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Knowledge, Attitude and Behavior of GPs in Shanghai during the Pandemic of COVID-19: A Cross Sectional Study

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Abstract

Objectives To grasp the knowledge, attitude and behavior of general practitioners (GPs) towards COVID-19, and to provide evidence for better prevention and control of the pandemic.

Setting/participants A cross-sectional study was conducted with 1018 GPs in Shanghai from February 21 to March 2, 2020 by using online questionnaire platform, Wechat..

Main outcomes measures Stratified random sampling was adopted according to the regional division of urban area, urban-rural fringe area, and rural area. A mobile self-designed questionnaire was used.The questionnaire collected: knowledge of COVID-19,attitude towards COVID-19 behavior for COVID-19 prevention and control.

Results 989 questionnaires were valid.The average score of GPs' knowledge, attitude and behavior towards COVID-19 was 6.14±1.42 (range 0-10), 13.59±4.42 (range 0-25), 7.82±1.53 (range 0-10), respectively. Multiple linear regression analysis showed that knowledge score of male GPs was lower than that of female GPs (P=0.002). Attitude score of female GPs was higher than that of male GPs (P=0.004). Married GPs was higher than that of unmarried GPs (P=0.021). Behavior score of GPs in urban areas was lower than that of GPs in urban-rural fringe areas (P<0.001). Male GPs' behavior scores were lower than female GPs' (P=0.002). The higher the knowledge score, the higher the behavior score (P<0.001).

Conclusions The scores for knowledge, attitude and behavior of Shanghai GPs towards COVID-19 was limited at the beginning of COVID-19 outbreak. Pandemic prevention training for GPs should be strengthened to win the pandemic prevention and control campaign.

Keywords

General practitioner·COVID-19·Knowledge· Attitude·Behavior

Strengths and limitations of this study

This is a first large-scale cross-sectional survey of General practitioners' (GPs) knowledge, attitude and behavior towards COVID-19 at the early stage in Shanghai, a city with highly developed economy and high population mobility. And stratified random cluster sampling was adopted.

GPs had first become the main force of community pandemic prevention and control and were in the front line of community grid management system. Their knowledge, attitude and behavior would directly affect the results of prevention and control of the pandemic.

However,the scores for knowledge, attitude and behavior of Shanghai GPs towards COVID-19 was limited at the beginning of COVID-19 outbreak. Pandemic prevention training for GPs should be strengthened to win the pandemic prevention and control campaign.

The survey has some limitations. Although stratified random cluster sampling was adopted, one-to-one interview could not be conducted during the pandemic. All the

participants completed the questionnaire using Wechat, so the quality of the questionnaire can not be guaranteed. Thus, although the study did provide necessary reference for the gap in knowledge, attitude and practice of GPs, the extrapolation of conclusions was limited to some extent. Secondly, as the study was based on a cross-sectional design, a causal relationship could not be inferred with certainty. We can do in-depth research in the future.

Background

Coronavirus disease (COVID-19) is an emerging infectious disease[1].In December 2019, COVID-19 cases were first confirmed in Wuhan, China, and subsequently reported nationwide and globally [1]. Up to February 20th, 2020, within the launch of the first-level response measures for major public health emergencies[2], the cumulative number of confirmed cases across the country had reached 125,529, and the cumulative number of deaths has reached 5,695 [3]. Meanwhile, 2,055 medical workers who participated in the treatment were reported to be infected with COVID-19 [4], mainly due to the lack of sufficient knowledge of COVID-19 [5].

Shanghai was the largest port city in China as well as international trade and shipping center [6]. The Shanghai municipal government issued regulation on community prevention and control network [7] as early as January 23rd, the same day Wuhan was closed down. However, by February 20th, 2020, the number of confirmed cases had

reached 334.

The main force to undertake the task of community pandemic prevention and control is general practitioners (GPs), the gatekeeper of the health of community residents [8]. But, GPs have never been involved in community pandemic prevention before. In the face of the challenge of this emerging infectious disease, whether the GPs had mastered the correct knowledge, had high morale and normative behavior, so that they can protect themselves and educate community residents well, to win the tough fight? To this end, we launched a survey of GPs' knowledge, attitude and behavior towards COVID-19 in Shanghai, aiming to find out the problems and provide a basis for improving the pandemic prevention and control capacity at the grassroot level, so as to better control the pandemic.

Methods

Study Design and Population

This cross-sectional survey was conducted from February 21st to March 2rd, 2020. Stratified random cluster sampling was adopted. According to the regional division of Shanghai, regions were divided into the urban, urban-rural fringe, and rural areas [9]. Three districts were randomly selected from each of the three areas, and three community health service centers (CHCs) were randomly selected from each district [10].

According to the formula

$$n = \frac{\mu^2_{\alpha/2} P\ (1-P)}{\delta^2}$$

P=0.0222，1-P=0.9778，α=0.05，$\mu_{\alpha/2}$=1.96， δ=0.5P=0.0111,

$$n = \frac{1.96^2 \times 0.0222 \times 0.9778}{0.0111^2} = 676.1 \approx 677$$

n stands for the required sample size. $\mu_{\alpha/2}$ stands for the μ value when the cumulative probability from left to right is 1-α/2 (both sides) in the standard normal distribution. P stands for the accuracy rate of all the questions in the pre-survey. δ stands for the allowable error. Based on the pre-survey results of 30 respondents, P=0.0222,1-P=0.987,α=0.05 was set, $\mu_{\alpha/2}$=1.96, a 5 percent margin of error was set, then δ=0.5, P=0.00715, the required sample size would be at least 677. At a 20% shedding rate, the total sample size would be at least 847. Finally, a total of 1018 on-the-job GPs in the above 27 CHCs were investigated, including 341 GPs in urban area, 415 GPs in urban-rural fringe area, and 262 GPs in rural area（Fig 1）.No incentive was offered for completion of the questionnaire.

Questionnaire design

A self-designed questionnaire was used in the survey, based on the COVID-19 literature published by the Chinese Center for Disease Control and Prevention (CDC) and World Health Organization [11-14]. The questionnaire was pre-tested on a small sample of 30 GPs from three CHCs and some of the questions were adjusted after the pre-survey. The questionnaire collected: ①General information of the respondents, including region, gender, age, education, years of work, professional title, and marital status. ②

Knowledge of COVID-19, including 6 single-choice questions and 4 multiple-choice questions. For all multiple-choice questions, respondents must check all the correct items to be judged as correct. Each correctly answered question scores 1 point and the total score is 10 points. ③ Attitude towards COVID-19 pandemic: There are 5 questions in total. In answering each question, the extent of concern about COVID-19 is graded into 5 degrees. The score of 1 point for "not worried at all", 2 for "not very worried", 3 for "somewhat worried ", 4 for "quite worried" and 5 for "very worried". The total score is 25 points. ④Behavior for COVID-19 prevention and control. There are 10 single-choice questions. Each correctly answered question scores 1 point and the total score is 10 points. The total Cronbach's alpha coefficient for the questionnaire was 0.844, indicating that the internal consistency was acceptable.

Data Collection

The cross-sectional study was conducted by using online questionnaire platform, Wechat. All items in the questionnaire were required. If there were uncompleted items, the questionnaire could not be submitted, and the same IP address could only be used to submit the questionnaire once. Written consent was obtained from all respondents before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Zhongshan Hospital, Fudan University(B2020-027).

Statistical Analysis

Excel (Microsoft Office Professional Plus 2010) was used to establish the database, and SAS (Version 9.4) was used for data processing and analysis. Continuous variables were presented as mean±standard deviation($\bar{x} \pm SD$) and categorical variables as frequency (percentage). Kruskal-Wallis test was used as univariate analysis to compare the knowledge, attitude and behavior scores in different subgroups. The factors which had statistical significance in the single-factor analysis, or based on our hypotheses, were taken as the predictors in the multiple linear regression analysis to identify the potential impact factors related to knowledge, attitude and behavior scores. All of the tests for significance were two-sided.The P-Values of univariate analysis <0.1 and multiple linear regression analysis <0.05 were considered statistically significant.

Patient and public involvement

The public were not involved in the design, or conduct, or reporting, or dissemination plans of this research

Results

Descriptive Characteristic Results

1018 GPs were invited to participate in the survey, and 996 questionnaires were collected, with a response rate of 97.84% (996/1018). Among the 996 questionnaires, 989 questionnaires were valid, with a quality conformity rate of 99.30% (989/996). There were 279 males and 710 females and the average age was 39.18, ranging from 23 to 59. Bachelor degree and above accounted for 88.47%（Table 1）.

Table 1 The score of Knowledge, Attitude and Behavior on COVID-19 of Shanghai GPs by demographic variables

Characteristics	Number of participants (%)	Knowledge score ($\bar{x} \pm SD$)	Attitude score ($\bar{x} \pm SD$)	Behaviour score ($\bar{x} \pm SD$)
Total	989(100)	6.14±1.42	13.59±4.42	7.82±1.53
Region				
Urban area	336(33.97)	6.09±1.46	13.63±4.26	7.64±1.60
Urban-rural fringe area	396(40.04)	6.20±1.40	14.04±4.29	8.14±1.35
Rural area	257(25.99)	6.12±1.42	12.85±4.74	7.57±1.60
$\chi 2$		1.288	10.975	28.570
P		0.525	0.004	<.001
Gender				
Male	279(28.21)	5.90±1.41	12.89±4.89	7.49±1.71
Female	710(71.79)	6.24±1.42	13.87±4.20	7.95±1.43
$\chi 2$		11.548	9.400	14.710
P		<.001	0.002	<.001
Age (year)				
≤29	131(13.25)	6.23±1.40	12.96±4.27	8.13±1.46
30~39	414(41.86)	6.22±1.39	13.87±4.32	7.84±1.49
40~49	327(33.06)	6.08±1.49	13.98±4.31	7.80±1.54
≥50	117(11.83)	5.96±1.39	12.21±4.94	7.47±1.62
$\chi 2$		4.757	15.274	11.976
P		0.191	0.002	0.008
Education				
College degree and	114(11.53)	5.90±1.42	12.55±4.54	7.67±1.71
Bachelor degree	736(74.42)	6.15±1.42	13.72±4.42	7.85±1.50
Master degree or above	139(14.05)	6.31±1.44	13.73±4.27	7.78±1.53
$\chi 2$		5.172	6.290	0.590
P		0.075	0.043	0.745
Years of work				
	83(8.39)	6.29±1.49	12.96±4.32	8.14±1.62
5~9	202(20.42)	6.09±1.40	13.91±4.36	7.95±1.45
10~19	317(32.05)	6.29±1.34	13.72±4.22	7.81±1.46
≥20	387(39.13)	6.03±1.48	13.45±4.63	7.69±1.59
$\chi 2$		7.773	3.333	9.209
P		0.051	0.343	0.027
Professional title				
Resident	227(22.95)	6.03±1.41	13.37±4.56	7.91±1.56
Attending physician	591(59.76)	6.16±1.42	13.90±4.26	7.80±1.51
Associate chief physician or above	171(17.29)	6.25±1.44	12.81±4.71	7.79±1.55
$\chi 2$		1.759	9.153	1.979
P		0.415	0.010	0.372
Marriage				
Unmarried	195(19.72)	6.06±1.38	12.71±4.44	7.76±1.67
Married	794(80.28)	6.17±1.43	13.81±4.40	7.84±1.49
$\chi 2$		0.963	8.763	0.009
P		0.327	0.003	0.926

Abbreviation: SD=Standard Deviation

Knowledge scores of GPs on COVID-19

The correct percentage of the 989 GPs of each knowledge question was 25.58%-97.88% (Table 2). The average knowledge score was 6.14±1.42 (Table 1). Among them, the correct percentage for 'Which of the following objects or conditions can kill Novel Coronavirus?' was the lowest,accounting for 25.58% . The correct percentage for 'What are the transmission route of Novel Coronavirus' was the second lowest, accounting for 29.63% (Table 2).

Table 2 The Correct Percentage of GPs on Knowledge and Behavior on COVID-19 (N=989)

Questions	n (%)
Knowledge	
1.Which of the following objects or conditions can kill Novel Coronavirus?	253(25.58)
2.What are the transmission route of Novel Coronavirus?	293(29.63)
3.What kind of face mask should you wear when you make home visits to quarantined residents?	302(30.54)
4.Does disposable surgical mask need to be replaced if it is wet or dirty?	318(32.15)
5.What do you think is the minimum social safe distance between people ?	686(69.36)
6.What is the replacement time of disposable surgical masks?	769(77.76)
7.Do you know the steps of "six-step hand-washing method"?	806(81.50)
8.What kind of face mask should you wear in community clinics during epidemic period?	808(81.70)
9.Do you know what kind of face mask has the effect of preventing Novel Coronavirus?	874(88.37)
10.How long should close contacts be quarantined?	968(97.88)
Behavior	
1.Do your hands touch the external surface of the face mask after you put it on?	512(51.77)
2.What is your step to remove a disposable surgical mask?	579(58.54)
3.When you wear a disposable surgical mask, how to fit it entirely to the face?	630(63.70)
4.Have you taken the initiative to publicize the "six-step hand-washing method" since the COVID-19 outbreak?	633(64.00)
5.Do your hands touch the external surface of the face mask while removing it?	823(83.22)
6.Have you started using the "six-step hand-washing method" since the COVID-19 outbreak?	853(86.25)
7.Do you wash your hands before putting on a face mask?	899(90.90)
8.Have you increased hand-washing frequency since the COVID-19 outbreak?	913(92.32)
9.When you wear disposable surgical masks, how to recognize the external and inner face mask surface correctly?	933(94.34)
10.When you wear disposable surgical masks, how to recognize the upper and lower edge correctly?	960(97.07)

Attitude scores of GPs on COVID-19

The average attitude score of 989 GPs on COVID-19 was 13.59±4.42(Table 1). 26.29% of the GPs were very worried that themselves or their family member might get infected by Novel Coronavirus. 7.58% were very worried that their life was threatened by COVID-19(Table 3).

Table 3 GPs' Attitude Score on COVID-19 (N=989)

	n (%)					
Questions	Not worried at all	not worried	somewhat worried	quite worried	very worried	Score
1.Are you worried that yourself or your family member might get infected by Novel Coronavirus?	98(9.91)	159(16.08)	281(28.41)	191(19.31)	260(26.29)	3.36±1.29
2.Are you worried you'll be quarantined if you get infected?	114(11.53)	188(19.01)	338(34.18)	170(17.19)	179(18.10)	3.11±1.24
3.Are you worried that the pandemic might be out of control and the virus will spread widely?	141(14.26)	221(22.35)	341(34.48)	155(15.67)	131(13.25)	2.91±1.21
4.Do you feel your life threatened by COVID-19?	241(24.37)	317(32.05)	258(26.09)	98(9.91)	75(7.58)	2.44±1.18
5.Do you suspect that you have been infected with	460(46.51)	366(37.01)	120(12.13)	25(2.53)	18(1.82)	1.76±0.89

Novel Coronavirus?	
Totel	13.59±4.42

Behavior scores of GPs on COVID-19

The correct percentage of the 989 GPs of each behaviour question was 51.77-97.07% (Table 2). The average behaviour score was 7.82±1.53(Table 1). Among them, the correct percentage of the behaviors 'Do your hands touch the external surface of the face mask after you put it on?', 'What is your step to remove a disposable surgical mask?', 'When you wear a disposable surgical mask, how to fit it entirely to the face?', 'Have you taken the initiative to publicize the "six-step hand-washing method" since the COVID-19 outbreak' were the lowest, accounting for 51.77%, 58.54%, 63.70% and 64.00%, respectively(Table 2).

Univariate analysis of influencing factors of GPs' knowledge, attitude and behavior towards COVID-19

Univariate analysis showed that male GPs' knowledge score was lower than female GPs' ($P< 0.01$). GPs with college education and below, and those who had worked for 20 years or longer had the lowest knowledge score ($P < 0.1$). Female GPs were more worried than male GPs ($P=0.002$). GPs who worked in urban-rural fringe area, aged 40-49, having master's degree or above, being attending physician and married were the most worried ($P < 0.05$). Male GPs had the lower behavior score（$P<0.01$）. GPs

worked in rural areas, age 50 or above， had worked for 20 years or longer had the lowest behavior score (P < 0.05) (Table 1).

Multiple Linear Regression Analysis of the influencing factors of GPs' knowledge, attitude and behavior towards COVID-19

Multiple linear regression analysis showed that knowledge score of male GPs was lower than that of female GPs (P=0.002). Attitude score of female GPs was higher than that of male GPs (P=0.004). Married GPs was higher than that of unmarried GPs (P=0.021). Behavior score of GPs in urban areas was lower than that of GPs in urban-rural fringe areas (P<0.001). Male GPs' behavior scores were lower than female GPs' (P=0.002). The higher the knowledge score, the higher the behavior score (P<0.001)(Table 4).

Table 4 Multiple linear regression on factors associated with Shanghai GPs' knowledge, attitude and practice score on COVID-19

	Knowledge Score	
Variable	Coefficient (95% CI)	*P*
Knowledge Score		
Female	0.32 (0.12, 0.52)	0.002
Education Level*	0.15 (-0.01, 0.31)	0.074
Years of work Level*	-0.03 (-0.13, 0.07)	0.532
Attitude Score		
Urban-rural fringe area	0.42 (-0.23, 1.06)	0.203
Rural area	-0.43 (-1.18, 0.32)	0.258
Female	0.90 (0.29, 1.51)	0.004
Age group level*	-0.02 (-0.46, 0.41)	0.913
Education Level*	0.37 (-0.19, 0.92)	0.200
Professional title Level*	-0.20 (-0.73, 0.33)	0.458
Married	0.88 (0.13, 1.63)	0.021
Knowledge Score	0.01 (-0.18, 0.21)	0.890
Behaviour Score		
Urban-rural fringe area	0.44 (0.23, 0.66)	<.001
Rural area	-0.05 (-0.28, 0.18)	0.673

Female	0.32 (0.12, 0.52)	0.002
Age group Level*	-0.12 (-0.31, -0.06)	0.198
Years of work Level*	0.01 (-0.16,0.17)	0.951
Knowledge Score	0.28 (0.22, 0.34)	<.001
Attitude Score	0.02 (0, 0.04)	0.065

* Education Level: 1=College degree and below, 2=Bachelor degree, 3=Master degree or above;
*Years of work Level: 1=less than 5, 2=5~9, 3=10~19, 4=greater or equal than 20;
*Age group Level: 1=less and equal than 29, 2=30~39, 3=40~49, 5=greater or equal than 50;
*Professional title Level: 1=Resident, 2=Attending physician, 3=Associate chief physician or above.
Abbreviation: CI=Confidence Interval

Discussion

Of the 989 GPs who were respondents of our study, their average age was 39.18 years old, among whom 88.2% were younger than 50, and 88.47% had bachelor's degree or above. This was a relatively young team with high education background. However, the average score was 6.14±1.42(range 0-10), which was much lower than that of the online survey of 1357 medical workers in Henan Province conducted by Zhang M et al. at the same time[15]. This is worrying. GPs are the main force in this community pandemic prevention and control campaign against COVID-19 in Shanghai[16]. How can GPs with poor knowledge on COVID-19 lead the community to win the pandemic prevention and control campaign?It was necessary for GPs to master the transmission route of Novel Coronavirus [17], so as to protect themselves and to educate the population well. However, the percentage of Shanghai GPs with correct knowledge of transmission route was only 29.63%. Feng Xiang et al. demonstrated the correct rate of 43.27% in an online survey of 617 medical workers in Jiangsu Province in early March 2020[18]. Cutting the route of transmission is especially important for infectious diseases.Therefore, it is necessary to strengthen training of basic knowledge of

infectious diseases.During the pandemic, people need to keep a safe social distance of one meter [19]. However, only 69.36% of the GPs have mastered the social safety distance of at least one meter during the pandemic[20], which was much lower than the rate shown by Parikh PA's survey of 744 medical personnel in India in March 2020 [20]. Thus, social safety distance is another weak point that needs to be focused on in pandemic training.CDC recommends using medical masks and N95 masks in preventing novel coronavirus[21]. Our study showed that GPs had a high rate of 88.37% for choosing the correct face masks. But the rate for choosing the correct face mask when making home visits to quarantined residents was only 30.54%. Many GPs only chose N95 masks on this occasion. However, when visiting people quarantined at home, either of the disposable surgical mask or N95 mask is optional[12]. Compared with disposable surgical masks, N95 respirators are optimized in structure with core filtration and their filtering efficiency raised up to 95%[22]. Such choice might be due to the great fear caused by the outbreak of the pandemic at that time, and many GPs prefer excessive protection. Under the circumstances of lacking medical supplies for pandemic prevention, it is necessary to ensure not only the safety of GPs, but also the scientific and rational use of medical supplies.Disposable surgical masks should be discarded at the interval of 4 hours and should also be replaced when they are wet or dirty [11,21]. If the filter layer of a disposable surgical mask absorbs moisture or gets dirty, the filtering function will be reduced or even lost[11]. However, the correct awareness of GPs of the discard interval and occasion was 35.19% and 51.26%,

respectively. Therefore, it is essential to make GPs master the correct discard interval and occasion of disposable surgical masks in pandemic training.

