Knowledge, attitude and behaviour of general practitioners in Shanghai during the pandemic of COVID-19: a cross-sectional study

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ABSTRACT
Objectives To understand the knowledge, attitude and behaviour of general practitioners (GPs) towards COVID-19 and 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 of 989 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) and 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 programmes for GPs in times of crisis will contribute to disease control and prevention. Lessons learnt from the current pandemic will hopefully help GPs handle similar future challenges and potential novel pandemics.

INTRODUCTION
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 5695.3 Meanwhile, 2055 medical workers who had helped to treat COVID-19 were infected,4 mainly due to insufficient knowledge of COVID-19.

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 networks7 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 21 February and 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. Three districts were randomly selected from each of the three areas, and three community health service centres (CHCs) were randomly selected from each district.

According to the formula

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

\[P = 0.0222, \quad 1 - P = 0.977, \quad \alpha = 0.05, \quad \mu = 1.96, \quad \delta = 0.5 \quad P = 0.0111,
\]

\[
 n = \frac{1.96^2 \times 0.0222 \times 0.97778}{0.0111^2} = 676.1 \approx 677
\]

‘n’ refers to the required sample size. \(\mu^2 / \alpha^2\) is the \(\mu\) value when the cumulative probability from left to right is \(1-\alpha/2\) (both sides) in the standard normal distribution. \(P\) represents the accuracy rate of all the questions in the pre-survey, where \(\delta\) is the allowable error. Based on the presurvey results of 30 respondents (\(p=0.0222, \quad 1-P=0.987,\) \(\alpha=0.05\)), \(\mu = 1.96, \quad \alpha = 0.05\), a 5% margin of error was set. Through this, the calculations altered as follows: \(\delta=0.5, \quad p=0.00715\), 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 (figure 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 WHO and the Chinese Center for Disease Control and Prevention (CDC). The questionnaire was pretested on a small sample of 30 GPs from three CHCs, and some questions were adjusted after the presurvey. 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 five 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.

**Statistical analysis**

Excel (Microsoft Office Professional Plus 2010) was used to establish the database, and SAS (V.9.4) was used for data processing and analysis. Continuous variables are presented as mean±SD (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 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 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 to 59 years. Bachelor’s degree and above accounted for 88.47% (table 1).

Knowledge and behaviour 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

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**Figure 1** One thousand and eighteen on-the-job GPs in the 27 CHCs were investigated, including 341 GPs in urban areas, 415 GPs in urban–rural fringe areas and 262 GPs in rural areas. CHCs, community health service centres; GPs, general practitioners.
Table 1  The score of knowledge, attitude and behaviour regarding COVID-19 of GPs

| Characteristics                      | Number of participants (%) | Knowledge score (x±SD) | Attitude score (x±SD) | Behaviour score (x±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 value                              |                           | 0.525                  | 0.004                 | <0.001                 |
| 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 value                              |                           | <0.001                 | 0.002                 | <0.001                 |
| 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 value                              |                           | 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              |
| $\chi^2$                             |                           | 5.172                  | 6.290                 | 0.590                  |
| P value                              |                           | 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              |
| $\chi^2$                             |                           | 7.773                  | 3.333                 | 9.209                  |
| P value                              |                           | 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 value                              |                           | 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 value                              |                           | 0.327                  | 0.003                 | 0.926                  |

GPs, general practitioners.
method’ since the COVID-19 outbreak were highly dissatisfaction and unnerving, accounting for the lowest strata of 51.77%, 58.54%, 63.70%, and 64%, respectively (table 2).

**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).

**Univariate analysis of GPs’ knowledge, attitude and behaviour 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 years, 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). Furthermore, GPs who worked in rural areas, aged 50 years 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 behaviour 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 behaviour score turned out to be (p<0.001) (table 4).

**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 1357 medical workers in Henan Province conducted by Zhang et al15 at the same time, 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 coronavirus17 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%. Feng 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 1 m.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 4 hours 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.

