Knowledge, beliefs/attitudes and practices of rural residents in the prevention and control of COVID-19: An online questionnaire survey

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Research article

Keywords: COVID-19, Knowledge, Belief/attitude, Practice/behavior, Rural residents, Survey

Posted Date: April 20th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-22257/v1

Abstract

Background: The outbreak of COVID-19 in Wuhan quickly spread to 34 provinces, municipalities and autonomous regions in the country and 184 countries and regions around the world. It has drawn great attention from the International Health Organization and was declared an international public health emergency on January 31, 2020. Because the population is generally susceptible to the virus, there are no effective drugs and vaccines, and active participation of the entire population in self-protection and self-isolation has become the key to cutting off transmission routes and effectively controlling the epidemic. China has vast land and a vast area with a large population. Although the agricultural population has decreased this year with the acceleration of urbanization, according to national demographics, 40% of China's rural population is still living in remote areas. This population is relatively lacking in material and economic conditions and has limited access to medical services and education. Influencing factors such as traditional health habits and consciousness should not be underestimated in rural areas. In addition, the COVID-19 outbreak coincided with the Chinese New Year, and people's return and post-holiday resumption of work greatly increased the chance of transmission of the virus. Rural residents accounted for 60% of the people returning to the Spring Festival. They are the most mobile and susceptible group and are at high risk of viral transmission. The knowledge, consciousness, attitude and behavior of rural residents with regard to COVID-19 control are related to the success or failure of epidemic prevention and control. To investigate the knowledge, attitudes and behaviors related to the prevention and control of COVID-19 among rural residents, to analyze the influencing factors, difficulties and challenges of prevention and control in this population, and to develop a plan to improve rural residents' awareness of COVID-19 prevention and control. Targeted interventions for prevention and control capabilities provide scientific evidence.

Methods: A self-designed questionnaire to assess residents' knowledge, attitudes and behaviors related to COVID-19 prevention and control was borrowed from the Questionnaire Star service platform, and snowball sampling was used to invite rural residents to complete the questionnaire on WeChat. Data analysis was performed with SPSS 22.0 statistical software.

Results: A total of 554 valid questionnaires were collected. Rural residents' average score of knowledge about the prevention and control of new coronary pneumonia was 39.75 ± 6.703, the average score of prevention and control attitude was 45.40 ± 3.341, and the average score of prevention and control behavior was 104.69 ± 12.167. Multiple linear regression analysis showed that male residents' scores for knowledge, attitudes and behaviors related to SARS were significantly higher than those of women who had not experienced SARS ($P < 0.01$); the scores of attitudes and behaviors of rural residents aged 30 and under were significantly higher than those of other age groups ($P < 0.01$) 0.01); residents with an education level of junior high school or below and those who worked as farmers had significantly lower scores in knowledge, attitude, and behavior than those with other education levels ($P < 0.05$); the knowledge and behavior scores of respondents with poor family economic conditions were significantly lower than those with good and moderate family economic conditions ($P < 0.05$); and residents with chronic diseases and those living in areas with confirmed cases had significantly higher knowledge and behavior scores than those without chronic diseases and no or unknown living cases ($P < 0.05$). Rural residents' scores for knowledge and attitudes, attitudes and behaviors, and knowledge and behavior were positively correlated with new coronary pneumonia control ($P < 0.05$). The difficulties and challenges they perceived during the epidemic were a lack of protective equipment and travel difficulties (lack of transportation) and weak awareness of prevention and control.

Conclusions: Rural residents have a good grasp of COVID-19 and a positive attitude toward the need for prevention and control by individuals, communities, and the government during the epidemic. They use common chopsticks or split meals and take Chinese herbal medicines that nourish yin, invigorate the spleen, and nourish the lungs. Protective measures such as cleaning furniture with alcohol or chlorine disinfectant, returning home, and handwashing with soap before and after meals and after contact with pollutants need to be further strengthened. A lack of protective materials and weak awareness of prevention and control are the greatest difficulties and challenges experienced by rural residents during the epidemic.

Trial registration:"Not applicable" in this section

Background

Since the outbreak of coronavirus disease-2019 (COVID-19) in Wuhan, China, in December 2019, it has spread rapidly to 34 provinces, municipalities and autonomous regions in China and 184 countries around the world and is spreading at an increasingly faster rate. As of March 29, 2020, the cumulative number of reported confirmed cases of COVID-19 in China exceeded 82,419, and the cumulative number of confirmed cases overseas was 59,6612 [1]. The WHO declared the virus an international public health emergency on January 31 [2]. People are generally susceptible to the virus, and there are no effective drugs or vaccines. Controlling the source of infection and cutting off the transmission route have become the only reliable and directly effective epidemic control measures. Whether transmission can be blocked depends on the active participation of the people, high levels of self-discipline and effective adoption of self-defense behavior. According to the China Demographic Network, China has 564,010,000 rural residents, accounting for 40.42% of the total population. Rural residents have the characteristics of relatively scattered living areas, limited social connections, and a lack of medical resources. Furthermore, the outbreak of COVID-19 and the epidemic peaked during the return and resumption of work during and after the Spring Festival, and rural residents account for the largest number of people returning to the Spring Festival. Rural residents constitute the largest mobile population at 60%, which greatly increases their susceptibility to disease and the risk of infection. Rural areas have become an important battlefield for epidemic prevention and control after residents return home [3]. At the same time, compared with urban residents, rural residents have a lower education level and relatively weak awareness of disease prevention and control; due to their remote residence and poor economic conditions, the availability of protective materials, protective facilities, health education, and medical services is lower than that of cities. Furthermore, there is a large gap between residents. These factors have greatly increased the difficulty of preventing and controlling epidemics in rural areas. To this end, this study uses an online survey to understand rural residents' knowledge, attitudes, behaviors, and other factors related to COVID-19 prevention and control as well as the difficulties and challenges they experience in the process of self-protection. Targeted intervention measures for the prevention and control of the COVID-19 virus in residents provide a scientific basis.