Univariate and multivariate analyses showed that male GPs had lower knowledge scores than female GPs, which was consistent with the results of an online survey of residents around the country on COVID-19 conducted by Qi Y at the end of January 2020.[23] Women tend to be in the center of family life and were usually more nervous about the pandemic[24]. They were more serious about the prevention of the pandemic for the health of themselves and their families and were more willing to follow standardized measures[24].

The score of worry of GPs on COVID-19 was 13.59±4.42, which was between not worried and somewhat worried. The proportion of GPs who were somewhat worried, quite worried and very worried that themselves or their family members might get infected by Novel Coronavirus was 28.41%, 19.31% and 26.29%, respectively. In general, the proportions of worry were slightly lower than the studies conducted by Zhang M et al.[15] and Abdel Wahed WY et al.[25]. Our results can indirectly reflect the relatively perfect prevention and control work in Shanghai. For the question, 'Do you feel your life threatened by COVID-19?', the proportion of those GPs who were not worried at all and not worried was 56.42%. And those who were quite worried and very worried was only 17.49%. This demonstrated that Shanghai GPs had confidence in China's pandemic prevention and control capability although they knew the highly contagious nature of Novel Coronavirus. This confidence might also be related to the experience in handling pandemic of Severe Acute Respiratory Syndrome in Shanghai

in 2003. Shanghai's pandemic control and prevention capability has improved step by step in the past 17 years [26].

Multivariate analysis showed that gender and marriage were the influencing factors of attitude on COVID-19 for GPs, which was consistent with the online survey of Zhu Z et al. of 5,062 medical workers in Wuhan Tongji Hospital in February 2020 [27].Female GPs were more anxiety in the face of COVID-19. An online survey conducted by Shiyan Yan et al. on 3088 people in February 2020 also showed gender differences on stress[28]. Married people take more responsibilities for their families and worry more. Therefore, for these GPs, appropriate psychological support should be provided to reduce their psychological pressure.

Doctor is a high-risk profession. If GPs wore face mask in an incorrect way, they would be at the risk of being infected [29]. In our study, although 88.37% of the GPs selected the correct type of face mask to prevent the invasion of COVID-19, only 63.70% of them knew how to fit disposable surgical mask entirely to the face. The correct percentage of GPs for hands not touching the external surface of the face mask while wearing it was only 51.77%, and the percentage of GPs who had mastered the correct step to remove a disposable surgical mask was only 58.54%. Therefore, it is necessary to emphasize the proper way to wear face masks in detail in GP training. Contact transmission is a major route of COVID-19 transmission. Therefore, hand hygiene is as important as wearing masks and keeping a safe social distance [30]. Ran L et al. demonstrated that hand hygiene was closely related to COVID-19 infection through his investigation of 72 medical workers in Wuhan in January 2020 [31， 32]. After the

outbreak of COVID-19, Shanghai GPs' hand-washing frequency increased by 92.32% and the number of GPs who strictly used 'six-step hand-washing method' increased by 86.25% compared with that before the outbreak[32]. The majority of GPs performed well in hand hygiene, which was consistent with the survey of 744 medical personnel in India [20]. Moreover, educating the public is also the social responsibility that GPs should take on their initiative. However, only 64.00% of Shanghai GPs actively publicized the "six-step hand-washing method" to the public. Therefore, GPs should have the awareness of educating the public to improve the efficiency of pandemic prevention and control.

Both of the univariate and multivariate analysis showed that behaviour score of male GPs was lower than that of female GPs, which was consistent with the survey of 461 medical workers conducted by Dimitrios Papagiannis et al. in Greece in February 2020 [33].Women are better than men in knowledge mastery and more nervous than men in attitude. It is understandable that they are more serious in behavior implementation.The study also showed that the higher the knowledge score, the higher the behavior score. Which was consistent with the survey of 706 Syrian residents conducted by Sanaa Al ahdab et al. in April 2020 [34]. Therefore, there is a need for further training of GPS to improve their understanding of the disease and their behaviour of epidemic prevention in their communities.

Conclusions

This is a large-scale cross-sectional survey of GPs' knowledge, attitude and behavior

towards COVID-19 in Shanghai, a city with highly developed economy and high population mobility. GPs, as the "health gatekeepers" of the community , are in the important position of the community grid management system, and their knowledge, attitude and behavior will greatly affect the results of prevention and control of pandemic. However, according to our survey of GPs in Shanghai, their related knowledge was limited at the beginning of COVID-19 outbreak and their behaviors towards COVID-19 needed improving. At the same time, we should also care about the physical and mental health of GPs to build a strong frontline of community prevention and control.Pandemic prevention training for GPs should be strengthened to win the pandemic prevention and control campaign.

Limitations

The survey has some limitations. Although stratified random cluster sampling was adopted, one-to-one interview could not be conducted during the pandemic. All the participants completed the questionnaire using Wechat, so the quality of the questionnaire can not be guaranteed. Thus, although the study did provide necessary reference for the gap in knowledge, attitude and practice of GPs, the extrapolation of conclusions was limited to some extent. Secondly, as the study was based on a cross-sectional design, a causal relationship could not be inferred with certainty. We can do in-depth research in the future.

Abbreviations Coronavirus disease(COVID-19);Chinese Center for Disease Control and Prevention(CDC);community health service center (CHC); general practitioners (GPs)

Contribution JW conceived and designed the study, implemented the research and helped to draft and revise the manuscript. HY T implemented the research, conducted data collection and helped to draft the manuscript. JL F and BX T performed data collection and statistical analysis. All the authors contributed to the preparation of the final document, and had read and approved the final manuscript

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Competing interests None declared

Ethics approval and consent to participate The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Zhongshan Hospital, Fudan University(B2020-027).

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References

1. Zhang H. Early lessons from the frontline of the 2019-nCoV outbreak. *The Lancet* 2020; 395(10225):687.
2. CCTV. 30 provinces, cities and autonomous regions launch Level 1 response to major public health emergencies. The role of the funder is to help to train general practitioners in healthcare, education, and research. baijiahao.baidu.com .2020.https://baijiahao.baidu.com/s?id=1656706957364692630&wfr=spider&for=pc;2020.
3. Chinese Journal of General Practitioners. Practical prevention and control of novel coronavirus infection at the primary level. mp.weixin.qq.com. 2020.https://mp.weixin.qq.com/s/K1ymC-L3u6J2vMiEraeG1w;2020.
4. Chutian Metropolis Daily. Central steering group again pays tribute to fallen medical staff as more than 2,000 infected. baijiahao.baidu.com .2020.https://baijiahao.baidu.com/s?id=1659772948930826692&wfr=spider&for=pc& searchword=2.20;2020.
5. World Health Organization (WHO).Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). www.who.int .2020.https://www.who.int/publications-detail/report-of-the-who-china-jointmission-on-coronavirus-disease-2019-(covid-19);2020.
6. State Council of China.Approval of the State Council on the Shanghai City Master Plan.www.gov.cn.2020. http://www.gov.cn/zhengce/content/2017-12/25/content_5250134.htm;2020.

7. China News Network. Shanghai "strictest measures, fastest speed" to prevent and control the new coronavirus pneumonia pandemic. www.chinanews.com .2020.http://www.chinanews.com/sh/2020/01-23/9068502.shtml;2020.

8. People's Daily. People's Times Review: Building a firm "community defense line" for epidemic prevention and control. www.nhc.gov.cn .2020.http://www.nhc.gov.cn/jkj/s7916/202001/44a3b8245e8049d2837a4f27529cd386.shtml;2020.

9. Song S, Liu P, Monday S. The division of urban and rural physical regions in Shanghai. *Journal of Geography* 2006;61(8):11.

10. Xu J, Peng Y, Shi Y, *et al*. A study on hospice service provision and compensation in Shanghai community health service centres. *China Health Economics* 2019;38(8): 4.

11. Bureau of Disease Control and Prevention.National Health and Health Commission. Notice on issuing guidelines on protection for people at different risks of novel coronavirus infection and guidelines on the use of pneumonia masks for the prevention of novel coronavirus infection. www.gov.cn .2020.http://www.gov.cn./zhengceku/2020-01/31/content_5473401.htm;2020.

12. General Office of the National Health Care Commission. General Office of the National Health and Health Commission on the issuance of guidelines for the prevention and control of pneumonia caused by novel coronavirus infection in

Notice on the Guidelines for Prevention and Control of Infection under Medical Observation in Home Isolation (for Trial Implementation). www.gov.cn.2020. http://www.gov.cn/zhengce/zhengceku/2020-02/05/content_5474688.htm;2020.

13. General Office of the National Health Care Commission. Novel Coronavirus Pneumonia Treatment Protocol (Trial Version 6). www.nhc.gov.cn.2020. http://www.nhc.gov.cn/yzygj/s7652m/202002/54e1ad5c2aac45c19eb541799bf637e9.shtml;2020.
14. World Health Organization (WHO). Advice on the outbreak of novel coronavirus (2019-nCoV) in the community, home care and health care settings Use of masks. apps.who.int .2020.https://apps.who.int/iris/bitstream/handle/10665/330987/WHO-nCov-IPC_Masks-2020.1-chi.pdf;2020.
15. Zhang M, Zhou M, Tang F, *et al.* Knowledge, attitude, and practice regarding COVID-19 among healthcare workers in Henan, China. *Journal of Hospital Infection* 2020;105(2):183–187. https://doi.org/10.1016/j.jhin.2020.04.012
16. Xinmin Evening News.Shanghai's family doctor team: acting as the gatekeeper of residents' health and guarding the first gate of community epidemic prevention and control Epidemic Prevention and Control Conferenc. news.sina.com.cn .2020.https://news.sina.com.cn/o/2020-05-18/doc-iirczymk2252223.shtml;2020.
17. General Office of the National Health Care Commission. General Office of the National Health and Wellness Commission on the issuance of Technical Guidelines for the Protection of Medical Personnel during the New Coronary

Pneumonia Outbreak (for Trial Implementation).www.gov.cn .2020.http://www.gov.cn/zhengce/zhengceku/2020-02/20/content_5481310.htm;2020.

18. Feng X, Hua Z, Shi Q, *et al.* An analysis of the knowledge, beliefs, and behaviors of primary health care workers on the protection against neonic pneumonia. *China Rural Health Management* 2020;40(6):6.
19. World Health Organization (WHO). Basic protective measures against the new coronavirus/who.int .2020.http://who.int/emergencies/diseases/novel-coronavirs-2019/advice-fo-public;2020.
20. Parikh, P. A., Shah, B. V., Phatak, A. G., *et al*. COVID-19 Pandemic: Knowledge and Perceptions of the Public and Healthcare Professionals. *Cureus* 2020.https://doi.org/10.7759/cureus.8144.
21. Bureau of disease control and Prevention. Guidelines for public protection of pneumonia caused by New Coronavirus. *Beijing.People's Health Publishing House* 2020.
22. Lin Q, Huang Y,Sun G. Feasibility of reuse and disinfection of single-use medical masks in a novel coronavirus pneumonia pandemic.*Journal of Nursing Management* 2020;20:280-284.
23. Qi Y,Chen L,Zhang L,*et al.* Public practice,attitude and knowledge of coronavirus disease.*Journal of Tropical Medicine* 2020;20:145-149.
24. Lou M,Jiang Y,Liu Z.Anxiety and depression analysis of the general public people during the COVID-19. Chinese *Journal of Disaster Medicin*e

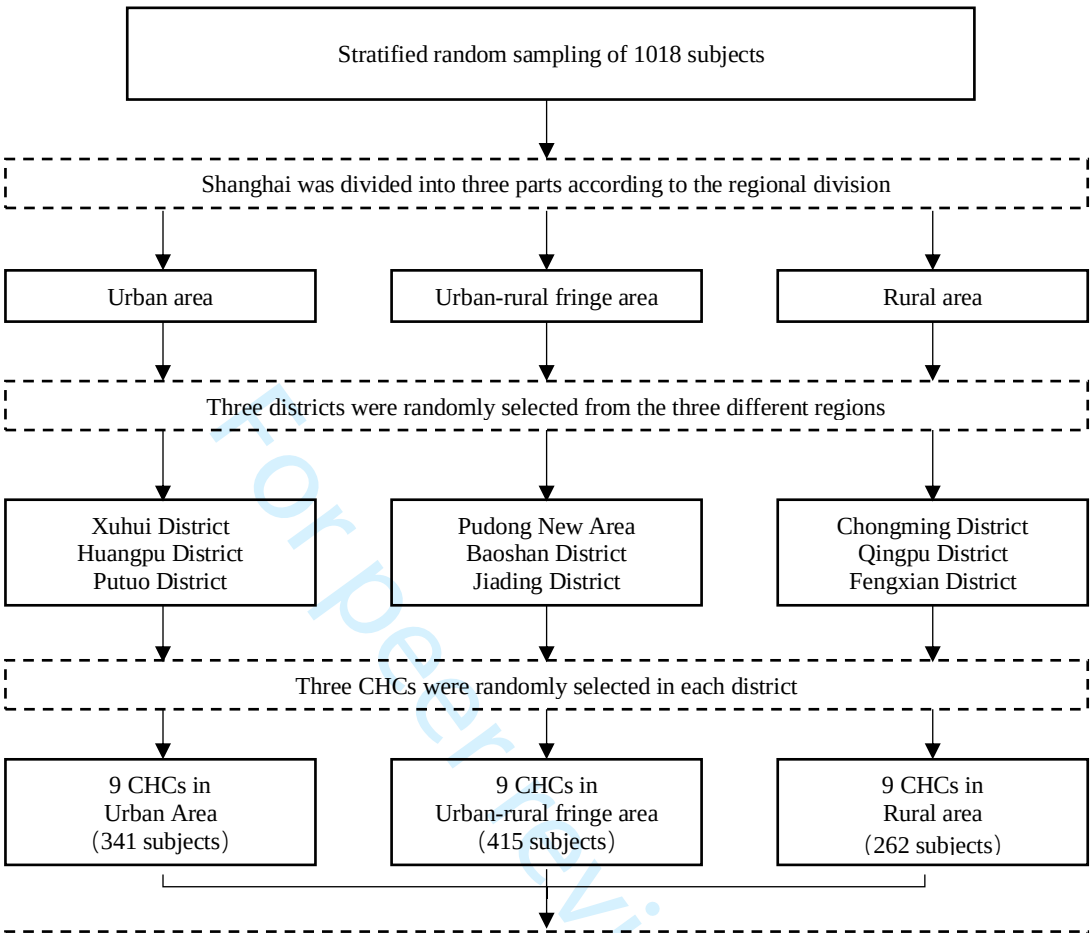
2020;8(9):481-484.

25. Abdel Wahed WY, Hefzy EM, Ahmed MI. Assessment of Knowledge, Attitudes, and Perception of Health Care Workers Regarding COVID-19, A Cross-Sectional Study from Egypt. *Journal of Community Health* 2020.
26. Dong Y. Refined governance and community epidemic prevention and control mechanisms in megacities: A case study of community epidemic prevention and control at the grassroots level in Shanghai. *Social Science Series* 2020;9.
27. Zhu Z, Xu S, Wang H, *et al.* COVID-19 in Wuhan: Sociodemographic Characteristics and Hospital Support Measures Associated with the Immediate Psychological Impact on Healthcare Workers. *SSRN Electronic Journal* 2020.
28. Yan S, Xu R, Stratton TD, *et al*. Sex differences and psychological stress: responses to the COVID-19 pandemic in China. *BMC Public Health* 2021;21.
29. Kumar J, Katto MS, Siddiqui AA, *et al.* Knowledge, Attitude, and Practices of Healthcare Workers Regarding the Use of Face Mask to Limit the Spread of the New Coronavirus Disease (COVID-19). *Cureus* 2020;12.
30. Li C, Huang X, Cai G,*et al.* Expert consensus on personal protection in different work areas of healthcare institutions during the New Coronary Pneumonia outbreak. *Chinese Journal of Infection Control* 2020;19(3):15.
31. Ran L, Chen X, Wang Y,*et al*. Risk Factors of Healthcare Workers with Corona Virus Disease 2019: A Retrospective Cohort Study in a Designated Hospital of Wuhan in China. *Clinical Infectious Diseases* 2020.
32. World Health Organization (WHO). WHO SAVES LIVES: Clean your hands in

the context of COVID-19. www.who.int .2020.https://www.who.int/publications/m/item/who-saves-lives-clean-your-hands-in-the-context-of-covid-19;2020.

33. Papagiannis D, Malli F, Raptis DG, *et al*. Assessment of Knowledge, Attitudes, and Practices towards New Coronavirus (SARS-CoV-2) of Health Care Professionals in Greece before the Outbreak Period. International *Journal of Environmental Research and Public Health* 2020;17:4925.
34. Al ahdab, S. A cross-sectional survey of knowledge, attitude and practice (KAP) towards COVID-19 pandemic among the Syrian residents. *BMC Public Health* 2020;21(1).

