4.8	110. 5 ± 12.9	0.2 ± 0.8	8.6 ± 1.2
18–30	36.3 ± 6.0	29.4 ± 4.8	44.2 ± 4.5	109.8 ± 12.9	0.2 ± 0.6	8.5 ± 1.4
31–40	37.2 ± 6.4	29.5 ± 4.9	44.5 ± 5.3	111.2 ± 14.6	0.3 ± 0.8	8.2 ± 1.7
41–50	36.5 ± 5.7	30.0 ± 3.9	44.2 ± 4.9	110.7 ± 12.7	0.3 ± 0.8	8.6 ± 1.5
51–60	35.9 ± 6.8	28.6 ± 5.2	43.8 ± 5.0	108.2 ± 14.0	0.2 ± 0.7	8.8 ± 1.4
> 60	34.0 ± 6.2	27.6 ± 3.9	41.0 ± 5.7	102.7 ± 14.8	0.4 ± 0.9	7.9 ± 1.2
P-value	0.420	0.277	**0.025**	0.123	0.841	0.080
Living district						
City	36.6 ± 6.3	29.7 ± 4.9	44.9 ± 4.2	111.2 ± 13.2	0.2 ± 0.6	8.6 ± 1.5
Town	36.4 ± 6.1	29.3 ± 4.8	44.1 ± 4.8	109.7 ± 13.1	0.3 ± 0.8	8.4 ± 1.4
Village	35.9 ± 6.0	29.1 ± 4.4	43.5 ± 5.1	108.5 ± 13.2	0.2 ± 0.7	8.5 ± 1.3
P-value	0.403	0.477	**0.004**	0.084	0.186	0.407
Occupation						
Medical professionals	40.3 ± 5.8	31.6 ± 4.6	46.6 ± 3.4	118. 5 ± 11.1	0.1 ± 0.4	8.8 ± 1.3
Civil servants/employees of state-owned enterprises/public institutions	37.1 ± 5.3	30.4 ± 4.1	44.8 ± 3.9	112.3 ± 11.3	0.2 ± 0.8	8.8 ± 1.5
Company employees	37.5 ± 5.3	30.2 ± 4.2	44.5 ± 4.5	112.2 ± 12.5	0.1 ± 0.4	8.8 ± 1.3
Workers	34.8 ± 5.7	28.5 ± 4.8	43.1 ± 4.2	106.4 ± 12.2	0.3 ± 0.8	8.3 ± 1.5
Farmers	33.7 ± 7.0	27.5 ± 5.0	40.9 ± 6.5	102.0 ± 16.0	0.6 ± 1.0	8.0 ± 1.7
Self-employed	35.2 ± 6.5	28.8 ± 5.1	43.6 ± 5.1	107.7 ± 14.8	0.2 ± 0.7	8.6 ± 1.5
Retired staff	35.8 ± 6.9	28.5 ± 5.4	44.2 ± 4.2	108.5 ± 13.5	0.3 ± 0.9	8.5 ± 1.5
Students	36.2 ± 6.0	29.3 ± 4.4	44.3 ± 4.6	109.8 ± 12.3	0.2 ± 0.6	8.4 ± 1.3
Others	35.2 ± 6.6	28.9 ± 5.2	44.5 ± 4.8	108.5 ± 12.6	0.1 ± 0.3	8.5 ± 1.2
P-value	**< 0.001**	**0.001**	**< 0.001**	**< 0.001**	**0.026**	**0.037**
Level of education						
Primary school or below	32.3 ± 5. 7	27.8 ± 4.2	40.8 ± 6.0	101.0 ± 13.7	0.2 ± 0.6	8.0 ± 1.5
Junior high school	34.8 ± 6.2	29.1 ± 4.1	43.0 ± 5.9	106.9 ± 13.8	0.3 ± 0.7	8.5 ± 1.5
Senior high school/technical secondary school	36.4 ± 5.8	28.9 ± 4.5	43.8 ± 4.7	109.1 ± 12.2	0.2 ± 0.7	8.8 ± 1.1
Junior college	35.7 ± 6.7	29.1 ± 5.0	44.3 ± 4.5	109.1 ± 13.4	0.3 ± 0.8	8.4 ± 1.3
Undergraduate	37.0 ± 5.6	29.6 ± 4.6	44.4 ± 4.4	111.0 ± 12.6	0.2 ± 0.7	8.5 ± 1.5
Post-undergraduate	39.0 ± 6.9	31.8 ± 5.5	47.0 ± 3.4	117.8 ± 13.1	0.0 ± 0.2	9.0 ± 1.0
P-value	**< 0.001**	**0.049**	**< 0.001**	**< 0.001**	0.590	0.104

Student's *t*-test was used to compare between two groups; the ANOVA test was used to compare between three or more groups. Bold values represent the largest proportion in the corresponding part.