Objective

To investigate the knowledge, attitudes and behaviors related to the prevention and control of COVID-19 among rural residents, to analyze the influencing factors, difficulties and challenges of prevention and control in this population, and to develop a plan to improve rural residents' awareness of COVID-19 prevention and control. Targeted interventions for prevention and control capabilities provide scientific evidence.

Methods

Survey tools

(1) General information questionnaire: gender, age, education level, marital status, whether you have experienced SARS, etc.

(2) Questionnaire on Knowledge, Attitude and Behavior of COVID-19: Based on the "Knowledge, Attitude/Belief, and Practice" (KAP) model, with reference to the COVID-19 Prevention and Control Guidelines issued by the World Health Organization, the Chinese Health Commission, and the Centers for Disease Control and Prevention, as well as the prevention and control knowledge of official public platforms Popular education documents and related research literatures [4-6] are designed by themselves, including three sections of knowledge, attitudes and behaviors. The knowledge content includes 11 aspects, namely the classification of infectious diseases, the source of infection, the transmission route, the transmission rate, the susceptible population, the incubation period, the close contacts, the main symptoms, the medical observation time, the nearby designated treatment hospitals, and effective prevention and control measures, a total of 34 items; sources of knowledge: including WeChat, online news, television, etc. Prevention/control/attitude: There are 5 items, including 13 aspects: including awareness of the necessity of prevention and control, perception of the possibility of being infected, willingness to take prevention and control measures, attitude towards eating wild animals, and legislation on prohibiting the eating of wild animals, yielding 5 aspects in total. Each item was rated on a 4-point likert scale, and the total score ranged from 13-52 points. Practice of prevention and control, such as daily living hygiene, diet, exercise, and sleep behavior, yielding a total of 27 items. Except for 2 dichotomous items, other items were rated on a 5-point likert scale, and the total score ranged from 54-121 points. Open-ended question: what difficulties and challenges are you encountered in the prevention and control of the epidemic?

The Questionnaire Star (https://www.wjx.cn/) online survey platform was utilized to record the questionnaire, forming an online questionnaire. The questionnaire covered the following eight aspects.

Survey methods and objects

From February 5th to February 13th, 2020, the epidemic is rising. Based on the questionnaire star service platform, using descriptive research and snowball sampling methods to invite rural residents to participate in the survey, residents use mobile phone WeChat to fill in online. The survey involved a total of 12 basic information, 76 questionnaire items, 18 dimensions, and 30 variables for statistical analysis. According to the Kendall sample estimation method of multivariate analysis, the number of samples required should be 10-20 times the number of variables [7]. The minimum sample size for this survey was calculated to be 300-600. The subjects invited to participate in the survey are rural residents over 14 years of age, living in rural areas during the survey period will voluntarily participate after informed consent. A total of 554 online questionnaires were collected.

Data analysis

The SPSS software (version 25.0; SPSS Inc., Chicago, IL, USA) was used for statistical analysis in this study. Continuous variables were described as means with standard deviations (SD), whereas categorical variables were presented as frequencies with percentages. The item scoring rate and the total scoring rate for Knowledge, Attitude/Belief, and Practice were calculated by dividing the actual score of a item or total items by the total item/items score and multiplying by 100%. Two independent samples t-tests or one way analysis of variance (ANOVA) were conducted to evaluate the differences among respondents with different social demographic characteristics. Pearson correlation analysis was carried out to examine the relationships among knowledge, belief/attitude and practice. The statistically significant variables identified in univariate analysis, and those professionally considered as the significant factors, were screened as the independent variables, which were incorporated into the multivariate linear regression analysis equation to further clarify the influencing factors of knowledge, belief/attitude and practice. A difference of $P < 0.05$ was considered as statistically significant (two-tailed).

Results

Characteristics of respondents

A total of 559 questionnaires were recovered in this survey, 5 invalid questionnaires were eliminated, and 554 valid questionnaires were collected. The effective questionnaire recovery rate was 99.10%. The basic characteristics of the respondents are shown in Table 4.

Knowledge, attitude and behavioral scores of rural residents with regard to COVID-19

The overall average knowledge score was 39.75 ± 6.703, the total scoring rate was 65.5%, the highest item scoring rate was 87.2% (close observer observation time), and the lowest was 16.2% (spread rate). The overall belief/attitude score was 45.40 ± 3.341, the total score was 84.7%, the highest score was 98.9% (the need for personal and community protection to control the epidemic), and the lowest was 78.3% (the awareness of the possibility of being infected). The average behavior score was 104.69 ± 12.167, the total scoring rate was 65.3%, the highest item score was 97.3% (wear a mask when going out), and the lowest was 14.8% (eating with chopsticks or eating at different meals). The results are shown in Tables 1-3.

Table 1 Scores of residents' knowledge on prevention and control of COVID-19 (N=554).