Fig. 1 Sampling flow chart



STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-5	
Objectives	3	State specific objectives, including any prespecified hypotheses	3-5	
Methods				
Study design	4	Present key elements of study design early in the paper	5-6	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-9	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5-6	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-9	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-8	
Bias	9	Describe any efforts to address potential sources of bias	7-8	
Study size	10	Explain how the study size was arrived at	7-8	

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	7-8
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	7-8
		(*e*) Describe any sensitivity analyses	7-8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8-9
		(c) Consider use of a flow diagram	8-9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	8-9
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9
		(*b*) Report category boundaries when continuous variables were categorized	8-9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-9

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	18, 19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18, 19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	18, 19
Generalisability	21	Discuss the generalisability (external validity) of the study results	18, 19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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

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Knowledge, Attitude and Behavior of General Practitioners in Shanghai during the Pandemic of COVID-19: A Cross Sectional Study

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Knowledge, Attitude and Behavior of General Practitioners in Shanghai during the Pandemic of COVID-19: A Cross Sectional Study

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Abstract

Objectives To grasp the knowledge, attitude and behavior of general practitioners (GPs) towards COVID-19, and to provide evidence for better prevention and control of the pandemic. **Study design** A cross-sectional study was conducted with 1018 GPs in Shanghai from February 21 to March 2, 2020 by using wechat platform. **Methods** Stratified random cluster sampling was adopted according to the regional division of urban area, urban-rural fringe area, and rural area. A

mobile self-designed questionnaire was used. The questionnaire collected knowledge,attitude and behavior regarding COVID-19 prevention and control. **Results** 989 questionnaires were valid. The average score of GPs' knowledge, attitude and behavior towards COVID-19 was 6.14±1.42 (range 0-10), 13.59±4.42 (range 0-25), 7.82±1.53 (range 0-10), respectively. Multiple linear regression analysis showed that knowledge score of male GPs was lower than that of female GPs (P=0.002). Attitude score of female GPs was higher than that of male GPs (P=0.004). Behavior score of GPs in urban areas was lower than that of GPs in urban-rural fringe areas (P<0.001). The higher the knowledge score, the higher the behavior score (P<0.001). **Conclusions** The scores for knowledge, attitude and behavior of Shanghai GPs towards COVID-19 was limited at the beginning of COVID-19 outbreak. The scores for knowledge, attitude and behavior of Shanghai GPs towards COVID-19 was limited at the beginning of COVID-19 outbreak. Early implementation of proper training programs for GPs in times of crisis will contribute to disease control and prevention. Lessons learned from the current pandemic will help GPs in effectively handling any possible similar future challenges and possible new pandemics in the future.

Keywords General practitioner；COVID-19；Knowledge；Attitude；Behavior

Strengths and limitations of this study

- This study was conducted on general practitioners who participated in community pandemic prevention and control as the main force for the first time at the early stage of the COVID-19 pandemic in Shanghai, a city with highly developed economy and high population mobility.
- According to the regional division of Shanghai, stratified random cluster sampling was adopted.
- This was one of the first large-scale cross-sectional study of knowledge, attitude and behavior of general practitioners at the early beginning of COVID-19.
- Although stratified random cluster sampling was adopted, one-to-one interview could not be conducted during the pandemic. All the participants completed the questionnaire using Wechat.
- As the study was based on a cross-sectional design, a causal relationship could not be inferred with certainty

Introduction

Coronavirus disease (COVID-19) is an emerging infectious disease[1].In December 2019, COVID-

19 cases were first confirmed in Wuhan, China, and subsequently reported nationwide and globally [1]. Up to February 20th, 2020, within the launch of the first-level response measures for major public health emergencies[2], the cumulative number of confirmed cases across the country had reached 125,529, and the cumulative number of deaths had reached 5,695 [3]. Meanwhile, 2,055 medical workers who participated in the treatment were reported to be infected with COVID-19 [4], mainly due to the lack of sufficient knowledge of COVID-19 [5].

Shanghai was the largest port city in China as well as international trade and shipping center [6]. The Shanghai municipal government issued regulation on community prevention and control network [7] as early as January 23rd, the same day Wuhan was closed down. However, by February 20th, 2020, the number of confirmed cases had reached 334.

The main force to undertake the task of community pandemic prevention and control is general practitioners (GPs), the gatekeeper of the health of community residents [8]. But, GPs have never been involved in community pandemic prevention before. In the face of the challenge of this emerging infectious disease, whether the GPs had mastered the correct knowledge, had high morale and normative behavior, so that they can protect themselves and educate community residents well, to win the tough fight? According to literature and theory, knowledge influences behavior directly or indirectly by attitude. We hypothesized that in this context, GP's knowledge could predict their attitude, and their knowledge and attitude could predict their behavior. To this end, we launched a survey of GPs' knowledge, attitude and behavior towards COVID-19 in Shanghai, aiming to find out the gaps and provide a basis for improving the pandemic prevention and control capacity at the grassroot level, so as to better control the pandemic.

Methods

Study Design and Population

This cross-sectional survey was conducted from February 21st to March 2rd, 2020. Stratified random cluster sampling was adopted. According to the regional division of Shanghai, regions were divided into the urban, urban-rural fringe, and rural areas [9]. Three districts were randomly selected from each of the three areas, and three community health service centers (CHCs) were randomly selected from each district [10].

According to the formula

$$n = \frac{\mu^2_{\alpha/2} P\ (1-P)}{\delta^2}$$

P=0.0222，1-P=0.9778，α=0.05，$\mu_{\alpha/2}$=1.96， δ=0.5P=0.0111,

$$n = \frac{1.96^2 \times 0.0222 \times 0.9778}{0.0111^2} = 676.1 \approx 677$$

n stands for the required sample size. $\mu_{\alpha/2}$ stands for the μ value when the cumulative probability from left to right is 1-α/2 (both sides) in the standard normal distribution. P stands for the accuracy rate of all the questions in the pre-survey. δ stands for the allowable error. Based on the pre-survey results of 30 respondents, P=0.0222,1-P=0.987, α=0.05 was set, $\mu_{\alpha/2}$=1.96, a 5 percent margin of error was set, then δ=0.5, P=0.00715, the required sample size would be at least 677. At a 20% shedding rate, the total sample size would be at least 847. Finally, a total of 1018 on-the-job GPs in the above 27 CHCs were investigated, including 341 GPs in urban area, 415 GPs in urban-rural fringe area, and 262 GPs in rural area（Fig 1）. No incentive was offered for completion of the questionnaire.

Measurement Tool

A self-designed questionnaire was used in the survey, based on the COVID-19 literature published by World Health Organization and the Chinese Center for Disease Control and Prevention (CDC) [11-14]. The questionnaire was pre-tested on a small sample of 30 GPs from three CHCs and some of the questions were adjusted after the pre-survey. The questionnaire collected: ①General information of the respondents: region, gender, age, education level, years of work, professional title, and marital status. ②Knowledge regarding COVID-19: There are 6 single-choice questions and 4 multiple-choice questions. For all multiple-choice questions, respondents must check all the correct items to be judged as correct. Each correctly answered question scores 1 point and the total score is 10 points. ③Attitude towards COVID-19 pandemic: There are 5 questions in total. In answering each question, the extent of concern about COVID-19 is graded into 5 degrees. The score of 1 point for "not worried at all", 2 for "not very worried", 3 for "somewhat worried ", 4 for "quite worried" and 5 for "very worried". The total score is 25 points. ④Behavior for COVID-19

prevention and control: There are 10 single-choice questions. Each correctly answered question scores 1 point and the total score is 10 points. The total Cronbach's alpha coefficient for the questionnaire was 0.844, indicating that the internal consistency was acceptable.

Data Collection

The cross-sectional study was conducted by using wechat platform. All items in the questionnaire were required. If there were uncompleted items, the questionnaire could not be submitted, and the same IP address could only be used to submit the questionnaire once. Written consent was obtained from all respondents before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Zhongshan Hospital, Fudan University (B2020-027).

Statistical Analysis

Excel (Microsoft Office Professional Plus 2010) was used to establish the database, and SAS (Version 9.4) was used for data processing and analysis. Continuous variables were presented as mean±standard deviation($\bar{x} \pm SD$) and categorical variables as frequency (percentage). Kruskal-Wallis test was used as univariate analysis to compare the knowledge, attitude and behavior scores in different subgroups. The factors which had statistical significance in the single-factor analysis, were taken as the predictors in the multiple linear regression analysis to identify the potential impact factors related to knowledge, attitude and behavior scores. For categorical variables, such as region, were entered as dummy variables. For ranked variables, such as education level and professional title, were entered as ordinal variables. All of the tests for significance were two-sided. The P-Values of univariate analysis<0.1 and multiple linear regression analysis<0.05 were considered statistically significant.

Patient and public involvement

The public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Results

Characteristics of participants

1,018 GPs were invited to participate in the survey, and 996 questionnaires were collected, with a response rate of 97.84% (996/1018). Among the 996 questionnaires, 989 questionnaires were valid,

with a quality conformity rate of 99.30% (989/996). There were 279 males and 710 females and the average age was 39.18, ranging from 23 to 59. Bachelor degree and above accounted for 88.47% (Table 1) .

Table 1 The score of Knowledge, Attitude and Behavior regarding COVID-19 of GPs

Characteristics	Number of participants (%)	Knowledge score ($\bar{x} \pm SD$)	Attitude score ($\bar{x} \pm SD$)	Behaviour score ($\bar{x} \pm SD$)
Total	989(100)	6.14±1.42	13.59±4.42	7.82±1.53
Region				
Urban area	336(33.97)	6.09±1.46	13.63±4.26	7.64±1.60
Urban-rural fringe area	396(40.04)	6.20±1.40	14.04±4.29	8.14±1.35
Rural area	257(25.99)	6.12±1.42	12.85±4.74	7.57±1.60
χ2		1.288	10.975	28.570
P		0.525	0.004	<.001
Gender				
Male	279(28.21)	5.90±1.41	12.89±4.89	7.49±1.71
Female	710(71.79)	6.24±1.42	13.87±4.20	7.95±1.43
χ2		11.548	9.400	14.710
P		<.001	0.002	<.001
Age (year)				
≤29	131(13.25)	6.23±1.40	12.96±4.27	8.13±1.46
30~39	414(41.86)	6.22±1.39	13.87±4.32	7.84±1.49
40~49	327(33.06)	6.08±1.49	13.98±4.31	7.80±1.54
≥50	117(11.83)	5.96±1.39	12.21±4.94	7.47±1.62
χ2		4.757	15.274	11.976
P		0.191	0.002	0.008
Education				
College degree and	114(11.53)	5.90±1.42	12.55±4.54	7.67±1.71
Bachelor degree	736(74.42)	6.15±1.42	13.72±4.42	7.85±1.50
Master degree or above	139(14.05)	6.31±1.44	13.73±4.27	7.78±1.53
χ2		5.172	6.290	0.590
P		0.075	0.043	0.745
Years of work				
	83(8.39)	6.29±1.49	12.96±4.32	8.14±1.62
5~9	202(20.42)	6.09±1.40	13.91±4.36	7.95±1.45
10~19	317(32.05)	6.29±1.34	13.72±4.22	7.81±1.46
≥20	387(39.13)	6.03±1.48	13.45±4.63	7.69±1.59
χ2		7.773	3.333	9.209
P		0.051	0.343	0.027
Professional title				
Resident	227(22.95)	6.03±1.41	13.37±4.56	7.91±1.56
Attending physician	591(59.76)	6.16±1.42	13.90±4.26	7.80±1.51
Associate chief physician or above	171(17.29)	6.25±1.44	12.81±4.71	7.79±1.55
χ2		1.759	9.153	1.979
P		0.415	0.010	0.372
Marriage				
Unmarried	195(19.72)	6.06±1.38	12.71±4.44	7.76±1.67
Married	794(80.28)	6.17±1.43	13.81±4.40	7.84±1.49
χ2		0.963	8.763	0.009
P		0.327	0.003	0.926

Abbreviation: SD=Standard Deviation

Knowledge and behavior scores of GPs regarding COVID-19

The correct response rate of the 989 GPs of each question on knowledge was 25.58%-97.88% (Table 2). The average knowledge score was 6.14±1.42 (Table 1). Among them, the correct response rate of 'Which of the following objects or conditions can kill Novel Coronavirus?' was the lowest, accounting for 25.58%. The correct response rate of 'What are the transmission route of Novel Coronavirus' was the second lowest, accounting for 29.63% (Table 2).

The average behaviour score was 7.82±1.53(Table 1). The correct response rate of the 989 GPs of each behaviour question was 51.77-97.07% (Table 2). Among them, the correct response rate of 'Do your hands touch the external surface of the face mask after you put it on?' , 'What is your step to remove a disposable surgical mask?' , 'When you wear a disposable surgical mask, how to fit it entirely to the face?' , 'Have you taken the initiative to publicize the "six-step hand-washing method" since the COVID-19 outbreak' were the lowest, accounting for 51.77%, 58.54% , 63.70% and 64.00%, respectively (Table 2).

Table 2 The Correct Response Rate of GPs on Knowledge and Behavior regarding COVID-19 (N=989)

Questions	n (%)
Knowledge	
1.Which of the following objects or conditions can kill Novel Coronavirus?	253(25.58)
2.What is the transmission route of Novel Coronavirus?	293(29.63)
3.What kind of face mask should you wear when you make home visits to quarantined residents?	302(30.54)
4.Does disposable surgical mask need to be replaced if it is wet or dirty?	318(32.15)
5.What do you think is the minimum social safe distance between people ?	686(69.36)
6.What is the appropriate replacement time of disposable surgical masks?	769(77.76)
7.Do you know the steps of "six-step hand-washing method"?	806(81.50)
8.What kind of face mask should you wear in community clinics during epidemic period?	808(81.70)
9.Do you know what kind of face mask has the effect of preventing Novel Coronavirus?	874(88.37)
10.How long should close contacts be quarantined?	968(97.88)
Behavior	
1.Do your hands touch the external surface of the face mask after you put it on?	512(51.77)
2.What is your step to remove a disposable surgical mask?	579(58.54)
3.When you wear a disposable surgical mask, how to fit it entirely to the face?	630(63.70)

4.Have you taken the initiative to publicize the "six-step hand-washing method" since the COVID-19 outbreak?	633(64.00)
5.Do your hands touch the external surface of the face mask while removing it?	823(83.22)
6.Have you started using the "six-step hand-washing method" since the COVID-19 outbreak?	853(86.25)
7.Do you wash your hands before putting on a face mask?	899(90.90)
8.Have you increased hand-washing frequency since the COVID-19 outbreak?	913(92.32)
9.When you wear disposable surgical masks, how to recognize the external and inner face mask surface correctly?	933(94.34)
10.When you wear disposable surgical masks, how to recognize the upper and lower edge correctly?	960(97.07)

Attitude scores of GPs regarding COVID-19

The average attitude score of 989 GPs on COVID-19 was 13.59±4.42 (Table 1). 26.29% of the GPs were very worried that themselves or their family member might get infected by Novel Coronavirus. 7.58% were very worried that their life was threatened by COVID-19 (Table 3).

Table 3 GPs' Attitude Score Regarding COVID-19 (N=989)

	n (%)					
Questions	Not worried at all	not worried	somewhat worried	quite worried	very worried	Score
1.Are you worried that yourself or your family member might get infected by Novel Coronavirus?	98(9.91)	159(16.08)	281(28.41)	191(19.31)	260(26.29)	3.36±1.29
2.Are you worried you'll be quarantined if you get infected?	114(11.53)	188(19.01)	338(34.18)	170(17.19)	179(18.10)	3.11±1.24
3.Are you worried that the pandemic might be out of control and the virus will spread widely?	141(14.26)	221(22.35)	341(34.48)	155(15.67)	131(13.25)	2.91±1.21
4.Do you feel	241(24.37)	317(32.05)	258(26.09)	98(9.91)	75(7.58)	2.44±1.18

your life threatened by COVID-19? 5.Do you suspect that you have been infected with Novel Coronavirus?	460(46.51)	366(37.01)	120(12.13)	25(2.53)	18(1.82)	1.76±0.89
Total						13.59±4.42

Univariate analysis of GPs' knowledge,attitude and behavior towards COVID-19

Univariate analysis showed that male GPs' knowledge score was lower than female GPs' (P< 0.01). GPs with college education and below, and those who had worked for 20 years or longer had the lowest knowledge score (P<0.1). Female GPs were more worried than male GPs (P=0.002). GPs who worked in urban-rural fringe area, aged 40-49, master degree or above, attending physician and married were the most worried (P<0.05). Male GPs had the lower behavior score (P < 0.01) . GPs worked in rural areas, age 50 or above, over 20 years of work had the lowest behavior score (P < 0.05) (Table 1).

Multiple linear regression analysis of GPs' knowledge,attitude and behavior towards COVID-19

Multiple linear regression analysis showed that knowledge score of male GPs was lower than that of female GPs (P=0.002). Attitude score of female GPs was higher than that of male GPs (P=0.004). Married GPs was higher than that of unmarried GPs (P=0.021). Behavior score of GPs in urban areas was lower than that of GPs in urban-rural fringe areas (P<0.001). Male GPs' behavior scores were lower than female GPs' (P=0.002). The higher the knowledge score, the higher the behavior score (P<0.001)(Table 4).

Table 4 Multiple linear regression on factors associated with Shanghai GPs' knowledge, attitude and behaviour score regarding COVID-19

	Knowledge Score	
Variable	Coefficient (95% CI)	*P*
Knowledge Score		
Female	0.32 (0.12, 0.52)	0.002
Education Level*	0.15 (-0.01, 0.31)	0.074

Years of work Level*	-0.03 (-0.13, 0.07)	0.532
Attitude Score		
Urban-rural fringe area	0.42 (-0.23, 1.06)	0.203
Rural area	-0.43 (-1.18, 0.32)	0.258
Female	0.90 (0.29, 1.51)	0.004
Age group level*	-0.02 (-0.46, 0.41)	0.913
Education Level*	0.37 (-0.19, 0.92)	0.200
Professional title Level*	-0.20 (-0.73, 0.33)	0.458
Married	0.88 (0.13, 1.63)	0.021
Knowledge Score	0.01 (-0.18, 0.21)	0.890
Behaviour Score		
Urban-rural fringe area	0.44 (0.23, 0.66)	<.001
Rural area	-0.05 (-0.28, 0.18)	0.673
Female	0.32 (0.12, 0.52)	0.002
Age group Level*	-0.12 (-0.31, -0.06)	0.198
Years of work Level*	0.01 (-0.16,0.17)	0.951
Knowledge Score	0.28 (0.22, 0.34)	<.001
Attitude Score	0.02 (0, 0.04)	0.065

* Education Level: 1=College degree and below, 2=Bachelor degree, 3=Master degree or above;
*Years of work Level: 1=less than 5, 2=5~9, 3=10~19, 4=greater or equal than 20;
*Age group Level: 1=less and equal than 29, 2=30~39, 3=40~49, 5=greater or equal than 50;
*Professional title Level: 1=Resident, 2=Attending physician,3=Associate chief physician or above.
Abbreviation: CI=Confidence Interval

Discussion

Of the 989 GPs who were respondents of our study, their average age was 39.18 years old, among whom 88.2% were younger than 50, and 88.47% had bachelor's degree or above. This was a relatively young team with high education level. However, the average score was 6.14 ± 1.42 (range 0-10), which was much lower than that of the online survey of 1,357 medical workers in Henan Province conducted by Zhang M et al. at the same time[15]. This is worrying. GPs are the main force in this community pandemic prevention and control campaign against COVID-19 in Shanghai[16]. How can GPs with poor knowledge on COVID-19 lead the community to win the pandemic prevention and control campaign? It was necessary for GPs to master the transmission route of Novel Coronavirus [17], so as to protect themselves and to educate the population well. However, the correct response rate of Shanghai GPs' knowledge of transmission route was only 29.63%. Feng Xiang et al. demonstrated the correct response rate of 43.27% in an online survey of 617 medical workers in Jiangsu Province in early March 2020[18]. Blocking transmission route is

especially important for infectious diseases. Therefore, it is necessary to strengthen training of basic knowledge of infectious diseases. During the pandemic, people need to keep a safe social distance of at least one meter [19]. However, only 69.36% of the GPs have mastered the social safety distance during the pandemic [20], which was much lower than the correct response rate of Parikh PA's survey of 744 medical personnel in India in March 2020 [20]. Thus, social safety distance is another weak point that needs to be focused on in pandemic training.CDC recommends using medical masks and N95 masks in preventing novel coronavirus [21]. Our study showed that GPs had a high rate of 88.37% for choosing the correct face masks. But the rate for choosing the correct face mask when making home visits to quarantined residents was only 30.54%. Many GPs only chose N95 masks on this occasion. However, when visiting people quarantined at home, either of the disposable surgical mask or N95 mask is optional [12]. Compared with disposable surgical masks, N95 respirators are optimized in structure with core filtration and their filtering efficiency raised up to 95% [22]. Such choice might be due to the great fear caused by the outbreak of the pandemic at that time, and many GPs prefer excessive protection. Under the circumstances of lacking medical supplies for pandemic prevention, it is necessary to ensure not only the safety of GPs, but also the scientific and rational use of medical supplies. Disposable surgical masks should be discarded at the interval of 4 hours and should also be replaced when they are wet or dirty [11,21]. If the filter layer of a disposable surgical mask absorbs moisture or gets dirty, the filtering function will be reduced or even lost [11]. However, the correct awareness of GPs of the discard interval and occasion was 35.19% and 51.26%, respectively. Therefore, it is essential to make GPs master the correct discard interval and occasion of disposable surgical masks.