Furthermore, univariate and multivariate analyses showed that male GPs had lower knowledge scores

### Table 3  GPs’ attitude score regarding COVID-19 (n=989)

| Questions                                                                 | n (%)         | Not worried at all | Not worried | Somewhat worried | Quite worried | Very worried | Score          |
|---------------------------------------------------------------------------|--------------|-------------------|------------|------------------|--------------|--------------|----------------|
| 1. Are you worried that you 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 may threaten 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 infected with the 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**| **100%**          | **100%**   | **100%**         | **100%**     | **100%**     | **100%**       |

GPs, general practitioners.
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.25 and Abdel Wahed et al.,23 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 17 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.24 involving 5062 medical workers in Wuhan Tongji Hospital in February 2020. Additionally, female GPs were more anxious in the face of COVID-19. Similarly, an online survey by Yan et al.28 involving 3088 respondents in February 2020, also depicted gender differences in stress. 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. If GPs 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 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 handwashing 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

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

| Variable                        | Knowledge score   | Attitude score | Behaviour score |
|---------------------------------|-------------------|----------------|----------------|
|                                 | Coefficient (95% CI) | P value      | Coefficient (95% CI) | P value |
| Knowledge score                 |                   |               |                   |         |
| Female                          | 0.32 (0.12 to 0.52) | 0.002         | 0.32 (0.12 to 0.52) | 0.002   |
| Education level*                | 0.15 (−0.01 to 0.31) | 0.074         | 0.15 (−0.01 to 0.31) | 0.074   |
| Years of work level†            | −0.03 (−0.13 to 0.07) | 0.532         | −0.03 (−0.13 to 0.07) | 0.532   |
| F                               | 5.474             |               | 5.474            |         |
| P value                         | 0.001             |               | 0.001            |         |
| Attitude score                  |                   |               |                   |         |
| Urban–rural fringe area         | 0.42 (−0.23 to 1.06) | 0.203         | 0.42 (−0.23 to 1.06) | 0.203   |
| Rural area                      | −0.43 (−1.18 to 0.32) | 0.258         | −0.43 (−1.18 to 0.32) | 0.258   |
| Female                          | 0.90 (0.29 to 1.51) | 0.004         | 0.90 (0.29 to 1.51) | 0.004   |
| Age group level‡                | −0.02 (−0.46 to 0.41) | 0.913         | −0.02 (−0.46 to 0.41) | 0.913   |
| Education level*                | 0.37 (−0.19 to 0.92) | 0.200         | 0.37 (−0.19 to 0.92) | 0.200   |
| Professional title level§       | −0.20 (−0.73 to 0.33) | 0.458         | −0.20 (−0.73 to 0.33) | 0.458   |
| Married                         | 0.88 (0.13 to 1.63) | 0.021         | 0.88 (0.13 to 1.63) | 0.021   |
| Knowledge score                 | 0.01 (−0.18 to 0.21) | 0.890         | 0.01 (−0.18 to 0.21) | 0.890   |
| F                               | 3.340             |               | 3.340            |         |
| P value                         | 0.001             |               | 0.001            |         |
| Behaviour score                 |                   |               |                   |         |
| Urban–rural fringe area         | 0.44 (0.23 to 0.66) | <0.001        | 0.44 (0.23 to 0.66) | <0.001  |
| Rural area                      | −0.05 (−0.28 to 0.18) | 0.673         | −0.05 (−0.28 to 0.18) | 0.673   |
| Female                          | 0.32 (0.12 to 0.52) | 0.002         | 0.32 (0.12 to 0.52) | 0.002   |
| Age group level‡                | −0.12 (−0.31 to 0.06) | 0.198         | −0.12 (−0.31 to 0.06) | 0.198   |
| Years of work level†            | 0.01 (−0.16,0.17)  | 0.951         | 0.01 (−0.16,0.17)  | 0.951   |
| Knowledge score                 | 0.28 (0.22 to 0.34) | <0.001        | 0.28 (0.22 to 0.34) | <0.001  |
| Attitude score                  | 0.02 (0 to 0.04)   | 0.065         | 0.02 (0 to 0.04)   | 0.065   |
| F                               | 19.757            |               | 19.757            |         |
| P value                         | <0.001            |               | <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, 4=greater than or equal to 50.
§Professional title level: 1=resident, 2=attending physician, 3=associate chief physician or above.
GPs, general practitioners.

than female GPs, which was consistent with the results of an online survey of residents around the country on COVID-19 conducted by Qi et al. in 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

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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 handwashing 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.33 in Greece in February 2020. 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 Al Ahdab et al.34 in April 2020. 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 frontend 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 R² 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 that 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
JW conceived and designed the study, implemented the research and helped to draft and revise the manuscript. HT implemented the research, conducted the data collection and helped draft the manuscript. JF and BT performed the data collection and statistical analysis. All authors contributed to the final document have approved the final manuscript. JW is responsible for the overall content as guarantor.

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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 applicable.

Ethics approval
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). Participants gave informed consent to participate in the study before taking part.

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Data availability statement
Data are available on reasonable request.

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