Dimension	Item type	Number of items	Item	Score range	Lowest score	Highest score	$\bar{x}\pm sd$	Scoring rate (%)
Incubation period	Fill in blank	1		0-1	0	1	0.86±0.347	85.9
Source of infection	Multiple choice	1		0-3	1	3	2.78±0.514	83.0
Route of transmission	Multiple choice	1		0-3	1	3	2.76±0.503	79.1
Medical observation time	Fill in blank	1		0-1	0	1	0.87±0.335	87.2
Close contact	Multiple choice	1		0-3	1	3	2.51±0.732	65.0
Major symptom	Multiple choice	1		0-5	1	5	4.61±1.041	89.1
Nearby designated hospital	Single choice (don't know, partly know, know)	1		0-2	0	2	1.36±0.479	78.1
Susceptible people	Multiple choice	1		0-5	1	5	3.44±1.410	54.6
Classification of infectious disease	Fill in blank	1		0-1	0	1	0.45±0.498	45.3
Transmission rate and doubling time	Fill in blank	2		0-2	0	2	0.72±0.726	16.2
Prevention and control measures	Multiple choice	27		0-24	1	24	20.85±4.716	76.4
			Wear masks when going out	0-1	0	1	0.99±0.095	99.1
			Avoid going to crowded places	0-1	0	1	0.98±0.152	97.7
			Not attend party/gathering	0-1	0	1	0.98±0.146	97.8
			Avoid going out	0-1	0	1	0.98±0.152	97.7
			Wash hands while going back home, before meals, after using the toilet, or contacting with dirty and contaminated items	0-1	0	1	0.94±0.244	94.8
			Open window to improve air circulation	0-1	0	1	0.95±0227	93.7
			Not eat wild animals	0-1	0	1	0.93±0.253	93.1
			Avoid taking public transportation	0-1	0	1	0.92±0.276	91.7
			Isolate at home and see doctor if have contact history or symptoms	0-1	0	1	0.90±0.299	90.1
			Cover nose and mouth when cough or sneeze	0-1	0	1	0.91±0.289	90.8
			Use disposable paper napkin for access to public facilities such as elevator buttons, and door handles	0-1	0	1	0.87±0.333	95.0
			Avoid going to live poultry market	0-1	0	1	0.86±0.350	85.7
			Take balanced nutrition diet	0-1	0	1	0.82±0.385	81.9
			Keep a good sleep	0-1	0	1	0.82±0.388	81.6
			Use serving chopsticks or separate meals	0-1	0	1	0.83±0.372	83.4
			Drink more water	0-1	0	1	0.87±0.341	86.6
			Take temperature	0-1	0	1	0.90±0.306	89.5
			Keep a good mood	0-1	0	1	0.77±0.418	77.4
			Hang the worn clothes on the balcony or other ventilated place	0-1	0	1	0.82±0.383	82.1
			Sterilize exposed parts and clothing with alcohol or chlorine-containing disinfectant when returning home	0-1	0	1	0.87±0.341	86.6
			Wipe furniture surface and household things with alcohol or chlorine-containing disinfectant	0-1	0	1	0.86±0.352	85.6
			Wear warm to prevent catching a cold	0-1	0	1	0.75±0.434	74.9
			Exercise, such as running on treadmill, indoor yoga, and tai chi	0-1	0	1	0.78±0.412	78.3
			Take Chinese herbal medicines for nourishing yin, nourishing vitality, tonifying spleen, and moistening lung	0-1	0	1	0.57±0.495	57.2
Total				0-49	14	48	39.75±6.703	65.2

Table 2 Scores of residents' belief/attitude on prevention and control of COVID-19 (N=554).

Dimension	Item type	Number of items	Item	Score range	Lowest score	Highest score	$\bar{x}\pm sd$	Scoring rate(%)
Necessity of prevention and control	4-point Likert Scale (unnecessary, somewhat necessary, necessary, very necessary)	3	Necessity of personal protection on epidemic control	1-4	1	4	3.89±0.360	98.9
			Necessity of community protection on epidemic control	1-4	1	4	387±0.377	98.9
			Necessity of government decision on epidemic control	1-4	1	4	3.84±0.449	97.9
Possibility of being infected	4-point Likert Scale (impossible, somewhat possible, possible, very possible)	2	Possibility of family members being infected	1-4	1	4	3.15±0.931	78.3
			Possibility of being infected	1-4	1	4	3.18±0.886	79.7
Willingness to take prevention and control measures	4-point Likert Scale (unwilling, somewhat willing, willing, very willing)	6	If you have a history of living or traveling in Wuhan, or have a history of close contact with an infected person, take the initiative to report and isolate at home	1-4	1	4	3.71±0.516	97.8
			If your family member has a history of living or traveling in Wuhan, or have a history of close contact with an infected person, persuade them to take the initiative to report and isolate at home	1-4	1	4	3.69±0.502	98.4
			If your family members have suspected symptoms such as fever and cough, persuade them to take the initiative to isolate themselves and go to see doctor in fever clinic	1-4	1	4	3.69±0.502	98.4
			If you have suspected symptoms such as fever and cough, take the initiative to isolate at home and go to see doctor in fever clinic	1-4	1	4	3.69±0.502	98.4
			Even if it may affect my work and daily life, I will cooperate with the government and community for epidemic prevention and control	1-4	1	4	3.62±0.569	96.4
			Even if it may affect my work and daily life, I will carry out self-protection measures	1-4	2	4	3.61±0.577	96.7
Attitude towards eating wild animals	Single choice (I will take the initiative to buy and eat; I will not take the initiative to buy but eat if others have prepared; I will not eat but not oppose others to eat; I will not eat and also oppose others to eat)	1		1-4	2	4	3.91±0.329	98.6
Attitude towards legislation to prohibit the eating of wild animals	4-point Likert Scale(disagree, somewhat agree, agree, very agree)	1		1-4	1	4	3.79±0.557	97.1
Total				13-52	26	50	45.40±3.341	84.7

Table 3 Scores of residents' practice on prevention and control of COVID-19 (N=554).