Univariate and Multivariate analysis showed that male GPs had lower knowledge scores than female GPs, which was consistent with the results of an online survey of residents around the country on COVID-19 conducted by Qi Y at the end of January 2020.[23] Women tend to be in the center of family life and were usually more nervous about the pandemic [24]. They were more serious about the prevention of the pandemic for the health of themselves and their families and were more willing to follow standardized measures [24].

The score of worry of GPs regarding COVID-19 was 13.59±4.42, which was between not worried and somewhat worried. The proportion of GPs who were somewhat worried, quite worried and very worried that themselves or their family members might get infected by Novel Coronavirus was 28.41%, 19.31% and 26.29%, respectively. In general, the proportions of GPs with worry were slightly lower than the studies conducted by Zhang M et al.[15] and Abdel Wahed WY et al.[25]. This can indirectly reflect the relatively perfect prevention and control work in Shanghai. For the

question, 'Do you feel your life threatened by COVID-19?', the proportion of those GPs who were not worried at all and not worried was 56.42%. And those who were quite worried and very worried was only 17.49%. This demonstrated that Shanghai GPs had confidence in China's pandemic prevention and control capability although they knew the highly contagious nature of Novel Coronavirus. This confidence might also be related to the experience in handling pandemic of Severe Acute Respiratory Syndrome in Shanghai in 2003. Shanghai's pandemic control and prevention capability has improved step by step in the past 17 years [26].

Multivariate analysis showed that gender and marriage were the influencing factors of attitude regarding COVID-19 for GPs, which was consistent with the online survey of Zhu Z et al. of 5,062 medical workers in Wuhan Tongji Hospital in February 2020 [27]. Female GPs were more anxiety in the face of COVID-19. An online survey conducted by Shiyan Yan et al. on 3,088 people in February 2020 also showed gender differences on stress [28]. Married people take more responsibilities for their families and worry more. Therefore, for these GPs, appropriate psychological support should be provided to reduce their psychological pressure.

Doctor is a high-risk profession. If GPs wore face mask in an incorrect way, they would be at the risk of being infected [29]. In our study, although 88.37% of the GPs selected the correct type of face mask to prevent the invasion of COVID-19, only 63.70% of them knew how to fit disposable surgical mask entirely to the face. The correct percentage of GPs for hands not touching the external surface of the face mask while wearing it was only 51.77%, and the percentage of GPs who had mastered the correct step to remove a disposable surgical mask was only 58.54%. Therefore, it is necessary to emphasize the proper way to wear face masks in detail in GP training. Contact transmission is a major route of COVID-19 transmission. Therefore, hand hygiene is as important as wearing masks and keeping a safe social distance [30]. Ran L et al. demonstrated that hand hygiene was closely related to COVID-19 infection through his investigation of 72 medical workers in Wuhan in January 2020 [31,32]. After the outbreak of COVID-19, Shanghai GPs' hand-washing frequency increased by 92.32% and the number of GPs who strictly used 'six-step hand-washing method' increased by 86.25% compared with that before the outbreak[32]. The majority of GPs performed well in hand hygiene, which was consistent with the survey of 744 medical personnel in India [20]. Moreover, educating the public is also the social responsibility that GPs should take on their initiative. However, only 64.00% of Shanghai GPs actively publicized the "six-step hand-washing method" to the public. Therefore, GPs should have the awareness of educating the public to improve the efficiency of pandemic prevention and control.

Both of the univariate and multivariate analysis showed that behaviour score of male GPs was lower than that of female GPs, which was consistent with the survey of 461 medical workers conducted by Dimitrios Papagiannis et al. in Greece in February 2020 [33]. Women are better than men in knowledge mastery and more nervous than men in attitude. It is understandable that they are more serious in behavior implementation. Our study also showed that the higher the knowledge score, the higher the behavior score. It was consistent with the survey of 706 Syrian residents conducted by Sanaa Al ahdab et al. in April 2020 [34]. Therefore, there is a need for further training of GPs to improve their understanding of the disease and the correct behaviour towards pandemic prevention in their communities.

Conclusions

This is a large-scale cross-sectional survey of GPs' knowledge, attitude and behavior towards COVID-19 in Shanghai, a city with highly developed economy and high population mobility. GPs, as the "health gatekeepers" of the community, are in the important position of the community grid management system, and their knowledge, attitude and behavior will greatly affect the results of prevention and control of pandemic. However, according to our survey of GPs in Shanghai, their related knowledge was limited at the difficult initial phase when protective equipment and knowledge of COVID-19 were lacking and their behaviors towards COVID-19 needed improving. When confronted with the sudden breakout of a new emerging contagious disease, it is important to train GPs the appropriate coping strategies in time. At the same time, we should also care about the physical and mental health of GPs to build a strong frontline of community prevention and control. Lessons learned from the current pandemic will help GPs in effectively handling any possible similar future challenges and possible new pandemics in the future.

Limitations

The survey has some limitations. Although stratified random cluster sampling was adopted, one-to-one interview could not be conducted during the pandemic. Thus, although the study did provide necessary reference for the gap in knowledge, attitude and practice of GPs, the extrapolation of conclusions to the population was limited to some extent. Secondly, as the study was based on a cross-sectional design, a causal relationship could not be inferred with certainty. We can do in-depth research in the future.

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Contributors

Jian Wang conceived and designed the study, implemented the research and helped to draft and revise the manuscript. Huiyun Tang implemented the research, conducted data collection and helped to draft the manuscript. Jialiang Fang and Boxiang Tu performed data collection and statistical analysis. All the authors contributed to the preparation of the final document, and had read and approved the final manuscript.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not reported

Ethics approval This study involves human participants. Written consent was obtained from all respondents before the investigation which was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Zhongshan Hospital, Fudan University (B2020-027). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

References

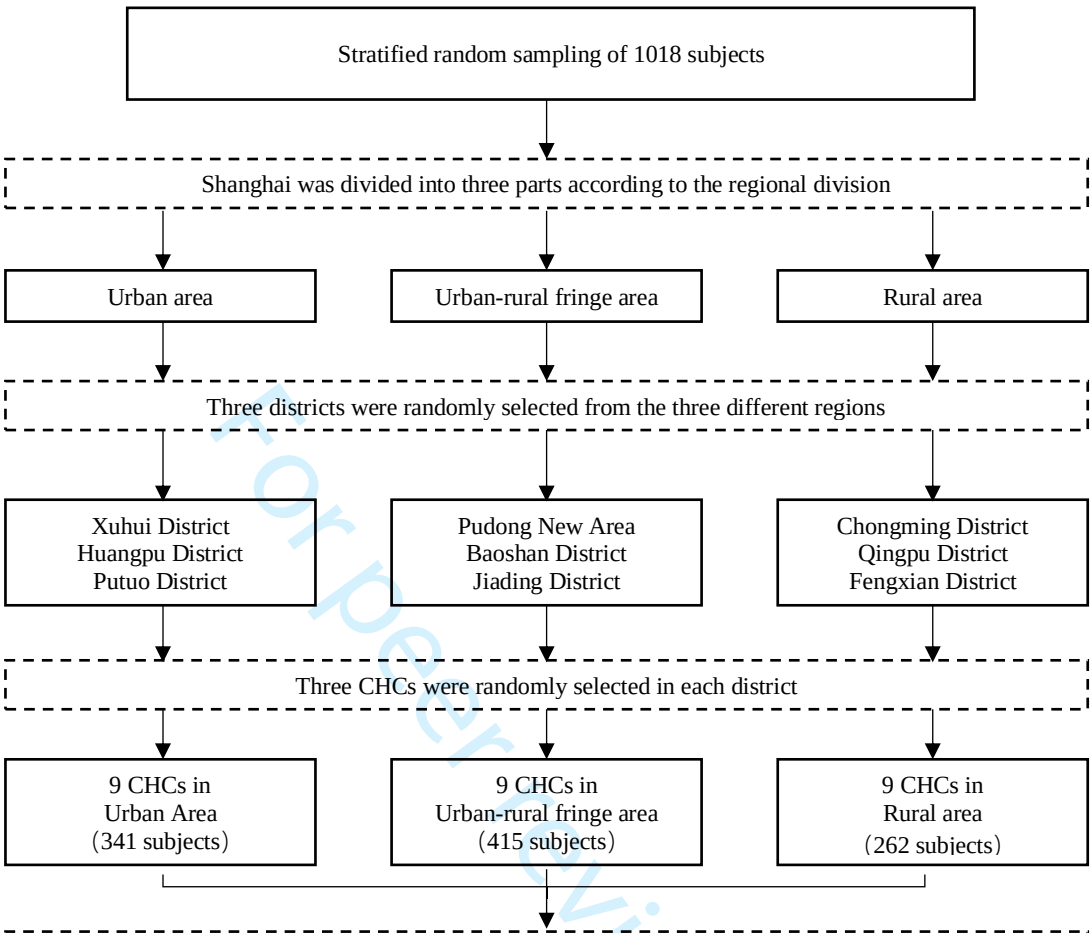
1. Zhang, H. (2020). Early lessons from the frontline of the 2019-nCoV outbreak. *The Lancet*, *395*(10225), 687. https://doi.org/10.1016/s0140-6736(20)30356-1.
2. CCTV. (2020). 30 provinces, cities and autonomous regions launch Level 1 response to major public health emergencies. Retrieved from baijiahao.baidu.com website: https://baijiahao.baidu.com/s?id=1656706957364692630&wfr=spider&for=pc.
3. Chinese Journal of General Practitioners. (2020). Practical prevention and control of novel coronavirus infection at the primary level. Retrieved from Weixin Official Accounts Platform website: https://mp.weixin.qq.com/s/K1ymC-L3u6J2vMiEraeG1w.
4. Chutian Metropolis Daily. (2020). Central steering group again pays tribute to fallen medical staff as more than 2,000 infected. Retrieved November 18, 2021, from baijiahao.baidu.com website: https://baijiahao.baidu.com/s?id=1659772948930826692&wfr=spider&for=pc&searchword=2.20.
5. World Health Organization (WHO). (2020).Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19).Retrieved from https://www.who.int/publications-detail/report-of-the-who-china-jointmission-on-coronavirus-disease-2019-(covid-19).
6. State Council of China.(2017).Approval of the State Council on the Shanghai City Master Plan. Retrieved from http://www.gov.cn/zhengce/content/2017-12/25/content_5250134.htm.
7. China News Network.(2020).Shanghai "strictest measures, fastest speed" to prevent and control the new coronavirus pneumonia pandemic.Retrieved from http://www.chinanews.com/sh/2020/01-23/9068502.shtml.
8. People's Daily. (2020).People's Times Review: Building a firm "community defense line" for epidemic prevention and control.Retrieved from http://www.nhc.gov.cn/jkj/s7916/202001/44a3b8245e8049d2837a4f27529cd386.shtml.
9. Song, S. D., Liu, P., & Monday, S. (2006). The division of urban and rural physical regions in Shanghai. *Journal of Geography, 61*(8), 11.
10. Xu,J., Peng,Y., Shi,Y., et al.(2019). A study on hospice service provision and compensation in Shanghai community health service centres. *China Health Economics, 38*(8), 4.
11. Bureau of Disease Control and Prevention.(2020).National Health and Health Commission. Notice on issuing guidelines on protection for people at different risks of novel coronavirus infection and guidelines on the use of pneumonia masks for the prevention of novel coronavirus infection.Retrieved from http://www.gov.cn./zhengceku/2020-01/31/content_5473401.htm.
12. General Office of the National Health Care Commission. (2020).General Office of the National Health and Health Commission on the issuance of guidelines for the prevention and control of pneumonia caused by novel coronavirus infection in Notice on the Guidelines for Prevention and Control of Infection under Medical Observation in Home Isolation (for Trial Implementation).Retrieved from http://www.gov.cn/zhengce/zhengceku/2020-02/05/content_5474688.htm.
13. General Office of the National Health Care Commission.(2020).Novel Coronavirus Pneumonia Treatment Protocol (Trial Version 6).Retrieved from http://www.nhc.gov.cn/yzygj/s7652m/202002/54e1ad5c2aac45c19eb541799bf637e9.shtml.

14. World Health Organization (WHO).(2020). Advice on the outbreak of novel coronavirus (2019-nCoV) in the community, home care and health care settings Use of masks. Retrieved from https://apps.who.int/iris/bitstream/handle/10665/330987/WHO-nCov-IPC_Masks-2020.1-chi.pdf.
15. Zhang, M., Zhou, M., Tang, F., et al. (2020). Knowledge, attitude, and practice regarding COVID-19 among healthcare workers in Henan, China. *Journal of Hospital Infection, 105*(2), 183-187. https://doi.org/10.1016/j.jhin.2020.04.012.
16. Xinmin Evening News.(2020).Shanghai's family doctor team: acting as the gatekeeper of residents' health and guarding the first gate of community epidemic prevention and control | Epidemic Prevention and Control Conference.Retrieved from https://news.sina.com.cn/o/2020-05-18/doc-iirczymk2252223.shtml.
17. General Office of the National Health Care Commission. (2020). General Office of the National Health and Wellness Commission on the issuance of Technical Guidelines for the Protection of Medical Personnel during the New Coronary Pneumonia Outbreak (for Trial Implementation).Retrieved from http://www.gov.cn/zhengce/zhengceku/2020-02/20/content_5481310.htm.
18. Feng,X., Hua,Z., Shi,Q.,et al. (2020). An analysis of the knowledge, beliefs, and behaviors of primary health care workers on the protection against neonic pneumonia. *China Rural Health Management, 40*(6), 6.
19. World Health Organization (WHO).(2020).Basic protective measures against the new coronavirus.Retrieved from.http://who.int/emergencies/diseases/novel-coronavirs-2019/advice-fo-public.
20. Parikh, P. A., Shah, B. V., Phatak, A. G., et al.(2020). COVID-19 Pandemic: Knowledge and Perceptions of the Public and Healthcare Professionals. *Cureus*. https://doi.org/10.7759/cureus.8144.
21. Bureau of disease control and Prevention.(2020).Guidelines for public protection of pneumonia caused by New Coronavirus. Beijing.People's Health Publishing House.
22. Lin,Q., Huang,Y.,Sun,G.(2020).Feasibility of reuse and disinfection of single-use medical masks in a novel coronavirus pneumonia pandemic.*Journal of Nursing Management,20*,280-284.
23. Qi,Y.,Chen,L.,Zhang,L.,et al.(2020).Public practice,attitude and knowledge of coronavirus disease.*Journal of Tropical Medicine,20*,145-149.
24. Lou,M.,Jiang,Y.,Liu,Z.,(2020).Anxiety and depression analysis of the general public people during the COVID-19. *Chinese Journal of Disaster Medicine,8*(9),481-484.
25. Abdel Wahed, W. Y., Hefzy, E. M., Ahmed, et al.(2020). Assessment of Knowledge, Attitudes, and Perception of Health Care Workers Regarding COVID-19, A Cross-Sectional Study from Egypt.*Journal of community health,45*(6),1242-1251. https://doi.org/10.1007/s10900-020-00882-0.
26. Dong,Y.(2020).Refined governance and community epidemic prevention and control mechanisms in megacities: A case study of community epidemic prevention and control at the grassroots level in Shanghai. *Social Science Series*,(3), 9.
27. Zhu,Z.,Xu,S.,Wang,H.,L,et al.(2020).COVID-19 in Wuhan:Sociodemographic characteristics and hospital support measures associated with the immediate psychological impact on

healthcare workers.*EClinicalMedicine*,*24*, 100443.https://doi.org/10.1016/j.eclinm.2020.100443.

28. Yan, S.,Xu, R.,Stratton,T. D.,et al.(2021). Sex differences and psychological stress: responses to the COVID-19 pandemic in China.*BMC public health,21*(1), 79.https://doi.org/10.1186/s12889-020-10085-w.
29. Kumar, J., Katto, M. S., Siddiqui, A. A., et al.(2020). Knowledge, Attitude, and Practices of Healthcare Workers Regarding the Use of Face Mask to Limit the Spread of the New Coronavirus Disease (COVID-19). *Cureus, 12*(4), e7737.https://doi.org/10.7759/cureus.7737.
30. Li,C.,Huang,X.,Cai,G.,et al.(2020). Expert consensus on personal protection in different work areas of healthcare institutions during the New Coronary Pneumonia outbreak. Chinese *Journal of Infection Control, 19*(3), 15.
31. Ran, L.,Chen, X.,Wang, Y.,et al.(2020).Risk Factors of Healthcare Workers With Coronavirus Disease 2019:A Retrospective Cohort Study in a Designated Hospital of Wuhan in China. *Clinical infectious diseases: an official publication of the Infectious Diseases Society of America*, *71*(16), 2218-2221. https://doi.org/10.1093/cid/ciaa287.
32. World Health Organization (WHO). (2020). WHO SAVES LIVES: Clean your hands in the context of COVID-19.Retrieved from.https://www.who.int/publications/m/item/who-saves-lives-clean-your-hands-in-the-context-of-covid-19.
33. Papagiannis, D., Malli, F., Raptis, D. G., et al.(2020). Assessment of Knowledge, Attitudes, and Practices towards New Coronavirus (SARS-CoV-2) of Health Care Professionals in Greece before the Outbreak Period. *International Journal of Environmental Research and Public Health, 17*(4925), 4925. https://doi.org/10.3390/ijerph17144925.
34. Al ahdab, S.(2021). A cross-sectional survey of knowledge, attitude and practice (KAP) towards COVID-19 pandemic among the Syrian residents. *BMC Public Health,21*(1). https://doi.org/10.1186/s12889-021-10353-3.