TABLE 10
Multivariable analyses: linear regressions

Variable	Unstandardized beta	Standardized beta	*P*-value	CI	
Linear regression 1 taking the perceived knowledge score as the dependent variable					
Medical professionals	18.3	0.1	< 0.001	15.5	21.1
Civil servants, and employees of state-owned enterprises and public institutions	7.5	0.0	< 0.001	5.4	9.7
Company employees	3.6	0.0	0.001	1.5	5.7
Junior college	33.2	0.3	< 0.001	30.9	35.4
Undergraduate	32.4	0.5	< 0.001	30.8	34.0
Post-undergraduate	31.9	0.6	< 0.001	30.4	33.4
Linear regression 2 taking the attitude score as the dependent variable					
Medical professionals	13.9	0.2	< 0.001	11.6	16.1
Civil servants, and employees of state-owned enterprises and public institutions	6.6	0.1	< 0.001	4.8	8.3
Company employees	2.7	0.0	0.002	1.0	4.4
Senior high school/technical secondary school	27.2	0.3	< 0.001	25.1	29.3
Junior college	26.7	0.3	< 0.001	24.6	28.2
Undergraduate	26.5	0.5	< 0.001	25.2	27.7
Post-undergraduate	25.4	0.6	< 0.001	24.2	26.6
Linear regression 3 taking the practice score as the dependent variable					
< 18	27.6	0.2	< 0.001	24.4	30.7
18 to 30	26.6	0.5	< 0.001	24.2	29.0
31 to 40	25.6	0.2	< 0.001	22.7	28.5
41 to 50	24.8	0.2	< 0.001	22.0	27.6
51 to 60	16.8	0.1	< 0.001	13.9	19.6
City	1.7	0.0	0.008	0.4	2.9
Town	2.0	0.0	0.003	0.7	3.3
Medical professionals	10.7	0.1	< 0.001	8.3	13.0
Civil servants, and employees of state-owned enterprises and public institutions	4.5	0.0	< 0.001	2.8	6.3
Self-employed	2.9	0.0	0.002	1.0	4.8
Retired staff	17.3	0.1	< 0.001	14.4	20.1
Students	7.5	0.0	< 0.001	5.3	9.6
Senior high school/technical secondary school	20.5	0.1	< 0.001	17.2	23.9
Junior college	16.1	0.2	< 0.001	13.6	18.6
Undergraduate	17.2	0.1	< 0.001	14.2	20.1
Linear regression 4 taking the total score as the dependent variable					
Medical professionals	54.9	0.1	< 0.001	47.5	62.3
Civil servants, and employees of state-owned enterprises and public institutions	24.3	0.1	< 0.001	18.4	30.2
Company employees	10.2	0.0	< 0.001	4.5	15.9
Retired staff	7.5	0.0	0.022	1.1	14.0
Senior high school/technical secondary school	103.5	0.3	< 0.001	96.6	110.3
Junior college	104.4	0.4	< 0.001	98.7	110.1
Undergraduate	103.9	0.5	< 0.001	100.1	107.6
Post-undergraduate	100.1	0.6	< 0.001	96.7	103.5
Linear regression 5 taking the barrier score as the dependent variable					
Male	0.1	0.2	< 0.001	0.0	0.1
Farmers	0.4	0.2	< 0.001	0.2	0.6

and promote policy implementation by positive cooperation. The slightest impact was on the group of workers and farmers; the restricted level of knowledge hindered them from having a comprehensive understanding of the outbreak, even with the national publicity, so they had the lowest mean score of cognition and behavior change, suggesting further improvements on more effective measures for target population.

Last, more than half of the respondents(51.4%) were optimistic about the government's prevention and control measures, believing the epidemic could be brought under control in 3 months (before 18 June). Based on the data from the National Health Commission of the People's Republic of China,[20–23] from March 24, 2020 on, there were only occasional domestic new confirmed cases, indicating the plateaued situation of the epidemic and the shift of focusing on preventing the importing of exogenous cases. It turned out that the respondents' expectations were in line with the actual situation of epidemic control in China, which proved the effectiveness of government publicity and interventions.

Limited researches of knowledge, attitude, and practice investigation have been published,[24–26] whose results were in accordance with the current study; that was, Chinese residents tended to have good knowledge, positive attitude, and supportive behavior during the outbreak of COVID-19. However, some different opinions existed in another cross-sectional survey, which believed that the finding of a high correct rate of COVID-19 knowledge in Chinese residents was unexpected. That study was conducted from January 27 to February 1, the week immediately after the lockdown of Hubei Province when the public were still on the way of having a full picture of the virus. The positive results in the very early stage of the outbreak may be related to the immediate interventions. It was also interesting to find that the investigations of foreign countries like Pakistan[27] and Nigeria[28] also showed an overall good result of knowledge,

attitude, and practice, except that 52.1% of the respondents perceived that the government was not doing enough to curtail COVID-19 in Nigeria.[27]

The strength of this study lies in bringing in the cognition and behavior changes, overall evaluation, barrier, and expectations about the government interventions. By identifying the most beneficial group of publicity and the reasons for barrier, more target policies can be established and more scientific approaches can be adopted to facilitate the epidemic control. However, there are certain limitations to the study. First, although the sample size is enough for statistical analyses to be carried out, the results could have been more representative if a larger sample had been recruited for the cross-sectional survey. Although the number of netizens reaches more than 900 million, there are still a group of people who do not have access to or use social media, which restricts the coverage of the research. Because of the limited sample representativeness, we must be cautious when interpreting the findings of the research, and further study is needed to resolve the issue. Second, the relatively low response rates, the absence of validation of these surveys due to the special case of COVID-19, and the large number of statistical analyses may lead to a potential result bias; however, we have tried our best to enhance the study reliability and validity to make sure high quality data were obtained, and we are ready to make improvements in the future studies.

CONCLUSION

In summary, our findings suggest that the respondents in China had good knowledge, attitude, and practice toward COVID-19; however, it is advisable to both strengthen nationwide publicity and focus on the target undereducated population by means of WeChat, microblog, website, community workers, and so on.

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Authors' addresses: Yaqing Fang, Panpan Liu, and Qisheng Gao, School of Public Health, Hangzhou Medical College, Hangzhou, China, E-mails: colourwind1035@126.com, 165272885@qq.com, and 281133802@qq.com.

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