Item type	Item	Score range	Lowest score	Highest score	$\bar{x}\pm sd$	Scoring rate (%)
4-point Likert Scale (never/not applicable, sometimes, often, always)	1. Wear masks when going out	1-5	1	5	4.77±0.521	97.3
	1. Not eat wild animals	1-5	1	5	4.48±1.091	86.3
	1. Avoid going to live poultry market	1-5	1	5	4.43±1.087	85.0
	1. Cover nose and mouth when cough or sneeze	1-5	1	5	4.56±0.782	92.2
	1. Wash hands while going back home, before meals, after using the toilet, or contacting with dirty and contaminated items	1-5	1	5	4.58±0.676	92.9
	1. Open window to improve air circulation	1-5	1	5	4.55±0.685	91.9
	1. Wear warm to prevent catching a cold	1-5	1	5	4.56±0.637	94.1
	1. Avoid going out	1-5	1	5	4.58±0.752	90.2
	1. Watch yourself and your family for symptoms such as fever and cough	1-5	1	5	4.59±0.639	94.3
	1. Not attend party/gathering	1-5	1	5	4.58±0.752	90.2
	1. Pay close attention to government and community reports on the epidemic and the living trajectory of infected people	1-5	1	5	4.52±0.714	91.2
	1. Avoid going to crowded places	1-5	1	5	4.37±1.139	83.2
	1. Avoid taking public transportation	1-5	1	5	4.34±1.151	82.3
	1. Take balanced nutrition diet	1-5	1	5	4.53±0.724	91.6
	1. Drink more water	1-5	1	5	4.55±0.682	91.9
	1. Keep a good mood	1-5	1	5	4.59±0.639	94.3
	1. Keep a good sleep	1-5	1	5	4.40±0.772	87.1
	1. Use disposable paper napkin for access to public facilities such as elevator buttons and door handles	1-5	1	5	4.41±1.197	76.4
	1. Hang the worn clothes on the balcony or other ventilated place	1-5	1	5	4.22±0.972	77.4
	1. Take temperature	1-5	1	5	4.26±0.913	77.6
	1. Sterilize exposed parts and clothing with alcohol or chlorine-containing disinfectant when returning home	1-5	1	5	3.26±1.074	69.3
	1. Use serving chopsticks or separate meals	1-5	1	5	2.04±1.225	14.8
	1. Exercise, such as running on treadmill, indoor yoga and tai chi	1-5	1	5	4.00±1.093	64.9
	1. Wipe furniture surface and household things with alcohol or chlorine-containing disinfectant	1-5	1	5	4.94±1.165	66.2
	1. Take Chinese herbal medicines for nourishing yin, nourishing vitality, tonifying spleen, and moistening lung	1-5	1	5	3.47±1.339	47.5
Single choice (no/not applicable, yes)	1. Review whether you have been to the epidemic area (like Hubei Province of China) during the epidemic, or have contact with infected people	0-1	0	1	0.92±0.279	91.5
	1. Isolate at home and seek medical care when you have exposure or symptoms such as fever and cough.	0-1	0	1	0.80±0.403	79.6
Total		25-127	54	121	91.69±12.167	65.3

Univariate and multivariate analyses of factors related to knowledge, belief/attitude, and practice scores

According to the results of two independent-sample t-tests and one-way analysis of variance, there were significant differences in the knowledge scores between respondents with different genders, education levels, occupations, family economic levels, incidence of chronic diseases, presence or absence of confirmed cases in their residential villages, and experienced of SARS. There were significant differences in the attitude scores between respondents with different genders, ages, education levels, occupations, and experience of SARS. There were significant differences in the behavioral scores between respondents with different genders, ages, education levels, occupations, family economic levels, incidence of chronic diseases, presence or absence of confirmed cases in their villages and towns, and experience of SARS.

Correlation analysis showed that the scores of knowledge, attitude, and behavior were positively correlated, and the correlation between attitude and behavior was the strongest (correlation coefficient r = 0.423) (P <0.001). The results are shown in Table 4.

Table 4 Univariate and multivariate analyses of factors associated with residents' knowledge, belief/attitude, and practice scores in prevention and control of COVID-19 (N=554).