Fig. 1 Sampling flow chart



STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-5	
Objectives	3	State specific objectives, including any prespecified hypotheses	3-5	
Methods				
Study design	4	Present key elements of study design early in the paper	5-6	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5-7	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-8	
Bias	9	Describe any efforts to address potential sources of bias	7-8	
Study size	10	Explain how the study size was arrived at	7-8	

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	7-8
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	7-8
		(*e*) Describe any sensitivity analyses	7-8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8-9
		(c) Consider use of a flow diagram	8-9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	8-11
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	8-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-11
		(*b*) Report category boundaries when continuous variables were categorized	8-11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-11

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	18, 19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18, 19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	18, 19
Generalisability	21	Discuss the generalisability (external validity) of the study results	18, 19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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

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Knowledge, Attitude and Behavior of General Practitioners in Shanghai during the Pandemic of COVID-19: A Cross Sectional Study

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Knowledge, Attitude, and Behavior of General Practitioners in Shanghai during the Pandemic of COVID-19: A Cross-Sectional Study

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Abstract

Objectives To grasp the knowledge, attitude, and behavior of the general practitioners (GPs) toward COVID-19, and to provide evidence for better prevention and control of the pandemic. **Study design** A cross-sectional study was conducted with 1018 GPs in Shanghai from February 21 to March 2, 2020, by using the WeChat platform. **Methods** Stratified random cluster sampling was adopted according to the regional division of urban area, urban-rural fringe area, and rural area. A mobile self-designed questionnaire was used. The questionnaire collected

knowledge, attitude, and behavior regarding COVID-19 prevention and control. **Results** 989 questionnaires were valid. The average score of GPs' knowledge, attitude, and behavior toward COVID-19 were 6.14±1.42 (range 0-10), 13.59±4.42 (range 0-25), 7.82±1.53 (range 0-10), respectively. Multiple linear regression analysis showed that the knowledge score of male GPs was lower than that of female GPs (P=0.002). The attitude score of female GPs was higher than that of male GPs (P=0.004). The behavior score of GPs in urban areas was lower than that of GPs in urban-rural fringe areas (P<0.001). The higher the knowledge score, the higher the behavior score (P<0.001). **Conclusions** The scores for knowledge, attitude, and behavior of Shanghai GPs towards COVID-19 were limited at the beginning of the COVID-19 outbreak. The scores for knowledge, attitude, and behavior of Shanghai GPs towards COVID-19 were limited at the beginning of the COVID-19 outbreak. Early implementation of proper training programs for GPs in times of crisis will contribute to disease control and prevention. Lessons learned from the current pandemic will help GPs effectively handle any similar future challenges and possible new pandemics in the future.

Keywords General practitioner;COVID-19;Knowledge;Attitude;Behavior

Strengths and limitations of this study、

- This study was conducted on general practitioners who participated in community pandemic prevention and control as the leading force for the first time at the early stage of the COVID-19 pandemic in Shanghai, a city with a highly developed economy and high population mobility.
- According to the regional division of Shanghai, stratified random cluster sampling was adopted.
- This was one of the first large-scale cross-sectional studies of general practitioners' knowledge, attitude, and behavior at the early beginning of COVID-19.
- Although stratified random cluster sampling was adopted, the one-to-one interview could not be conducted during the pandemic. All the participants completed the questionnaire using Wechat.
- As the study was based on a cross-sectional design, a causal relationship could not be inferred with certainty.

Introduction

Coronavirus disease (COVID-19) is an emerging infectious disease[1]. In December 2019, COVID-19 cases were first confirmed in Wuhan, China, and reported nationwide and globally [1]. Up to February 20, 2020, within the launch of the first-level response measures for major public health emergencies[2], the cumulative number of confirmed cases across the country had reached 125,529, and the cumulative number of deaths had reached 5,695 [3]. Meanwhile, 2,055 medical workers who had helped to treat COVID-19 were infected[4], mainly due to insufficient knowledge of COVID-19 [5].

Shanghai was the largest port city in China and international trade and shipping center [6]. The Shanghai municipal government issued a regulation on community prevention and control network [7] as early as January 23, the same day Wuhan was closed down. However, by February 20, 2020, confirmed cases had reached 334.

The main force to undertake the task of community pandemic prevention and control was general practitioners (GPs), the gatekeeper of the health of community residents [8]. Nevertheless, GPs had never been involved in community pandemic prevention before. In the face of the challenge of this emerging infectious disease, did the GPs master the correct knowledge; have high morale and normative behavior to protect themselves; educate community residents well to win the tough fight? According to literature and theory, knowledge influences behavior directly or indirectly by attitude. We hypothesized that in this context, GP's knowledge could predict their attitude, and their knowledge and attitude could predict their behavior. To this end, we launched a survey of GPs' knowledge, attitude, and behavior towards COVID-19 in Shanghai, aiming to find the gaps and provide a basis for improving the pandemic prevention and control capacity at the grassroots level to control the pandemic better.

Methods

Study Design and Population

This cross-sectional survey was conducted from February 21st to March 2rd, 2020. Stratified random cluster sampling was adopted. According to the regional division of Shanghai, regions were divided into the urban, urban-rural fringe, and rural areas [9]. Three districts were randomly

selected from each of the three areas, and three community health service centers (CHCs) were randomly selected from each district [10].

According to the formula

$$n = \frac{\mu^2_{\alpha/2} P\ (1-P)}{\delta^2}$$

P=0.0222，1-P=0.9778，α=0.05，$\mu_{\alpha/2}$=1.96， δ=0.5P=0.0111,

$$n = \frac{1.96^2 \times 0.0222 \times 0.9778}{0.0111^2} = 676.1 \approx 677$$

n stands for the required sample size. $\mu_{\alpha/2}$ stands for the μ value when the cumulative probability from left to right is 1-α/2 (both sides) in the standard normal distribution. P stands for the accuracy rate of all the questions in the pre-survey. δ stands for the allowable error. Based on the pre-survey results of 30 respondents, P=0.0222, 1-P=0.987, α=0.05 was set, $\mu_{\alpha/2}$=1.96, a 5 percent margin of error was set, then δ=0.5, P=0.00715, the required sample size would be at least 677. At a 20% shedding rate, the total sample size would be at least 847. Finally, a total of 1018 on-the-job GPs in the above 27 CHCs were investigated, including 341 GPs in urban area, 415 GPs in urban-rural fringe area, and 262 GPs in rural area（Fig 1）. No incentive was offered for completion of the questionnaire.

Measurement Tool

A self-designed questionnaire was used in the survey, based on the COVID-19 literature published by World Health Organization and the Chinese Center for Disease Control and Prevention (CDC) [11-14]. The questionnaire was pre-tested on a small sample of 30 GPs from three CHCs, and some of the questions were adjusted after the pre-survey. The questionnaire collected: ①General information of the respondents: region, gender, age, education level, years of work, professional title, and marital status. ②Knowledge regarding COVID-19: There are 6 single-choice questions and 4 multiple-choice questions. For all multiple-choice questions, respondents must check all the correct items to be judged as correct. Each correctly answered question scores 1 point, and the total score is 10 points. ③Attitude towards COVID-19 pandemic: There are 5 questions in total. In answering each question, the extent of concern about COVID-19 is graded into 5 degrees. The score of 1 point for "not worried at all", 2 for "not very worried", 3 for "somewhat worried", 4 for

"quite worried", and 5 for "very worried". The total score is 25 points. ④Behavior for COVID-19 prevention and control: There are 10 single-choice questions. Each correctly answered question scores 1 point, and the total score is 10 points. The total Cronbach's alpha coefficient for the questionnaire was 0.844, indicating that the internal consistency was acceptable.

Data Collection

The cross-sectional study was conducted using the WeChat platform. All items in the questionnaire were required. If there were uncompleted items, the questionnaire could not be submitted, and the same IP address could only be used to submit the questionnaire once. Written consent was obtained from all respondents before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Zhongshan Hospital, Fudan University (B2020-027).

Statistical Analysis

Excel (Microsoft Office Professional Plus 2010) was used to establish the database, and SAS (Version 9.4) was used for data processing and analysis. Continuous variables were presented as mean±standard deviation($\bar{x} \pm SD$) and categorical variables as frequency (percentage). Kruskal-Wallis test was used as a univariate analysis to compare the different subgroups' knowledge, attitude, and behavior scores. Subsequently, three multiple linear regression models were tested to identify which variables significantly influenced knowledge, attitude and behavior respectively. The factors which had statistical significance in the single-factor analysis were taken as the predictors in the multiple linear regression analysis. Categorical variables, such as region, were entered as dummy variables; ranked variables, such as education level and professional title, were entered as ordinal variables; all significance tests were two-sided. The P-Values of univariate analysis<0.1 and multiple linear regression analysis<0.05 were considered statistically significant.

Patient and public involvement

The public was not involved in this research's design, conduct, reporting, or dissemination plans.

Results

Characteristics of participants

1,018 GPs were invited to participate in the survey, and 996 questionnaires were collected, with a response rate of 97.84% (996/1018). Among the 996 questionnaires, 989 questionnaires were valid, with a quality conformity rate of 99.30% (989/996). There were 279 males and 710 females, and

the average age was 39.18, ranging from 23 to 59. Bachelor's degree and above accounted for 88.47%（Table 1）.

Table 1 The score of Knowledge, Attitude and Behavior regarding COVID-19 of GPs

Characteristics	Number of participants	Knowledge score ($\bar{x} \pm SD$)	Attitude score ($\bar{x}$	Behaviour score ($\bar{x} \pm SD$)
Total	989(100)	6.14±1.42	13.59±4.42	7.82±1.53
Region				
Urban area	336(33.97)	6.09±1.46	13.63±4.26	7.64±1.60
Urban-rural fringe	396(40.04)	6.20±1.40	14.04±4.29	8.14±1.35
Rural area	257(25.99)	6.12±1.42	12.85±4.74	7.57±1.60
χ2		1.288	10.975	28.570
P		0.525	0.004	<.001
Gender				
Male	279(28.21)	5.90±1.41	12.89±4.89	7.49±1.71
Female	710(71.79)	6.24±1.42	13.87±4.20	7.95±1.43
χ2		11.548	9.400	14.710
P		<.001	0.002	<.001
Age (year)				
≤29	131(13.25)	6.23±1.40	12.96±4.27	8.13±1.46
30~39	414(41.86)	6.22±1.39	13.87±4.32	7.84±1.49
40~49	327(33.06)	6.08±1.49	13.98±4.31	7.80±1.54
≥50	117(11.83)	5.96±1.39	12.21±4.94	7.47±1.62
χ2		4.757	15.274	11.976
P		0.191	0.002	0.008
Education				
College degree and	114(11.53)	5.90±1.42	12.55±4.54	7.67±1.71
Bachelor degree	736(74.42)	6.15±1.42	13.72±4.42	7.85±1.50
Master degree or	139(14.05)	6.31±1.44	13.73±4.27	7.78±1.53
χ2		5.172	6.290	0.590
P		0.075	0.043	0.745
Years of work				
＜5	83(8.39)	6.29±1.49	12.96±4.32	8.14±1.62
5~9	202(20.42)	6.09±1.40	13.91±4.36	7.95±1.45
10~19	317(32.05)	6.29±1.34	13.72±4.22	7.81±1.46
≥20	387(39.13)	6.03±1.48	13.45±4.63	7.69±1.59
χ2		7.773	3.333	9.209
P		0.051	0.343	0.027
Professional title				
Resident	227(22.95)	6.03±1.41	13.37±4.56	7.91±1.56
Attending physician	591(59.76)	6.16±1.42	13.90±4.26	7.80±1.51
Associate chief physician or above	171(17.29)	6.25±1.44	12.81±4.71	7.79±1.55
χ2		1.759	9.153	1.979
P		0.415	0.010	0.372
Marriage				
Unmarried	195(19.72)	6.06±1.38	12.71±4.44	7.76±1.67
Married	794(80.28)	6.17±1.43	13.81±4.40	7.84±1.49
χ2		0.963	8.763	0.009

P	0.327	0.003	0.926

Abbreviation: SD=Standard Deviation

Knowledge and behavior scores of GPs regarding COVID-19

The correct response rate of the 989 GPs of each question on knowledge was 25.58%-97.88% (Table 2). The average knowledge score was 6.14±1.42 (Table 1). Among them, the correct response rate of 'Which of the following objects or conditions can kill Novel Coronavirus?' was the lowest, accounting for 25.58%. The correct response rate of 'What are the transmission routes of Novel Coronavirus' was the second lowest, accounting for 29.63% (Table 2).

The average behavior score was 7.82±1.53(Table 1). The correct response rate of the 989 GPs of each behavior question was 51.77-97.07% (Table 2). Among them, the correct response rate of 'Do your hands touch the external surface of the face mask after you put it on?', 'What is your step to remove a disposable surgical mask?', 'When you wear a disposable surgical mask, how to fit it entirely to the face?', 'Have you taken the initiative to publicize the "six-step hand-washing method" since the COVID-19 outbreak' was the lowest, accounting for 51.77%, 58.54%, 63.70%, and 64.00%, respectively (Table 2).

Table 2 The Correct Response Rate of GPs on Knowledge and Behavior regarding COVID-19 (N=989)

Questions	n (%)
Knowledge	
1.Which of the following objects or conditions can kill Novel Coronavirus?	253(25.58)
2.What is the transmission route of Novel Coronavirus?	293(29.63)
3.What kind of face mask should you wear when you make home visits to quarantined residents?	302(30.54)
4.Does disposable surgical mask need to be replaced if it is wet or dirty?	318(32.15)
5.What do you think is the minimum social safe distance between people ?	686(69.36)
6.What is the appropriate replacement time of disposable surgical masks?	769(77.76)
7.Do you know the steps of "six-step hand-washing method"?	806(81.50)

8.What kind of face mask should you wear in community clinics during pandemic period?	808(81.70)
9.Do you know what kind of face mask has the effect of preventing Novel Coronavirus?	874(88.37)
10.How long should close contacts be quarantined?	968(97.88)
Behavior	
1.Do your hands touch the external surface of the face mask after you put it on?	512(51.77)
2.What is your step to remove a disposable surgical mask?	579(58.54)
3.When you wear a disposable surgical mask, how to fit it entirely to the face?	630(63.70)
4.Have you taken the initiative to publicize the "six-step hand-washing method" since the COVID-19 outbreak?	633(64.00)
5.Do your hands touch the external surface of the face mask while removing it?	823(83.22)
6.Have you started using the “six-step hand-washing method” since the COVID-19 outbreak?	853(86.25)
7.Do you wash your hands before putting on a face mask?	899(90.90)
8.Have you increased hand-washing frequency since the COVID-19 outbreak?	913(92.32)
9.When you wear disposable surgical masks, how to recognize the external and inner face mask surface correctly?	933(94.34)
10.When you wear disposable surgical masks, how to recognize the upper and lower edge correctly?	960(97.07)

Attitude scores of GPs regarding COVID-19

The average attitude score of 989 GPs on COVID-19 was 13.59±4.42 (Table 1). 26.29% of the GPs were very worried that themselves or their family member might get infected by Novel Coronavirus. 7.58% were very worried that their lives were threatened by COVID-19 (Table 3).

Table 3 GPs' Attitude Score Regarding COVID-19 (N=989)

Questions	n (%)	Score

	Not worried at all	not worried	somewhat worried	quite worried	very worried	
1.Are you worried that yourself or your family member might get infected by Novel Coronavirus?	98(9.91)	159(16.08)	281(28.41)	191(19.31)	260(26.29)	3.36±1.29
2.Are you worried you'll be quarantined if you get infected?	114(11.53)	188(19.01)	338(34.18)	170(17.19)	179(18.10)	3.11±1.24
3.Are you worried that the pandemic might be out of control and the virus will spread widely?	141(14.26)	221(22.35)	341(34.48)	155(15.67)	131(13.25)	2.91±1.21
4.Do you feel COVID-19 threatened your life?	241(24.37)	317(32.05)	258(26.09)	98(9.91)	75(7.58)	2.44±1.18
5.Do you suspect that you have been	460(46.51)	366(37.01)	120(12.13)	25(2.53)	18(1.82)	1.76±0.89

infected with Novel Coronavirus?	
Total	13.59±4.42

Univariate analysis of GPs' knowledge, attitude, and behavior towards COVID-19

Univariate analysis showed that male GPs' knowledge score was lower than female GPs' (P< 0.01). GPs with a college education and below and those who had worked for 20 years or longer had the lowest knowledge score (P<0.1). Female GPs were more worried than male GPs (P=0.002). GPs who worked in an urban-rural fringe area, aged 40-49, had a master's degree or above, worked as attending physicians, and married were the most worried (P<0.05). Male GPs had a lower behavior score （P < 0.01）. GPs worked in rural areas, aged 50 or above, over 20 years of work had the lowest behavior score (P < 0.05) (Table 1).

Multiple linear regression analysis of GPs' knowledge, attitude, and behavior towards COVID-19

Multiple linear regression analysis showed that the knowledge score of male GPs was lower than that of female GPs (P=0.002). The attitude score of female GPs was higher than that of male GPs (P=0.004). Married GPs were higher than that unmarried GPs (P=0.021). The behavior score of GPs in urban areas was lower than that of GPs in urban-rural fringe areas (P<0.001). Male GPs' behavior score was lower than female GPs' (P=0.002). The higher the knowledge score, the higher the behavior score (P<0.001)(Table 4).

Table 4 Multiple linear regression on factors associated with Shanghai GPs' knowledge, attitude and behaviour score regarding COVID-19

	Knowledge Score	
Variable	Coefficient (95% CI)	*P*
Knowledge Score		
Female	0.32 (0.12, 0.52)	0.002
Education Level*	0.15 (-0.01, 0.31)	0.074
Years of work Level*	-0.03 (-0.13, 0.07)	0.532
F	5.474	

P	0.001	
Attitude Score		
Urban-rural fringe area	0.42 (-0.23, 1.06)	0.203
Rural area	-0.43 (-1.18, 0.32)	0.258
Female	0.90 (0.29, 1.51)	0.004
Age group level*	-0.02 (-0.46, 0.41)	0.913
Education Level*	0.37 (-0.19, 0.92)	0.200
Professional title Level*	-0.20 (-0.73, 0.33)	0.458
Married	0.88 (0.13, 1.63)	0.021
Knowledge Score	0.01 (-0.18, 0.21)	0.890
F	3.340	
P	0.001	
Behaviour Score		
Urban-rural fringe area	0.44 (0.23, 0.66)	<.001
Rural area	-0.05 (-0.28, 0.18)	0.673
Female	0.32 (0.12, 0.52)	0.002
Age group Level*	-0.12 (-0.31, -0.06)	0.198
Years of work Level*	0.01 (-0.16,0.17)	0.951
Knowledge Score	0.28 (0.22, 0.34)	<.001
Attitude Score	0.02 (0, 0.04)	0.065
F	19.757	
P	<0.001	

* Education Level: 1=College degree and below, 2=Bachelor degree, 3=Master degree or above;

*Years of work Level: 1=less than 5, 2=5~9, 3=10~19, 4=greater or equal than 20;

*Age group Level: 1=less and equal than 29, 2=30~39, 3=40~49, 5=greater or equal than 50;

*Professional title Level: 1=Resident, 2=Attending physician,3=Associate chief physician or above.

Abbreviation: CI=Confidence Interval

Discussion

Of the 989 GPs who were our study respondents, their average age was 39.18 years old, among whom 88.2% were younger than 50, and 88.47% had a bachelor's degree or above, which was a relatively young team with high education level. However, the average score was 6.14±1.42 (range 0-10), much lower than that of the online survey of 1,357 medical workers in Henan Province conducted by Zhang M et al. at the same time[15], which is worrying. GPs are the leading force in this community pandemic prevention and control campaign against COVID-19 in Shanghai[16]. How can GPs with poor knowledge of COVID-19 lead the community to win the pandemic prevention and control campaign? GPs needed to master the transmission route of Novel Coronavirus [17] to protect themselves and to educate the population well. However, the correct response rate of Shanghai GPs' knowledge of the transmission route was only 29.63%. Feng Xiang et al. demonstrated the correct response rate of 43.27% in an online survey of 617 medical workers in Jiangsu Province in early March 2020[18]. Blocking the transmission route is especially important for infectious diseases. Therefore, it is necessary to strengthen the training of basic knowledge of infectious diseases. During the pandemic, people must keep a safe social distance of at least one meter [19]. However, only 69.36% of the GPs mastered the social safety distance during the pandemic [20], which was much lower than the correct response rate of Parikh PA's survey of 744 medical personnel in India in March 2020 [20]. Thus, social safety distance is another weak point that needs to be focused on in pandemic training. CDC recommends using medical masks and N95 masks to prevent novel coronavirus [21]. Our study showed that GPs had a high rate of 88.37% for choosing the correct face masks.

Nevertheless, the rate for choosing the correct face mask when making home visits to quarantined residents was only 30.54%. Many GPs only chose N95 masks on this occasion. However, when visiting people quarantined at home, the disposable surgical mask or N95 mask is optional [12]. Compared with disposable surgical masks, N95 respirators are optimized in structure with core filtration, and their filtering efficiency increased to 95% [22]. Choosing N95 masks may be due to the great fear caused by the pandemic outbreak, and many GPs prefer excessive protection. Under the circumstances of lacking medical supplies for pandemic prevention, it is necessary to ensure the safety of GPs and the scientific and rational use of medical supplies. Disposable surgical masks should be discarded at the interval of 4 hours and should also be replaced when they are wet or dirty [11,21]. If the filter layer of a disposable surgical mask absorbs moisture or gets dirty, the filtering function will be reduced or even lost [11]. However, the correct

awareness of GPs of the discard interval and occasion was 35.19% and 51.26%, respectively. Therefore, making GPs master the correct discard interval and occasion of disposable surgical masks is essential.

Univariate and Multivariate analysis showed that male GPs had lower knowledge scores than female GPs, which was consistent with the results of an online survey of residents around the country on COVID-19 conducted by Qi Y at the end of January 2020.[23] Women tend to be in the center of family life and are usually more nervous about the pandemic [24]. They were more serious about the prevention of the pandemic for the health of themselves and their families and were more willing to follow standardized measures [24].

The score of worry of GPs regarding COVID-19 was 13.59±4.42, which was between not worried and somewhat worried. The proportion of GPs who were somewhat quite or very worried that themselves or their family members might get infected by Novel Coronavirus was 28.41%, 19.31%, and 26.29%, respectively. In general, the proportions of GPs with worry were slightly lower than in the studies by Zhang M et al.[15] and Abdel Wahed WY et al.[25], which can indirectly reflect the relatively perfect prevention and control work in Shanghai. For the question, 'Do you feel your life threatened by COVID-19?', the proportion of those GPs who were not worried at all and not worried was 56.42%. Furthermore, those who were quite worried and very worried were only 17.49%, which demonstrated that Shanghai GPs had confidence in China's pandemic prevention and control capability, even though they knew the highly contagious nature of Novel Coronavirus. This confidence might also be related to the experience in handling the Severe Acute Respiratory Syndrome pandemic in Shanghai in 2003. Shanghai's pandemic control and prevention capability had improved in the past 17 years [26].

Multivariate analysis showed that gender and marriage were the influencing factors of attitude regarding COVID-19 for GPs, which was consistent with the online survey of Zhu Z et al. of 5,062 medical workers in Wuhan Tongji Hospital in February 2020 [27]. Female GPs were more anxious in the face of COVID-19. An online survey by Shiyan Yan et al. on 3,088 people in February 2020 also showed gender differences in stress [28]. Married people take more responsibility for their families and worry more. Therefore, these GPs should provide appropriate psychological support to reduce their psychological pressure.

Medicine is a high-risk profession. If GPs incorrectly wore face masks, they would be at risk of infection [29]. In our study, although 88.37% of the GPs selected the correct type of face mask to

prevent the invasion of COVID-19, only 63.70% of them knew how to fit a disposable surgical mask entirely to the face. The correct percentage of GPs for hands not touching the external surface of the face mask while wearing it was only 51.77%, and the percentage of GPs who had mastered the correct step to remove a disposable surgical mask was only 58.54%. Therefore, it is necessary to emphasize the proper way to wear face masks in detail in GP training. Contact transmission is a significant route of COVID-19 transmission. Therefore, hand hygiene is as crucial as wearing masks and keeping a safe social distance [30]. Ran L et al. demonstrated that hand hygiene was closely related to COVID-19 infection by investigating 72 medical workers in Wuhan in January 2020 [31,32]. After the outbreak of COVID-19, Shanghai GPs' hand-washing frequency increased by 92.32%, and the number of GPs who strictly used the 'six-step hand-washing method' increased by 86.25% compared with that before the outbreak[32]. Most GPs performed well in hand hygiene, consistent with the survey of 744 medical personnel in India [20].

Moreover, educating the public is also a social responsibility that GPs should take on their initiative. However, only 64.00% of Shanghai GPs actively publicized the "six-step hand-washing method" to the public. Therefore, GPs should be aware of educating the public to improve the efficiency of pandemic prevention and control.

The univariate and multivariate analysis showed that the behavior score of male GPs was lower than that of female GPs, which was consistent with the survey of 461 medical workers conducted by Dimitrios Papagiannis et al. in Greece in February 2020 [33]. Women are better than men in knowledge mastery and more nervous than men in attitude. Understandably, they are more dedicated to behavior implementation. Our study also showed that the higher the knowledge score, the higher the behavior score. It was consistent with the survey of 706 Syrian residents conducted by Sanaa Al ahdab et al. in April 2020 [34]. Therefore, there is a need for further training of GPs to improve their understanding of the disease and the correct behavior toward pandemic prevention in their communities.

Conclusions

This is a large-scale cross-sectional survey of GPs' knowledge, attitude, and behavior toward COVID-19 in Shanghai, a city with a highly developed economy and high population mobility. GPs, as the "health gatekeepers" of the community, are in a critical position in the community grid management system. Their knowledge, attitude, and behavior will significantly affect the results

of preventing and controlling the pandemic. Based on our survey, GPs in Shanghai had limited knowledge at the beginning of the pandemic; when protective equipment and knowledge of COVID-19 were lacking, their behavior toward COVID-19 needed improvement. When confronted with the sudden breakout of a new emerging contagious disease, it is crucial to train GPs in the appropriate coping strategies in time. At the same time, we should also care about the physical and mental health of GPs to build a strong frontline of community prevention and control. Lessons learned from the current pandemic will help GPs effectively handle any similar future challenges and possible new pandemics in the future.

Limitations

The survey has some limitations. The R^2 values were not high for the three multiple regression models, which suggested that there might be other predictor variables. Further studies are needed to examine other potential variables which could predict the knowledge, attitude and practice of GPs. Although stratified random cluster sampling was adopted, the one-to-one interview could not be conducted during the pandemic. Despite providing a necessary reference for the gap in knowledge, attitude, and practice of GPs in our study, the extrapolation of conclusions to the population was limited. Secondly, as the study was based on a cross-sectional design, a causal relationship could not be inferred with certainty. We can do in-depth research in the future.

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Contributors

Jian Wang conceived and designed the study, implemented the research, and helped to draft and revise the manuscript. Huiyun Tang implemented the research, conducted data collection, and helped to draft the manuscript. Jialiang Fang and Boxiang Tu performed data collection and

statistical analysis. All the authors contributed to the final document and read and approved the final manuscript.

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Competing interests None declared.

Patient and public involvement The patients and the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

Patient consent for publication Not reported

Ethics approval This study involves human participants. Written consent was obtained from all respondents before the investigation, which was conducted per the Declaration of Helsinki, and the Ethics Committee approved the protocol of Zhongshan Hospital, Fudan University (B2020-027). Participants gave informed consent to participate in the study before taking part.

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Data availability statement Data are available upon reasonable request.

References

1. Zhang, H. (2020). Early lessons from the frontline of the 2019-nCoV outbreak. *The Lancet*, *395*(10225), 687. https://doi.org/10.1016/s0140-6736(20)30356-1.
2. CCTV. (2020). 30 provinces, cities and autonomous regions launch Level 1 response to major public health emergencies. Retrieved from baijiahao.baidu.com website: https://baijiahao.baidu.com/s?id=1656706957364692630&wfr=spider&for=pc.
3. Chinese Journal of General Practitioners. (2020). Practical prevention and control of novel coronavirus infection at the primary level. Retrieved from Weixin Official Accounts Platform

website: https://mp.weixin.qq.com/s/K1ymC-L3u6J2vMiEraeG1w.

4. Chutian Metropolis Daily. (2020). Central steering group again pays tribute to fallen medical staff as more than 2,000 infected. Retrieved November 18, 2021, from baijiahao.baidu.com website: https://baijiahao.baidu.com/s?id=1659772948930826692&wfr=spider&for=pc&searchword=2.20.
5. World Health Organization (WHO). (2020).Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19).Retrieved from https://www.who.int/publications-detail/report-of-the-who-china-jointmission-on-coronavirus-disease-2019-(covid-19).
6. State Council of China.(2017).Approval of the State Council on the Shanghai City Master Plan. Retrieved from http://www.gov.cn/zhengce/content/2017-12/25/content_5250134.htm.
7. China News Network.(2020).Shanghai "strictest measures, fastest speed" to prevent and control the new coronavirus pneumonia pandemic.Retrieved from http://www.chinanews.com/sh/2020/01-23/9068502.shtml.
8. People's Daily. (2020).People's Times Review: Building a firm "community defense line" for epidemic prevention and control.Retrieved from http://www.nhc.gov.cn/jkj/s7916/202001/44a3b8245e8049d2837a4f27529cd386.shtml.
9. Song, S. D., Liu, P., & Monday, S. (2006). The division of urban and rural physical regions in Shanghai. *Journal of Geography, 61*(8), 11.
10. Xu,J., Peng,Y., Shi,Y., et al.(2019). A study on hospice service provision and compensation in Shanghai community health service centres. *China Health Economics, 38*(8), 4.
11. Bureau of Disease Control and Prevention.(2020).National Health and Health Commission. Notice on issuing guidelines on protection for people at different risks of novel coronavirus infection and guidelines on the use of pneumonia masks for the prevention of novel coronavirus infection.Retrieved from http://www.gov.cn./zhengceku/2020-01/31/content_5473401.htm.
12. General Office of the National Health Care Commission. (2020).General Office of the National Health and Health Commission on the issuance of guidelines for the prevention and control of pneumonia caused by novel coronavirus infection in Notice on the Guidelines for Prevention and Control of Infection under Medical Observation in Home Isolation (for Trial Implementation).Retrieved from http://www.gov.cn/zhengce/zhengceku/2020-02/05/content_5474688.htm.

13. General Office of the National Health Care Commission.(2020).Novel Coronavirus Pneumonia Treatment Protocol (Trial Version 6).Retrieved from http://www.nhc.gov.cn/yzygj/s7652m/202002/54e1ad5c2aac45c19eb541799bf637e9.shtml.
14. World Health Organization (WHO).(2020). Advice on the outbreak of novel coronavirus (2019-nCoV) in the community, home care and health care settings Use of masks. Retrieved from https://apps.who.int/iris/bitstream/handle/10665/330987/WHO-nCov-IPC_Masks-2020.1-chi.pdf.
15. Zhang, M., Zhou, M., Tang, F., et al. (2020). Knowledge, attitude, and practice regarding COVID-19 among healthcare workers in Henan, China. *Journal of Hospital Infection, 105*(2), 183-187. https://doi.org/10.1016/j.jhin.2020.04.012.
16. Xinmin Evening News.(2020).Shanghai's family doctor team: acting as the gatekeeper of residents' health and guarding the first gate of community epidemic prevention and control | Epidemic Prevention and Control Conference.Retrieved from https://news.sina.com.cn/o/2020-05-18/doc-iirczymk2252223.shtml.
17. General Office of the National Health Care Commission. (2020). General Office of the National Health and Wellness Commission on the issuance of Technical Guidelines for the Protection of Medical Personnel during the New Coronary Pneumonia Outbreak (for Trial Implementation).Retrieved from http://www.gov.cn/zhengce/zhengceku/2020-02/20/content_5481310.htm.
18. Feng,X., Hua,Z., Shi,Q.,et al. (2020). An analysis of the knowledge, beliefs, and behaviors of primary health care workers on the protection against neonic pneumonia. *China Rural Health Management, 40*(6), 6.
19. World Health Organization (WHO).(2020).Basic protective measures against the new coronavirus.Retrieved from.http://who.int/emergencies/diseases/novel-coronavirs-2019/advice-fo-public.
20. Parikh, P. A., Shah, B. V., Phatak, A. G., et al.(2020). COVID-19 Pandemic: Knowledge and Perceptions of the Public and Healthcare Professionals. *Cureus*. https://doi.org/10.7759/cureus.8144.
21. Bureau of disease control and Prevention.(2020).Guidelines for public protection of pneumonia caused by New Coronavirus. Beijing.People's Health Publishing House.
22. Lin,Q., Huang,Y.,Sun,G.(2020).Feasibility of reuse and disinfection of single-use medical

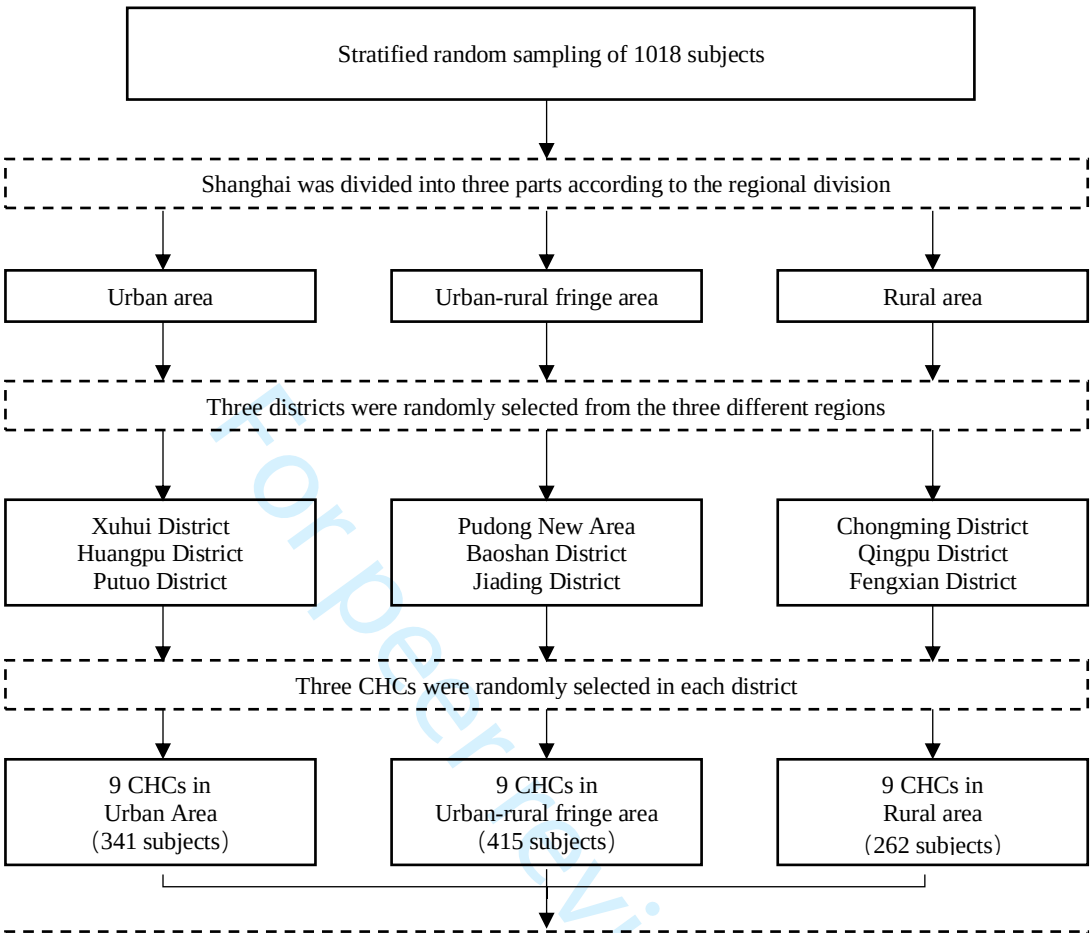
masks in a novel coronavirus pneumonia pandemic.*Journal of Nursing Management,20*,280-284.

23. Qi,Y.,Chen,L.,Zhang,L.,et al.(2020).Public practice,attitude and knowledge of coronavirus disease.*Journal of Tropical Medicine,20*,145-149.
24. Lou,M.,Jiang,Y.,Liu,Z.,(2020).Anxiety and depression analysis of the general public people during the COVID-19. *Chinese Journal of Disaster Medicine,8*(9),481-484.
25. Abdel Wahed, W. Y., Hefzy, E. M., Ahmed, et al.(2020). Assessment of Knowledge, Attitudes, and Perception of Health Care Workers Regarding COVID-19, A Cross-Sectional Study from Egypt.*Journal of community health,45*(6),1242-1251. https://doi.org/10.1007/s10900-020-00882-0.
26. Dong,Y.(2020).Refined governance and community epidemic prevention and control mechanisms in megacities: A case study of community epidemic prevention and control at the grassroots level in Shanghai. *Social Science Series*,(3), 9.
27. Zhu,Z.,Xu,S.,Wang,H.,L,et al.(2020).COVID-19 in Wuhan:Sociodemographic characteristics and hospital support measures associated with the immediate psychological impact on healthcare workers.*EClinicalMedicine*,*24*, 100443.https://doi.org/10.1016/j.eclinm.2020.100443.
28. Yan, S.,Xu, R.,Stratton,T. D.,et al.(2021). Sex differences and psychological stress: responses to the COVID-19 pandemic in China.*BMC public health,21*(1), 79.https://doi.org/10.1186/s12889-020-10085-w.
29. Kumar, J., Katto, M. S., Siddiqui, A. A., et al.(2020). Knowledge, Attitude, and Practices of Healthcare Workers Regarding the Use of Face Mask to Limit the Spread of the New Coronavirus Disease (COVID-19). *Cureus, 12*(4), e7737.https://doi.org/10.7759/cureus.7737.
30. Li,C.,Huang,X.,Cai,G.,et al.(2020). Expert consensus on personal protection in different work areas of healthcare institutions during the New Coronary Pneumonia outbreak. Chinese *Journal of Infection Control, 19*(3), 15.
31. Ran, L.,Chen, X.,Wang, Y.,et al.(2020).Risk Factors of Healthcare Workers With Coronavirus Disease 2019:A Retrospective Cohort Study in a Designated Hospital of Wuhan in China. *Clinical infectious diseases: an official publication of the Infectious Diseases Society of America*, *71*(16), 2218-2221. https://doi.org/10.1093/cid/ciaa287.
32. World Health Organization (WHO). (2020). WHO SAVES LIVES: Clean your hands in the

context of COVID-19.Retrieved from.https://www.who.int/publications/m/item/who-saves-lives-clean-your-hands-in-the-context-of-covid-19.

33. Papagiannis, D., Malli, F., Raptis, D. G., et al.(2020). Assessment of Knowledge, Attitudes, and Practices towards New Coronavirus (SARS-CoV-2) of Health Care Professionals in Greece before the Outbreak Period. *International Journal of Environmental Research and Public Health, 17*(4925), 4925. https://doi.org/10.3390/ijerph17144925.
34. Al ahdab, S.(2021). A cross-sectional survey of knowledge, attitude and practice (KAP) towards COVID-19 pandemic among the Syrian residents. *BMC Public Health,21*(1). https://doi.org/10.1186/s12889-021-10353-3.