Variable		n (%)	Knowledge $\bar{x}\pm sd$	*t/F*	*P*	*B*	Belief/attitude $\bar{x}\pm sd$	*t/F*	*P*	*B*	Practice $\bar{x}\pm sd$	*t/F*
Gender	Female	342 (61.7)	38.58±7.316	10.703	0.001^{**}	0.138	44.86±4.064	8.979	0.003^{**}	0.127	101.96±14.298	17.76
	Male	199 (21.7)	40.48±6.194				45.73±2.755				106.38±10.300	
Age (years)	≤30	339 (61.2)	39.70±6.616	2.485	0.015		45.73±3.137	5.898	0.015^{*}	-0.103	104.29±12.479	6.584
	31-45	312 (33.9)	41.31±5.668				45.84±3.160				101.40±14.366	
	≥46	165 (18.0)	37.19±7.957				44.11±4.167				104.66±12.266	
Nationality	Han	529 (95.5)	39.67±6.786	1.650	0.200		45.40±3.363	0.003	0.956		104.66±12.266	0.061
	Others	25 (4.5)	46.86±4.388				45.44±2.887				105.28±10.022	
Education level	Undergraduate or associate degree	79 (14.3)	41.16±5.484	22.661	0.000^{***}	0.199	46.11±2.898	4.048	0.046^{*}	-0.085	106.99±11.935	8.913
	Senior high school or Vocational degree	232 (41.9)	39.40±7.010				45.06±4.179				105.07±14.541	
	junior school and below	243 (43.8)	37.53±8.186				44.83±3.319				102.35±11.113	
Marital status	Married	241 (43.5)	40.08±6.775	1.002	0.317		45.36±3.526	0.047	0.829		104.08.±13.121	1.058
	Unmarried/Divorced/Widowed	313 (56.5)	39.50±6.648				45.43±3196				105.15±11.377	
Occupation	farmer	125 (22.5)	37.76±7.570	-3.834	0.000^{***}	-0.161	44.80±4.352	-2.276	0.023^{*}	-0.096	101.77±14.799	-3.069
	Enterprise workers	153 (27.6)	42.04±4.771				45.96±2.682				106.77±10.631	
	student	239(43.1)	39.12±6.935				45.28±3.153				104.85±11.377	
	Others	37 (3.0)	45.86±2.689				45.86±2.689				104.89±11.770	
Family economic level	Good	15 (2.7)	42.00±4.855	9.227	0.002^{**}	-0.128	46.53±2.099	1.282	0.258		105.00±11.148	6.188
	Medium	377 (68.1)	40.20±6.554				45.43±3.323				105.60±11.731	
	Poor	162 (29.2)	38.50±7.030				45.23±3.466				104.69±12.167	
With chronic disease or not	No	535 (96.6)	39.64±6.765	4.333	0.038^{*}	0.088	45.40±3.292	0.014	0.907		104.39±1.151	9.672
	Yes	19 (3.4)	42.89±3446				45.31±4.619				113.15±9.406	
With confirmed cases in your residential area or not	No	400 (72.2)	37.77±7.619	7.689	0.006^{**}	0.117	45.44±3.323	0.934	0.334		99.14±13.275	17.07
	Yes	69 (12.5)	41.84±4.689				45.76±3.010				110.27±9.897	
	Unknown	85 (15.3)	39.82±6.687				44.90±3.650				104.91±11.806	
Have been to the epidemic area (like Hubei Province of China) or not	No	547 (98.7)	40.50±4.806	0.447	0.505		45.33±2.422	0.135	0.893		102.00±11.489	0.496
	Yes	7 (1.3)	41.77±4.88				45.49±2.836				105.12±10.710	
Have experienced SARS or not	No	452 (81.6)	40.16±6.777	-3.238	0.001^{**}	-0.137	45.56±3.271	-2.351	0.019	-0.100	105.37±12.045	-2.736
	Yes	102 (18.4)	37.98±6.090				44.70±3.563				101.75±12.310	
Knowledge										0.208^{***}		
Belief/attitude												
Variable		n (%)	Knowledge				Belief/attitude				Practice	

Variable code: for **gender**: 1 = male, 0 = female; for **age**: 1 = 30 years and below, 2 = 31-45 years, 3 =45 years and above; for **education level**: 1 =junior high school and below, 2 = high school and technical secondary school, 3 = graduate/ undergraduate or associate degree; for **marital status**: 0 = unmarried/divorced/widowed, 1 = married; for **occupation**: farmer=(0,0,0,0)enterprise worker =(0,1,0,0)student= (0,0,1,0), others (self-employed/freelance/grass-roots medical worker and solider) =(0,0,0,1); for **family economic level**: 1 = good, 2 = medium, 3 = poor; for **have chronic disease or not**: 0= no, 1 = yes; for with **confirmed cases** in your residential village and town or not:no=(0,0), yes=(1,0), unknown=(0,1); for have been to **epidemic area** (like Hubei Province of China) or no: 1 = yes, 0 = no; for **have experienced SARS** or not: 1 = yes, 0 = no.

$^{*}P<0.05$, $^{**}P<0.01$, $^{***}P<0.001$.

Multiple linear regression analysis showed that the scores of knowledge, attitudes, and behaviors of males and residents who had experienced SARS were significantly higher than those of females and residents who had not experienced SARS (P <0.01); the attitudes and behaviors of rural residents aged 30 and under were significantly higher than those of residents of other ages (P <0.01); residents with an education level of junior high school or below and occupations as farmers had significantly lower scores in knowledge, attitude, and behavior than those with high school/secondary school, college or higher education (P <0.05); the knowledge and behavior scores of families with poor economic conditions were significantly lower than those with good and moderate family economic conditions (P <0.05); and residents with chronic diseases and those living in areas with confirmed cases had significantly higher knowledge and behavior scores than those without chronic diseases and no or unknown confirmed cases in their area (P <0.05). The results are shown in Table 4.

Information sources and the possible difficulties and challenges encountered

The survey showed that there are 10 types of information sources for rural residents to receive information on prevention and control. Six of them have a utilization rate of more than 50%, including WeChat (89.2%), Internet news (87.2%), and TV (85.0%), community/village epidemic prevention propaganda (75.6%), government announcements (69.7%), and short messages (60.1%). The results are shown in Table 5.

Table 5 Information sources of residents' knowledge on prevention and control of COVID-19 (N=554).