Fig. 1 Sampling flow chart



STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-5	
Objectives	3	State specific objectives, including any prespecified hypotheses	3-5	
Methods				
Study design	4	Present key elements of study design early in the paper	5-6	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-9	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5-9	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-9	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-9	
Bias	9	Describe any efforts to address potential sources of bias	7-8	
Study size	10	Explain how the study size was arrived at	7-8	

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	7-8
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	7-8
		(*e*) Describe any sensitivity analyses	7-8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8-9
		(c) Consider use of a flow diagram	8-9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	8-11
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	8-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-11
		(*b*) Report category boundaries when continuous variables were categorized	8-11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-11

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18-19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	18-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	18-19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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

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Knowledge, Attitude, and Behaviour of General Practitioners in Shanghai during the Pandemic ofCOVID-19: A Cross-Sectional Study

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Abstract

Objectives: To understand the knowledge, attitude, and behaviour of general practitioners (GPs) towards COVID-19and to provide evidence for improved prevention and control measures against the pandemic. **Study design:** A cross-sectional study was conducted with 1018 GPs in Shanghai from 21 February to 2 March 2020 using the WeChat platform. **Methods:** Stratified random cluster sampling was performed according to the regional division of urban, urban-rural fringe, and rural areas. This study used a self-designed mobile questionnaire. The questionnaire collected information on knowledge, attitudes, and behaviours regarding COVID-19 prevention

and control. **Results:** A total of989 questionnaires were declared valid. The average scores of GPs' knowledge, attitude, and behaviour towards COVID-19 were 6.14±1.42 (range 0-10), 13.59±4.42 (range 0-25), 7.82±1.53 (range 0-10), respectively. Multiple linear regression analysis showed that the knowledge score of male GPs was lower than that of female GPs (P=0.002). In addition, the 'attitude' score of female GPs was higher than that of male GPs (P=0.004). The 'behaviour' score of GPs in urban areas was lower than that of GPs in urban-rural fringe areas (P<0.001). The higher the knowledge score, the higher the behavioural score was observed to be (P<0.001). **Conclusions:** The scores of knowledge, attitude, and behaviour of Shanghai GPs towards COVID-19 were limited at the beginning of the COVID-19 outbreak. As a hopeful measure, the early implementation of proper training programs for GPs in times of crisis will contribute to disease control and prevention. Lessons learned from the current pandemic will hopefully help GPs handle similar future challenges and potential novel pandemics.

Keywords: General practitioner; COVID-19; Knowledge; Attitude; Behaviour

Strengths and limitations of this study

- This is the first large-scalestudy to examine the knowledge, attitude, and behaviour towards COVID-19 among general practitioners in Shanghai, who had become the leading force of community pandemic prevention and controlprocedures at the early stage of the pandemic.
- Stratified random cluster sampling was used to improve the representativeness of the sample and minimize selection bias.
- The cross-sectional nature of this study precludes formal conclusions on causality.
- Other potential predictor variables, such as factors related to society and culture, could be considered in future studies.

INTRODUCTION

Coronavirus disease (COVID-19) is an emerging infectious disease. Its cases were first confirmed in Wuhan, China in December 2019 and were reported nationwide[1]. It rapidly engulfed the entire world and became a global pandemic. Up to 20 February 2020, by the launch of the first-level response measures for major public health emergencies[2], the cumulative

number of confirmed cases across the country had reached 125,529, and the cumulative number of deaths had reached 5,695[3]. Meanwhile, 2,055 medical workers who had helped to treat COVID-19 were infected[4], mainly due to insufficient knowledge of COVID-19[5].

Shanghai is the largest port city in China, with international trade and shipping centres[6]. Owing to this, the Shanghai municipal government issued regulations on community prevention and control networks[7] as early as on 23 January—the same day Wuhan became socioeconomically inoperative. However, by 20 February 2020, 334 confirmed cases had been reported.

The main force undertaking the task of community pandemic prevention and control was general practitioners (GPs)—the gatekeeper of community residents' health[8]. Nevertheless, there had never been a precedent of GPs being involved in community pandemic prevention. In the face of this emerging infectious disease, did the GPs master the appropriate knowledge field, have high morale and normative behaviour to protect themselves, and educate community residents competently to win the tough fight? According to the literature and theory, knowledge influences behaviour directly or indirectly through attitude. We hypothesised that, in this context, GP's knowledge could predict their attitudes, and their knowledge and attitude could predict their behaviour. To this end, we launched a survey of GPs' knowledge, attitude, and behaviour towards COVID-19 in Shanghai, aiming to find gaps to provide a groundwork for improving the pandemic prevention and control capacity at the grassroots level, enabling fortification of pandemic control measures.

METHODS

Study Design and Population

This cross-sectional survey was conducted between 21st February and 2nd March 2020. As a means to the end, stratified random cluster sampling was performed. According to the regional division of Shanghai, regions were divided into urban, urban-rural fringe, and rural areas[9]. Three districts were randomly selected from each of the three areas, and three community health service centres (CHCs) were randomly selected from each district[10].

According to the formula

$$n = \frac{\mu^2_{\alpha/2} P \ (1-P)}{\delta^2}$$

P=0.0222，1-P=0.9778，α=0.05，$\mu_{\alpha/2}$=1.96， δ=0.5P=0.0111,

$$n = \frac{1.96^2 \times 0.0222 \times 0.9778}{0.0111^2} = 676.1 \approx 677$$

In this, 'n' refers to the required sample size. $\mu_{\alpha/2}$ is the μ value when the cumulative probability from left to right is 1-α/2 (both sides) in the standard normal distribution. P represents the accuracy rate of all the questions in the pre-survey, where δ is the allowable error. Based on the pre-survey results of 30 respondents (P=0.0222, 1-P=0.987, α=0.05), $\mu_{\alpha/2}$=1.96, a 5 percent margin of error was set. Through this, the calculations altered as follows: δ=0.5, P=0.00715, and the required sample size was deemed to be at least 677. At a shedding rate of 20%, the total sample size was at least 847. Finally, 1018 on-the-job GPs in the above 27 CHCs were investigated, including 341 GPs in urban areas, 415 GPs in urban-rural fringe areas, and 262 GPs in rural areas (Fig. 1). It must be noted that no incentives were offered to complete the questionnaires.

Measurement Tool

A self-designed questionnaire was used in the survey based on COVID-19 literature published by the World Health Organization and the Chinese Center for Disease Control and Prevention (CDC)[11-14]. The questionnaire was pre-tested on a small sample of 30 GPs from three CHCs, and some questions were adjusted after the pre-survey. The questionnaire collected general information of the respondents such as details regarding region, gender, age, education level, years of work, professional title and marital status. Furthermore, knowledge regarding COVID-19 was tested through six single-choice questions and four multiple-choice questions. For all multiple-choice questions, respondents had to check all the correct items to be judged as correct. Each correctly answered question was scored 1 point, and the total score was 10 points. In addition, the participants'attitude towards the COVID-19 pandemic was assessed through five questions. In answering each question, the extent of concern about COVID-19 was graded as per 5 categories with respective scores. The scores were assigned as follows: 1 point for 'not worried at all', 2 for 'not very worried', 3 for 'somewhat worried', 4 for 'quite worried', and 5 for 'very worried'. The total was 25 points. In the end, behaviour towards COVID-19 prevention and control was observed through 10 single-choice questions. Each correctly answered question scored 1 point, and the total score was 10 points. The total Cronbach's alpha coefficient for the questionnaire was 0.844, indicating acceptable internal consistency.

Data Collection

This cross-sectional study was conducted via the WeChat platform. All items in the questionnaire were mandatory. If there were incomplete items, the questionnaire could not be submitted and one IP address could only be used to submit the questionnaire once. Written consent was obtained from all the respondents before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki and the protocol was approved by the Ethics Committee of Zhongshan Hospital, Fudan University (B2020-027).

Statistical Analysis

Excel (Microsoft Office Professional Plus 2010) was used to establish the database, and SAS (version 9.4) was used for data processing and analysis. Continuous variables are presented as mean±standard deviation (x±SD) and categorical variables as frequency (percentage). The Kruskal-Wallis test was used for univariate analysis to compare the different subgroups' knowledge, attitude, and behaviour scores. Subsequently, three multiple linear regression models were tested to identify the variables that significantly influenced knowledge, attitude, and behaviour. The factors that had statistical significance in single-factor analysis were considered predictors in the multiple linear regression analysis.Categorical variables, such as region, were entered as dummy variables; ranked variables, such as education level and professional title, were entered as ordinal variables; and all significance tests were two-sided. P-values of univariate analysis (<0.1) and multiple linear regression analysis (<0.05) were considered statistically significant.

PATIENT AND PUBLIC INVOLVEMENT: The patients and the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

RESULTS

Characteristics of participants

A total of 1,018 GPs were invited to participate in the survey and 996 questionnaires were collected, with a response rate of 97.84% (996/1018). Among the 996 questionnaires, 989 were considered valid with a quality conformity rate of 99.30% (989/996). There were 279 males and 710 females with an average age of 39.18 years, ranging from 23-59 years. Bachelor's degree and above accounted for 88.47%（Table 1）.

Table 1: The score of Knowledge, Attitude and Behavior regarding COVID-19 of GPs

Characteristics	Number of participants (%)	Knowledge score ($x\pm SD$)	Attitude score ($x\pm SD$)	Behaviour score ($x\pm SD$)
Total	989(100)	6.14±1.42	13.59±4.42	7.82±1.53
Region				
Urban area	336(33.97)	6.09±1.46	13.63±4.26	7.64±1.60
Urban-rural fringe area	396(40.04)	6.20±1.40	14.04±4.29	8.14±1.35
Rural area	257(25.99)	6.12±1.42	12.85±4.74	7.57±1.60
χ^2		1.288	10.975	28.570
P		0.525	0.004	<.001
Gender				
Male	279(28.21)	5.90±1.41	12.89±4.89	7.49±1.71
Female	710(71.79)	6.24±1.42	13.87±4.20	7.95±1.43
χ^2		11.548	9.400	14.710
P		<.001	0.002	<.001
Age (year)				
≤29	131(13.25)	6.23±1.40	12.96±4.27	8.13±1.46
30~39	414(41.86)	6.22±1.39	13.87±4.32	7.84±1.49
40~49	327(33.06)	6.08±1.49	13.98±4.31	7.80±1.54
≥50	117(11.83)	5.96±1.39	12.21±4.94	7.47±1.62
χ^2		4.757	15.274	11.976
P		0.191	0.002	0.008
Education level				
College degree and below	114(11.53)	5.90±1.42	12.55±4.54	7.67±1.71
Bachelor's degree	736(74.42)	6.15±1.42	13.72±4.42	7.85±1.50
Master's degree or above	139(14.05)	6.31±1.44	13.73±4.27	7.78±1.53
χ^2		5.172	6.290	0.590
P		0.075	0.043	0.745
Years of work				
＜5	83(8.39)	6.29±1.49	12.96±4.32	8.14±1.62
5~9	202(20.42)	6.09±1.40	13.91±4.36	7.95±1.45
10~19	317(32.05)	6.29±1.34	13.72±4.22	7.81±1.46
≥20	387(39.13)	6.03±1.48	13.45±4.63	7.69±1.59
χ^2		7.773	3.333	9.209
P		0.051	0.343	0.027
Professional title				
Resident	227(22.95)	6.03±1.41	13.37±4.56	7.91±1.56
Attending physician	591(59.76)	6.16±1.42	13.90±4.26	7.80±1.51
Associate chief physician	171(17.29)	6.25±1.44	12.81±4.71	7.79±1.55
χ^2		1.759	9.153	1.979
P		0.415	0.010	0.372
Marriage				
Unmarried	195(19.72)	6.06±1.38	12.71±4.44	7.76±1.67

Married	794(80.28)	6.17±1.43	13.81±4.40	7.84±1.49
χ^2		0.963	8.763	0.009
P		0.327	0.003	0.926

Abbreviation: SD=Standard Deviation

Knowledge and behavior scores of GPs regarding COVID-19

The correct response rate of the 989 GPs for each question on knowledge was 25.58%-97.88% (Table 2). The average knowledge score was 6.14±1.42 (Table 1). Among them, the correct response rate for 'Which of the following objects or conditions can kill the novel coronavirus?' was the lowest (25.58%). In addition, the correct response rate for 'What are the transmission routes of novel coronavirus' was the second lowest, accounting for 29.63% (Table 2).

The average behaviour score was 7.82±1.53 (Table 1). The correct response rate of the 989 GPs for each behaviour question was 51.77-97.07% (Table 2).Among them, the correct response rates for questions that investigated touching of external surface of the masks after wearing it, steps to remove disposable masks, the proper fitting and procedure of wearing disposable masks and the proactive spirit to publicise the 'six-step hand-washing method' since the COVID-19 outbreak were highly dissatisfactory and unnerving, accounting for the lowest strata of 51.77%, 58.54%, 63.70% and 64%, respectively (Table 2).

Table 2: The Correct Response Rate of GPs on Knowledge and Behavior regardingCOVID-19 (N=989)

Questions	n (%)
Knowledge	
1.Which of the following objects or conditions can kill novel Coronavirus?	253(25.58)
2.What is the transmission route of novel Coronavirus?	293(29.63)
3.What kind of face mask should you wear when you make home visits to quarantined residents?	302(30.54)
4.Does disposable surgical mask need to be replaced if it becomes wet or dirty?	318(32.15)
5.What do you think is the minimum social safe distance between people ?	686(69.36)
6.What is the appropriate replacement time of a disposable surgical mask?	769(77.76)
7.Do you know the steps of 'six-step hand-washing method'?	806(81.50)
8.What kind of face mask should you wear in community clinics during pandemic period?	808(81.70)
9.Do you know what kind of face mask has the effect of preventing novel Coronavirus?	874(88.37)
10.How long should close contacts be quarantined?	968(97.88)
Behavior	

1.Do your hands touch the external surface of the face mask after you put it on?	512(51.77)
2.What is your step to remove a disposable surgical mask?	579(58.54)
3.When you wear a disposable surgical mask, how do you fit it entirely to the face?	630(63.70)
4.Have you taken the initiative to publicize the 'six-step hand-washing method' since the COVID-19 outbreak?	633(64.00)
5.Do your hands touch the external surface of the face mask while removing it?	823(83.22)
6.Have you started using the 'six-step hand-washing method' since the COVID-19	853(86.25)
7.Do you wash your hands before putting on a face mask?	899(90.90)
8.Have you increased hand-washing frequency since the COVID-19 outbreak?	913(92.32)
9.When you wear disposable surgical masks, how to recognize the external and	933(94.34)
10.When you wear disposable surgical masks, how to recognize the upper and	960(97.07)

Attitude scores of GPs regarding COVID-19

The average attitude score of the 989 GPs towards COVID-19 was 13.59±4.42 (Table 1). Of the GPs, 26.29% were very worried that they or their family members might become infected with the novel coronavirus. A total of 7.58% were very worried that their lives would be threatened by COVID-19 (Table 3).

Table 3: GPs' Attitude Score Regarding COVID-19 (N=989)

Questions	n (%)					Score
	Not worried	not	somewhat	quite	very	
1.Are you	98(9.91)	159(16.08)	281(28.41)	191(19.31)	260(26.29)	3.36±1.29
2.Are you	114(11.53)	188(19.01)	338(34.18)	170(17.19)	179(18.10)	3.11±1.24
3.Are you	141(14.26)	221(22.35)	341(34.48)	155(15.67)	131(13.25)	2.91±1.21
4.Do you feel	241(24.37)	317(32.05)	258(26.09)	98(9.91)	75(7.58)	2.44±1.18
5.Do you	460(46.51)	366(37.01)	120(12.13)	25(2.53)	18(1.82)	1.76±0.89
Total						

Univariate analysis of GPs' knowledge, attitude, and behavior towards COVID-19

Univariate analysis showed that the knowledge scores of male GPs were lower than those of female GPs (P< 0.01). GPs with a college education and below, along with those who had worked for 20 years or longer, had the lowest knowledge scores (P<0.1). It is interesting to note that the female GPs were more worried than the male GPs (P=0.002). Moreover, GPs who worked in an urban-rural fringe area, aged 40-49, had a master's degree or above, worked as attending physicians, and were married seemed the most worried (P<0.05). Male GPs had lower behavioural scores (P<0.01). Further, GPs who worked in rural areas, aged 50 or above, and boasted of over 20 years of work experience had the lowest behaviour score (P < 0.05) (Table 1).

Multiple linear regression analysis of GPs' knowledge, attitude, and behavior towards COVID-19

Multiple linear regression analysis showed that the knowledge score of male GPs was inferior to female GPs (P=0.002). In the same vein, the 'Attitude' score of female GPs was higher than male GPs (P=0.004) and the 'behaviour' score of male GPs was also lower than that of female GPs (P=0.002). In addition, the number of married GPs was higher than that of unmarried GPs (P=0.021). The 'behaviour' score of GPs in urban areas was lower than that of GPs in urban-rural fringe areas (P<0.001). It was observed that the higher the knowledge score, the higher the behavior score turned out to be (P<0.001) (Table 4).

Table 4: Multiple linear regression on factors associated with Shanghai GPs' knowledge, attitude and behaviour score regarding COVID-19

	Knowledge Score	
Variable	Coefficient (95% CI)	*P*
Knowledge Score		
Female	0.32 (0.12, 0.52)	0.002
Education Level*	0.15 (-0.01, 0.31)	0.074
Years of work Level*	-0.03 (-0.13, 0.07)	0.532
F	5.474	
P	0.001	
Attitude Score		
Urban-rural fringe area	0.42 (-0.23, 1.06)	0.203
Rural area	-0.43 (-1.18, 0.32)	0.258
Female	0.90 (0.29, 1.51)	0.004
Age group level*	-0.02 (-0.46, 0.41)	0.913
Education Level*	0.37 (-0.19, 0.92)	0.200
Professional title Level*	-0.20 (-0.73, 0.33)	0.458
Married	0.88 (0.13, 1.63)	0.021
Knowledge Score	0.01 (-0.18, 0.21)	0.890
F	3.340	
P	0.001	
Behaviour Score		
Urban-rural fringe area	0.44 (0.23, 0.66)	<.001
Rural area	-0.05 (-0.28, 0.18)	0.673
Female	0.32 (0.12, 0.52)	0.002
Age group Level*	-0.12 (-0.31, -0.06)	0.198
Years of work Level*	0.01 (-0.16,0.17)	0.951
Knowledge Score	0.28 (0.22, 0.34)	<.001
Attitude Score	0.02 (0, 0.04)	0.065
F	19.757	
P	<0.001	

*Education level:1= college degree and below, 2= bachelor's degree, 3= master's degree or above

* Work level:1=less than 5, 2=5-9, 3=10-19, 4=greater than or equal to 20;

*Age group level:1=less than or equal to 29, 2=30–39, 3=40–49, 5=greater than or equal to 50

*Professional title level:1= resident, 2= attending physician, 3= associate chief physician or above.

Abbreviation: CI=Confidence Interval

DISCUSSION

The average age among the 989 GPs was 39.18 years old, among whom 88.2% were younger than 50 years and 88.47% had a bachelor's degree or above, which was a relatively young team with a high education level. However, the average score was 6.14±1.42 (range 0-10), much lower than that of the online survey of 1,357 medical workers in Henan Province conducted by Zhang M et al. at the same time[15], which is worrying. GPs are the leading force in this community pandemic prevention and control campaign against COVID-19 in Shanghai[16]. How can GPs with poor knowledge of COVID-19 lead the community to win pandemic prevention and control campaigns? GPs need to master the transmission route of the novel Coronavirus[17] to protect themselves and to educate the population effectively. However, the correct response rate for Shanghai GPs' knowledge of the transmission route was only 29.63%. Xiang et al. demonstrated a correct response rate of 43.27% in an online survey of 617 medical workers in Jiangsu Province in early March 2020[18]. As a preemptive measure, blocking transmission route is particularly advisable against infectious diseases. Therefore, it is necessary to strengthen the basic knowledge of GPs regarding the preventive measures against contagious diseases. During the pandemic, people had to maintain a safe social distance of at least one meter[19]. However, only 69.36% of the GPs mastered the social safety distance during the pandemic, which was painfully much lower than the correct response rate of Parikh PA's survey of 744 medical personnel in India in March 2020[20]. Thus, social safety distance is another disquieting issue that needs to be focused on during pandemic training. The CDC recommends using medical masks and N95 masks to prevent novel coronavirus[21]. Our study showed that GPs had a high rate of 88.37% when choosing correct face masks.