Source	n (%)
WeChat	494 (89.2)
Network news	483 (87.2)
TV	471 (85.0)
Community/village epidemic prevention pamphlet/bulletin board/campaign	419 (75.6)
Government announcements	386 (69.7)
SMS	333 (60.1)
Radio	267(48.2)
Work unit	11 (2.0)
Micro-Blog	5 (0.9)
	7 (0.8)
Others (Informed by others, Douyin APP, etc.)	13 (2.3)

A total of 401 people received feedback on self-control difficulties and challenges, accounting for 72.4% of the total. Rural residents reported difficulties and challenges in four main areas (representing more than 10% of the total number of responses): lack of protective equipment (40.15%), inconvenience of travel (23.69%), lack of awareness of prevention and control (16.96%), and life inconvenience (10.72%). The results are shown in Table 6.

Table 6 Difficulties and challenges encountered by residents in epidemic prevention and control (N=401).

View	n (%)
1. **Protective equipment:** Rural residents, who especially resided in remote mountainous areas cannot buy masks, alcohol, disinfectant, gloves, etc.; Rural medical workers/traffic police/duty personnel at the village entrance do not have protective equipment such as isolation clothing and goggles.	161 (40.15)
2. **Inconvenience of going out:** Suspension of public transport; Duty at the entrance of the village and banned in and access; Return work unit difficult	95 (23.69)
3. Weak awareness of prevention and control: patients or people in incubation period conceal their condition; old people do not wear masks gathered in the sun, epidemic period visit, playing mahjong; The family does not wash their hands in time after going out	68 (16.96)
4. Inconvenience to buy daily necessities: vegetables, rice, flour, oil and baby products	43 (10.72)
5. Affecting study and work: School delay, affecting study; worry about insufficient prevention and control conditions, lack of necessary prevention and control facilities, and cross infection at work units	31 (7.73)
6. **Affecting psychology:** Boredom arises from prolonged isolation at home; feeling nervous and panic when seeing the epidemic related reports and patient pictures; fear of being infected with COVID-19 whenever there is any discomfort present	23 (5.73)
7. Economic damage: delayed farming; crops (apples, shiitake) cannot be shipped out; vegetable prices double	16 (3.49)
8. Information reliability: lack of access to truthful and reliable information about the epidemic situation; inability to distinguish between common cold and COVID-19; unclear treatment of protective equipment such as contaminated masks	15 (3.74)

Discussion

Demographic characteristics

The survey objects of this study were rural residents in various provinces with wide coverage. The respondents included women, people of Han nationality, those with a junior high school education and below, unmarried/divorced/widowed people, farmers, people with middle-level family income, those without chronic diseases, people with no confirmed cases in their residential area, not having been to an epidemic area (such as Hubei Province in China) and having experienced the SARS epidemic. The areas were mainly related to the place where the questionnaire respondents were located or their schools. The average age of the rural residents in this study was 30.05 years old. Enterprise workers and students accounted for 70% of the total rural residents in this survey and 60% of returnees during the Spring Festival. However, during the epidemic, the state placed restrictions on personnel flow, resumed work and resumed production. Requirements such as delays in spring ploughing and home isolation for at least 14 days have a definite impact on the social economy, and enterprise workers account for more than 60% of labor-intensive industries and enterprises such as manufacturing, construction, and service industries [7]. Students over the age of 14 are usually high school/secondary school/university/graduate students. They have the characteristics of highly concentrated personnel, extensive social connections, and collective activities. After the winter vacation, students will return to the university, and the university will soon become the main battlefield for epidemic prevention and control. Students are also one of the most vulnerable groups. Once the epidemic spreads in schools, it will affect the stability of families, schools, and society [8]. Therefore, relevant research on the impact of the epidemic on the industry should be considered, and corresponding countermeasures should be implemented.

Rural residents' overall knowledge, belief/attitude and practice of the prevention and control of COVID-19

According to our research results, the scores for knowledge, belief/attitude, and practice were 65.5%, 84.7%, and 65.3%, respectively. The overall knowledge and behavior of rural residents are at a medium level, and attitudes are at a high level. These achievements are related to the new edition of the COVID-19 Education Manual issued by the government, health committees, disease control centers, and university hospitals and to the publicity, education, and supervision of communities, villages, and the media. Effective risk communication in the early stages of infectious diseases, timely understanding of relevant knowledge, and attitudes and behaviors of the public are very important to reduce the negative and panic mentality caused by the epidemic, adopt targeted

health education strategies and measures, and effectively prevent and control the spread of disease [9]. This epidemiological study conducted a rapid assessment of rural residents' knowledge, beliefs and actions during the rising stage of the new crown pneumonia epidemic, which can provide a basis for the government to develop targeted health education and behavioral intervention strategies.

Analysis of COVID-19 Knowledge, Belief/Attitude, Behavioral Items and Influencing Factors among Rural Residents

Knowledge

This survey shows that the source of COVID-19 infection, the route of transmission, incubation period, main symptoms, time of close contact isolation and observation, and awareness rate of personal protective measures are above 70% and the score rate of 20 of the 24 protective measures is above 80%, indicating that most rural residents have better knowledge of new crown pneumonia prevention and control, which is inseparable from government departments' propaganda and education for villagers. The scoring rates for new crown pneumonia infectious diseases, susceptible populations, and transmission rates are below 60%, at 45.3%, 54.6%, and 16.2%, respectively. The reasons for these findings may be that this COVID-19 knowledge is highly specialized, and rural residents often cannot obtain COVID-19 knowledge through simple WeChat and news information. Instead, it is necessary to develop rural publicity and education methods based on the characteristics of rural populations. Systematic knowledge and practice is an area that needs to be strengthened in subsequent publicity and education work. .

Regression analysis shows that men's knowledge scores are higher than women's knowledge scores. Possible reasons are that men's information processing speed and execution ability are generally higher than women's. Due to the influence of traditional ideas (rural masculinism), rural women mainly undertake housework and have a relatively low education level. Some females have dropped out of junior high school and have poor knowledge of COVID-19 [10]; those with a junior high school education or below with a knowledge score lower than that of junior high school may be subject to this level of education. COVID-19 knowledge is limited in its grasp and understanding. WeChat and related news and information alone cannot make provide relevant knowledge, and it is best to have professional guidance. Farmers have lower knowledge scores than enterprise workers, students, and other occupations. This result may be due to the fact that farmers' COVID-19-related knowledge is relatively simple. They rely mainly on the compulsory management of village/town leaders, such as not allowing clusters (e.g., playing mahjong). In addition, only 12.5% of the surveyed villages/towns had confirmed cases, which did not cause the necessary vigilance in thought or the willingness to actively acquire knowledge. Rural residents with poor household economic scores have lower knowledge scores than those with medium and high economic conditions. Residents with poor economic conditions may not pay much attention to health care and may not have the motivation to actively master knowledge. Rural residents with chronic disease have less information than those without. High knowledge scores among residents may be related to previous research reports (40% of patients with COVID-19 died of chronic diseases) [12]. People with chronic diseases experienced preventive treatment of the disease in the early stage and were more concerned about their own body changes; 81.5% of rural residents had experienced SARS, and rural residents who had experienced SARS had higher knowledge scores than rural residents who had not experienced SARS. The possible reasons are that SARS is similar to COVID-19, and both are infectious diseases of the respiratory tract. The prevention and control measures are basically the same, so it is necessary to conduct timely drills and multi-department cooperation to allow residents to obtain epidemic-related knowledge, effectively improve the level of epidemic prevention and control of residents in rural communities, and provide security for rural residents who experience public health emergencies. Prevention and control provide effective methods. It is suggested that in the promotion of knowledge about the prevention and control of new coronary pneumonia, women, farmers, families with poor economic conditions, people with no chronic diseases, those with no confirmed cases in their villages and towns, and people who have not experienced SARS should be the key educational objects.

The analysis of information sources shows that the main way for rural residents to obtain prevention and control knowledge is the mass media, indicating that mainstream media (such as WeChat, online news platforms, and television) play a very important role in disseminating prevention and control knowledge. Studies have shown that the integrity of the early warning system and the public's timely access to information will directly affect the ability to respond to public health emergencies [13]. Therefore, it is necessary to further strengthen the construction of modern communication network infrastructure and give full play to the active role of mainstream media in the process of disseminating news on public events and health education so that information is timely, accurate, scientific and accessible.

Belief/Attitude

Seventy-eight percent of rural residents think that they and their family members may be infected. The main reasons may be the high contagion level of COVID-19 and the lack of effective treatment methods. This finding suggests that in the rising stage of the disease epidemic, timely and accurate transmission of key information to rural areas is very important to help the public through the crisis [14]. We should continue to organize corresponding health education and publicity in a timely manner and address the concerns of rural residents according to the latest epidemic situation. More than 97% of the respondents believe that personal protection, community protection, and government decision-making are necessary for epidemic control and are willing to cooperate with the community and government's prevention and control work. This may be related to the Chinese government's high emphasis on the prevention and control of new coronary pneumonia and the restrictions imposed, including a series of measures related to personal travel in key areas and social mobilization [15-16]. A total of 98.6% of residents' held the attitude toward edible game that they "do not eat it themselves, and they are also opposed to eating by others". Of rural residents, 97.1% agree that the country currently has a law prohibiting the hunting, buying and selling of wild animals, which may be related to the source of the epidemic. With regard to wild animals, rural residents have a more positive attitude toward prevention and control and a stronger sense of social responsibility. This is also one of the important factors in controlling the epidemic. After two months of prevention and control cooperation, newly diagnosed cases of new coronary pneumonia in rural residents have basically not increased. This phenomenon is inseparable from the efforts of rural individuals, communities, and the government and is a positive reflection of qi and other public attitudes about new coronary pneumonia. The results are consistent [17]. The analysis also shows that even though 98.7% of the respondents in this survey were residents of severely affected areas (Hubei Province), only 21.7% believed that they could not be infected, and 20.3% believed that their families could not be infected. This shows that village residents have a good

perception of the danger of the epidemic; however, this may also have a certain impact on the public's psychology and cause panic, which needs to be further explored.

Regression analysis showed that gender, age, economic level, and experience of SARS are predictors of beliefs/attitudes. Higher information levels among males, those 30 years of age and below, and experience with the SARS epidemic indicate that the SARS epidemic response experience has a positive effect on confidence in epidemic prevention and control. Female residents who are over 30 years old and in poor economic condition should be the focus group for epidemic prevention and control.