Nevertheless, it is quite unsettling that the rate of choosing the correct face mask when making home visits to quarantined residents was only 30.54%. Many GPs chose only N95 masks on this occasion. However, when visiting quarantined people at home, disposable surgical masks or N95 masks are optional[12]. Compared with disposable surgical masks, N95 respirators are optimised

in structure with core filtration, and their filtering efficiency increases to 95%[22]. The choice of N95 masks may have been propelled by the great fear caused by the pandemic outbreak, whereby many GPs began to prefer excessive protection. Given the lack of medical supplies for pandemic prevention, it is necessary to ensure the safety of GPs and ensure a scientific and rational use of medical supplies. As a precaution and health concern, disposable surgical masks should be discarded at an interval of 4h and replaced when they become drenched or filthy[11,21]. If the filter layer of a disposable surgical mask absorbs moisture or becomes sordid, the filtering effectivity deteriorates or even becomes eliminated[11]. However, the correct awareness of GPs regarding the discard interval and occasion was 35.19% and 51.26%, respectively. Therefore, making GPs master the correct discard interval and the occasion of disposable surgical masks is essential.

Further, univariate and multivariate analyses showed that male GPs had lower knowledge scores than female GPs, which was consistent with the results of an online survey of residents around the country on COVID-19 conducted by Qi Y at the end of January 2020[23]. Women tend to be at the centre of family life and are usually more nervous about the pandemic[24]. They were more serious about the prevention of the pandemic for their own and their families' health and were more willing to follow standard measures[24].

The score of worrying behaviour regarding COVID-19 was 13.59±4.42, which was between not worried and somewhat worried. The proportion of GPs who were somewhat quite or very worried that themselves or their family members might get infected by the novel Coronavirus was 28.41%, 19.31%, and 26.29%, respectively. In general, the proportion of worried GPs was slightly lower than that reported by Zhang et al.[15] and Abdel Wahed et al.[25] which indirectly reflected the relatively perfect prevention and control work in Shanghai. For the question, 'Do you feel your life is threatened by COVID-19?', the proportion of GPs who were not worried at all and not worried was 56.42%. Furthermore, only 17.49% of quite worried and very worried GPs demonstrated that Shanghai GPs had confidence in China's pandemic prevention and control capability, even though they knew the highly contagious nature of the novel coronavirus. This confidence may also be related to the experience of handling the severe acute respiratory syndrome pandemic in Shanghai in 2003. Shanghai's pandemic control and prevention capabilities have improved tremendously in the past seventeen years[26].

In addition, multivariate analysis showed that gender and marriage were the influencing factors of attitude regarding COVID-19 for GPs, which was consistent with the online survey of Zhu et al. of 5,062 medical workers in Wuhan Tongji Hospital in February 2020[27] Additionally, female GPs were more anxious in the face of COVID-19. Similarly, an online survey by Yan et al., involving 3,088 respondents in February 2020, also depicted gender differences in stress[28]. In another context, married people assume more responsibility towards their families and are disconcerted easily. Therefore, GPs should provide appropriate psychological support to reduce such pressure and mental exhaustion of troubled family members.

In fact, being a doctor is considered a high-risk profession. IfGPs themselves wore face masks incorrectly, they would be at high risk of infection[29]. In our study, although 88.37% of the GPs selected the correct type of face mask to prevent the invasion of COVID-19, only 63.70% knew how to fit a disposable surgical mask entirely onto the face. The percentage of GPs acknowledging the correct method of hands not touching the external surface of the face mask while wearing it was only 51.77%, and the percentage of GPs who had mastered the correct step to remove a disposable surgical mask was only 58.54%. Therefore, it is necessary to emphasise the proper way to wear face masks in detail during GP training. Furthermore, contact transmission is a significant catalyst of COVID-19 transmission. Therefore, hand hygiene is as crucial as wearing masks and maintaining a safe social distance[30]. To corroborate this, Ran L et al. investigated 72 medical workers in Wuhan in January 2020 and demonstrated that hand hygiene was closely related to COVID-19 infection[31,32]. After the outbreak of COVID-19, the handwashing frequency of Shanghai GPs increased by 92.32%, and the number of GPs who strictly used the six-step hand-washing method increased by 86.25%[32]. Most GPs performed excellently in hand hygiene, which was consistent with the survey of 744 medical personnel in India[20].

Moreover, educating the public is also a social responsibility that GPs should undertake. However, only 64.00% of Shanghai GPs actively publicised the ‘six-step hand-washing method’. Hence, the GPs should make efforts at educating the public to ameliorate the efficiency of pandemic prevention and control.

Univariate and multivariate analyses showed that the behaviour score of male GPs was lower than that of female GPs, which was consistent with the survey of 461 medical workers conducted

by Papagiannis et al. in Greece in February 2020[33]. Women seemed profoundly better than men in knowledge mastery and more nervous. Understandably, they are more dedicated to the implementation of behavioural nuances. Our study also showed that the higher the knowledge score, the higher the behavioural score. This was consistent with a survey of 706 Syrian residents conducted by Ahdab et al. in April 2020[34]. Therefore, there is a need for further training of GPs to improve their understanding of the disease and the correct behaviour towards pandemic prevention in their communities.

CONCLUSION

This was a large-scale cross-sectional study of GPs' knowledge, attitude, and behaviour towards COVID-19 in Shanghai. GPs, as the 'health gatekeepers' of the community, are in a critical position in the community grid management system. Their knowledge, attitudes, and behaviours significantly affect the prevention and control of the pandemic. Based on our survey, GPs in Shanghai had limited knowledge at the beginning of the pandemic. When protective equipment and knowledge of COVID-19 were lacking, their behaviour towards COVID-19 needed improvement. When confronted with the sudden breakout of a new emerging contagious disease, it is crucial to train GPs with appropriate coping strategies. At the same time, we should also focus on the physical and mental health of GPs to build a strong frontline for prevention and control. In this regard, insights gained from the current pandemic will help GPs in mitigating similar challenges or pandemics in the future.

Limitations

This study had some limitations. The R^2 values were not high for the three multiple regression models, suggesting the presence of other predictor variables. Further studies are needed to examine other potential variables which could predict the knowledge, attitudes, and practices of GPs. Although stratified random cluster sampling was adopted, one-to-one interviews were not conducted during the pandemic. Despite providing a necessary reference for the gap in knowledge, attitude, and practice of GPs in our study, the extrapolation of conclusions to the population was limited. Second, as the study was based on a cross-sectional design, a causal relationship could not be inferred with certainty. Thus, in-depth research is required in the future to improve understanding of this subject.

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CONTRIBUTORS

Jian Wang conceived and designed the study, implemented the research, and helped to draft and revise the manuscript. Huiyun Tang implemented the research, conducted the data collection, and helped draft the manuscript. Jialiang Fang and Boxiang Tu performed the data collection and statistical analysis. All authors contributed to the final document have approved the final manuscript.

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REFERENCES

1 Zhang H. Early lessons from the frontline of the 2019-nCoV outbreak. *Lancet* 2020;395:687. https://doi.org/10.1016/S0140-6736(20)30356-1.

2 CCTV. 30 Provinces, cities and autonomous regions launch Level 1 response to major public health emergencies. baijiahao.baidu.com [Website]. https://baijiahao.baidu.com/s?id=1656706957364692630&wfr=spider&for=pc 2020.

3 Chinese Journal of General Practitioners. Practical prevention and control of novel coronavirus infection at the primary level. Retrieved from Weixin Official Accounts Platform website. https://mp.weixin.qq.com/s/K1ymC-L3u6J2vMiEraeG1w 2020.

4 Chutian metropolis daily. *Central steering group again pays tribute to fallen medical staff as more than 2,000 infected*. baijiahao.baidu.com (Accessed Nov 18, 2021) [Website]. https://baijiahao.baidu.com/s?id=1659772948930826692&wfr=spider&for=pc& searchword=2.20 2020.

5 World Health Organization (WHO). *Report of the WHO-China joint mission on coronavirus disease*,2019 (COVID-19). https://www.who.int/publications-detail/report-of-the-who-china-jointmission-on-coronavirus-disease-2019- 2020.

6 The state council.http://www.gov.cn/zhengce/content/2017-12/25/content_5250134.htm. Approval of the State Council on the Shanghai City Master Plan 2017.

7 China News Network. Shanghai "strictest measures, fastest speed" to prevent and control the new coronavirus pneumonia pandemic. http://www.chinanews.com/sh/2020/01-23/9068502.shtml 2020.

8 People's daily. *People's Times Review: Building a firm "community defense line" for epidemic prevention and control*. http://www.nhc.gov.cn/jkj/s7916/202001/44a3b8245e8049d2837a4f27529cd386.shtml 2020.

9 Song SD, Liu P, Monday S. The division of urban and rural physical regions in Shanghai. *J Geogr* 2006;61:11.

10 Xu J, Peng Y, Shi Y, et al. A study on hospice service provision and compensation in

Shanghai community health service centres. *Chin Health Econ* 2019;38:4.

11 Chinese center for disease control and prevention. National health and health Commission. Notice on issuing guidelines on protection for people at different risks of novel coronavirus infection and guidelines on the use of pneumonia masks for the prevention of novel coronavirus infection.http://www.gov.cn/zhengceku/2020-01/31/content_5473401.htm 2020.

12 National Health Commission of the People's Republic of China. *General Office of the National Health and Health Commission on the issuance of guidelines for the prevention and control of pneumonia caused by novel coronavirus infection in Notice on the Guidelines for Prevention and Control of Infection under Medical Observation in Home Isolation (for Trial Implementation)*. http://www.gov.cn/zhengce/zhengceku/2020-02/05/content_5474688.htm 2020.

13 National Health Commission of the People's Republic of China. *Novel coronavirus pneumonia treatment protocol (trial version 6)*. http://www.nhc.gov.cn/yzygj/s7652m/202002/54e1ad5c2aac45c19eb541799bf637e9.shtml 2020.

14 World Health Organization (WHO). Advice on the outbreak of novel coronavirus (2019-nCoV) in the community, home care and health care settings Use of masks. https://apps.who.int/iris/bitstream/handle/10665/330987/WHO-nCov-IPC_Masks-2020.1-chi.pdf 2020.

15 Zhang M, Zhou M, Tang F, et al. Knowledge, attitude, and practice regarding COVID-19 among healthcare workers in Henan, China. *J Hosp Infect* 2020;105:183-7. https://doi.org/10.1016/j.jhin2020.04.012.

16 Xinmin evening news. https://news.sina.com.cn/o/2020-05-18/doc-iirczymk2252223.shtml 2020.Shanghai's family doctor team: acting as the gatekeeper of residents' health and guarding the first gate of community epidemic prevention and control｜Epidemic Prevention and Control Conference.

17 National Health Commission of the People's Republic of China. *General Office of the National Health and Wellness Commission on the issuance of Technical Guidelines for the Protection of Medical Personnel during the New Coronary Pneumonia Outbreak (for Trial Implementation)*. http://www.gov.cn/zhengce/zhengceku/2020-

02/20/content_5481310.htm 2020.

18 Feng X, Hua Z, Shi Q, et al. An analysis of the knowledge, beliefs, and behaviors of primary health care workers on the protection against neonic pneumonia. *China Rural Health Manag* 2020;40:6.

19 World Health Organization (WHO). Basic protective measures against the new coronavirus. http://who.int/emergencies/diseases/novel-coronavirs-2019/advice-fo-public 2020.

20 Parikh PA, Shah BV, Phatak AG, et al. COVID-19 pandemic: Knowledge and perceptions of the public and healthcare professionals. *Cureus* 2020;12:e8144. https://doi.org/10.7759/cureus.8144.

21 Chinese center for disease control and prevention.*Guidelines for public protection of pneumonia caused by New coronavirus*. Beijing: People's Health Publishing House. 2020.

22 Lin Q, Huang Y, Sun G. Feasibility of reuse and disinfection of single-use medical masks in a novel coronavirus pneumonia pandemic. *J Nurs Manag* 2020;20:280-4.

23 Qi Y, Chen L, Zhang L, et al. Public practice,attitude and knowledge of coronavirus disease. *J Trop Med* 2020;20:145-9.

24 Lou M, Jiang Y, Liu Z. Anxiety and depression analysis of the general public people during the COVID-19. *Chin J Disaster Med* 2020;8:481-4.

25 Abdel Wahed WY, Hefzy EM, Ahmed MI, et al. Assessment of knowledge, attitudes, and perception of health care workers regarding COVID-19, A cross-sectional study from Egypt. *J Community Health* 2020;45:1242-51. https://doi.org/10.1007/s10900-020-00882-0.

26 Dong Y. *Refined governance and community epidemic prevention and control mechanisms in megacities: A case study of community epidemic prevention and control at the grassroots level in Shanghai*. *Social Science Series*2020;3:192-200.

27 Zhu Z, Xu S, Wang H, et al. COVID-19 in Wuhan:sociodemographic characteristics and hospital support measures associated with the immediate psychological impact on healthcare workers. *EClinicalmedicine* 2020;24:100443. https://doi.org/10.1016/j.eclinm.2020.100443.

28 Yan S, Xu R, Stratton TD, et al. Sex differences and psychological stress: Responses to

the COVID-19 pandemic in China. *BMC Public Health* 2021;21:79. https://doi.org/10.1186/s12889-020-10085-w.

29 Kumar J, Katto MS, Siddiqui AA, et al. Knowledge, attitude, and practices of healthcare workers regarding the use of face mask to limit the spread of the new coronavirus disease (COVID-19). *Cureus* 2020;12:e7737. https://doi.org/10.7759/cureus.7737.

30 Li C, Huang X, Cai G, et al. Expert consensus on personal protection in different work areas of healthcare institutions during the New Coronary Pneumonia outbreak. *Chin J Infect Control* 2020;19:15.

31 Ran L, Chen X, Wang Y, et al. Risk factors of healthcare workers with coronavirus disease 2019:A retrospective cohort study in a Designated Hospital of Wuhan in China. *Clin Infect Dis* 2020;71:2218-21. https://doi.org/10.1093/cid/ciaa287.

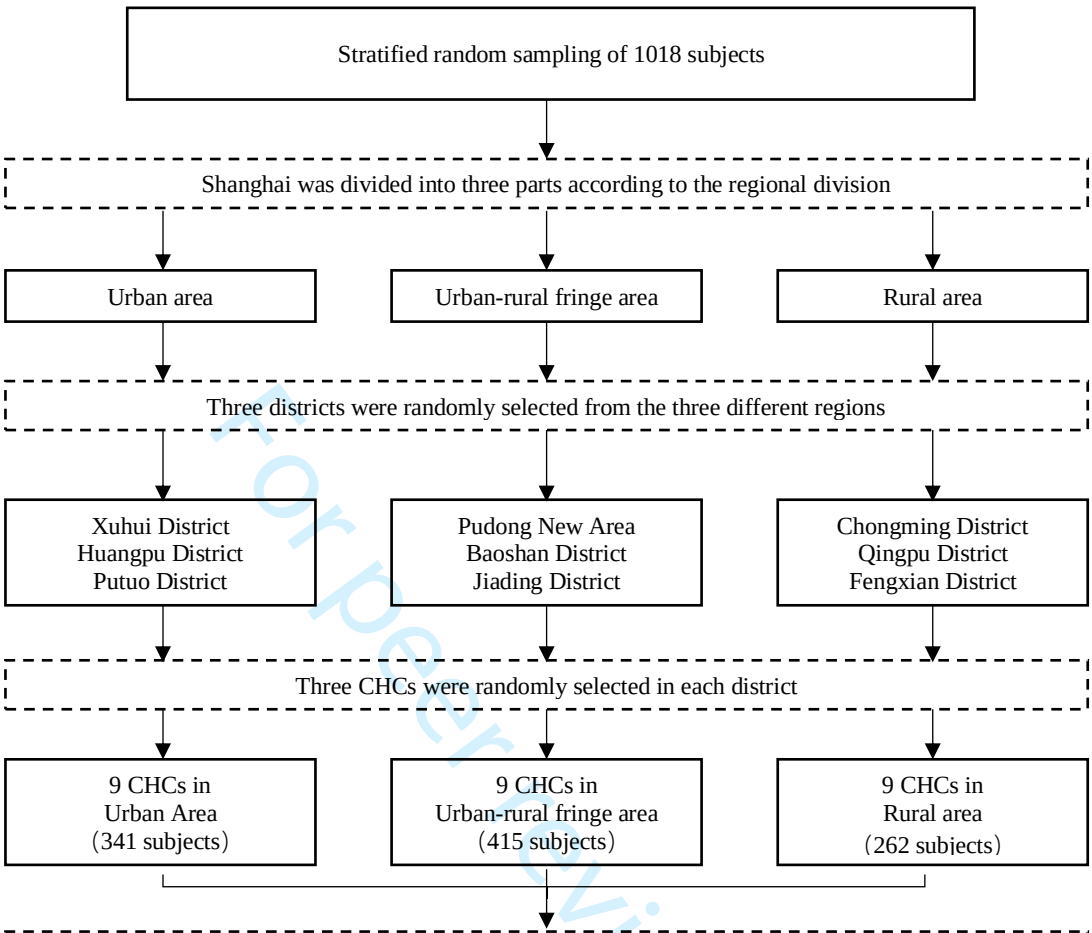
32 World Health Organization (WHO). WHO SAVES LIVES: Clean your hands in the context of COVID-19. https://www.who.int/publications/m/item/who-saves-lives-clean-your-hands-in-the-context-of-covid-19 2020.

33 Papagiannis D, Malli F, Raptis DG, et al. Assessment of knowledge, attitudes, and practices towards new coronavirus (SARS-CoV-2) of health care professionals in Greece before the outbreak period. *Int J Environ Res Public Health* 2020;17:4925. https://doi.org/10.3390/ijerph17144925.

34 Al Ahdab S. A cross-sectional survey of knowledge, attitude and practice (KAP) towards COVID-19 pandemic among the Syrian residents. *BMC Public Health* 2021;21:296. https://doi.org/10.1186/s12889-021-10353-3.

Figure Legend:1018 on-the-job GPs in the above 27 CHCs were investigated, including341GPs in urban areas, 415 GPs in urban-rural fringe areas, and 262 GPs in rural areas.

Fig. 1 Sampling flow chart



STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-5	
Objectives	3	State specific objectives, including any prespecified hypotheses	3-5	
Methods				
Study design	4	Present key elements of study design early in the paper	5-6	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5-7	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-8	
Bias	9	Describe any efforts to address potential sources of bias	7-8	
Study size	10	Explain how the study size was arrived at	7-8	

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	7-8
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	7-8
		(*e*) Describe any sensitivity analyses	7-8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8-9
		(c) Consider use of a flow diagram	8-9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	8-11
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	8-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-11
		(*b*) Report category boundaries when continuous variables were categorized	8-11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-11

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	18, 19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18, 19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	18, 19
Generalisability	21	Discuss the generalisability (external validity) of the study results	18, 19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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