Behavior

An analysis of the items showed that 18 of the 27 behaviors had scores above 80%. Low-scoring items indicated that the implementation of infrequent prevention and control measures needs to be further strengthened, such as "eating with chopsticks or splitting meals" and "taking Chinese herbal medicine ingredients for yin, qi, spleen and lungs." Not using public chopsticks for meals may be related to the constraints of traditional Chinese concepts. Many people still think that using public chopsticks is a manifestation of distrust and mutual disapproval among people, especially when eating with family members. The Municipal Health Promotion Committee and the Office of the Shanghai Municipal Committee for the Advancement of Spiritual Civilization issued an initiative suggesting that when people have dinner, they should not forget to add chopsticks or a spoon for each dish [18]. A total of 47.5% of rural residents always or frequently take Chinese herbal medicine to assist in health care, indicating that residents have high recognition of the preventive effect of Chinese herbal medicine [19].

The results of the regression analysis suggest that prevention and control interventions should be strengthened for females, people over 30 years of age, farmers, people with poor economic conditions, those with no chronic diseases, people with no confirmed cases in their rural villages, and rural residents who have not experienced SARS. During the epidemic prevention and control period, 85.6% of rural residents knew that wiping household products with alcohol or chlorine-containing disinfectant can prevent and control infection, but only 66.2% of rural residents wiped household products with alcohol or chlorine-containing disinfectant. This finding indicates that in some rural areas, residents' implementation of protective measures is not in place, and there is a risk of infection. This may be related to the lack of disinfection materials for rural residents. It is recommended that government departments reasonably allocate disinfection materials to rural areas. Of rural residents, 97.8% knew that attending parties would increase the chance of viral infection, but only 82.1% of rural residents reflected this knowledge in action. Feedback from open questions included clustering and playing mahjong; these issues require relevant epidemic prevention and control personnel. It is important to give villagers necessary knowledge in a timely manner.

Difficulties and Challenges:

The analysis and summary in this survey show that 72.4% of the residents had difficulties and challenges in epidemic prevention and control. The greatest difficulty is the lack of protective equipment (40.15%): rural residents, especially those in remote mountainous areas, purchase no masks, alcohol, or disinfectant, and rural medical workers, traffic police, and village staff on duty do not have protective clothing, such as isolation clothing and goggles. It is recommended that government departments give rural residents, especially those in remote mountainous areas, more front-line personnel when distributing protective materials. Furthermore, another issue is the inconvenience of travel (23.69%): vehicles are stopped and roads are obstructed (closed villages) and return trips are difficult (foreign residents are separated from their homes for 14 days at the destination), prompting government departments to humanely set up protective measures to close roads in closed villages and to adopt rational settings. Weak protection awareness (16.96%) is mainly reflected in the incubation period to conceal the illness. The elderly do not wear masks outside, go outside during the epidemic period, and play mahjong, and family members do not wash their hands when they return home. These findings indicate that knowledge, attitude, and behavior scores are positively correlated. To solve the problem of persuasion ineffectiveness, villagers must have a good understanding of COVID-19 to encourage them to adopt a positive attitude and correct behavior and to prevent psychological problems (5.73%). Long-term isolation and inactivity in homes will inevitably lead to boredom and panic about the disease. Villagers should be provided with appropriate psychological counseling or corresponding counselling channels during the epidemic so that they can report their mental disorders. At the same time, it is important to strengthen the rural network platform, appropriately reduce or exempt network traffic consumption, and let villagers chat with each other via video or play mahjong online, thereby reducing the chance of cross-infection.

Conclusion

This study provided a preliminary discussion of the knowledge, beliefs/attitudes, behavior levels and influencing factors of COVID-19 prevention and control in rural residents and the difficulties/challenges perceived during the implementation of prevention and control behaviors. Future research can focus on different aspects in different regions. Publicity and education on the prevention and control of COVID-19 can provide a reference basis, and scholars’ attention can be drawn to this research issue to expand the scope of investigation and populations in different countries and regions. This will help to comprehensively understand the current status of residents' knowledge and behavior in the prevention and control of COVID-19. The influencing factors provide a more comprehensive and objective theoretical basis for further optimization of prevention and control strategies.

Research Limitations

This study conducted a rapid population survey in the early stages of the development of COVID-19. Using Internet survey tools, a sample size of 554 cases was obtained in a short period of time. The timeliness was good, and rural residents in the early stages of disease development could be quickly identified and their knowledge, attitude and behavior could be assessed. A limitation of this study is the non-random sampling based on network invitation, which caused the sample to be under-represented in the rural population across the country. Furthermore, rural elderly people have limited access to mobile phones. Therefore, this part of the population may have failed to complete the questionnaire through WeChat. The information available to older people is limited, and the extrapolation of conclusions is therefore also limited.

Declarations

Ethical approval and consent to participate

This only questionnaire survey was approved by the Human Subjects Ethics Subcommittee of West China Hospital, Sichuan University. Informed consent was obtained from each participant online who was assured of the anonymity and confidentiality of data collected for academic use only, and their rights to withdraw from the study at any time.

Consent for publication

"Not applicable" in this section

Availability of data and materials

"Not applicable" in this section

Competing interests

All other authors report that there are no financial relationships with commercial interests.

Funding

"Not applicable" in this section

Authors' contributions

MLH and LH drafted this manuscript. JN and J XL collected the data. WS helped with data analysis. All people have read, reviewed, and approved this manuscript. All authors contributed to the analysis, interpretation of results and drafting the critical review of the manuscript. All authors reviewed and approved the final version of the manuscript.

Acknowledgments

Our thanks should go to all rural respondents in this survey for their time and sharing their experience.

Abbreviations

COVID-19: coronavirus disease-2019 ; KAP:Knowledge, Attitude/Belief, and Practice; SD: standard deviations; ANOVA: analysis of variance

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