BMJ Open

Concerns about and stimuli of COVID-19 vaccination hesitancy among diverse occupational groups in metropolitan areas of China: a cross-sectional study

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To cite: Xie Z, Tan Y, Yan Y, *et al*. Concerns about and stimuli of COVID-19 vaccination hesitancy among diverse occupational groups in metropolitan areas of China: a cross-sectional study. *BMJ Open* 2022;**12**:e062032. doi:10.1136/bmjopen-2022-062032

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-062032).

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Received 16 February 2022
Accepted 08 November 2022

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ABSTRACT

Objectives In this study, we aimed to identify concerns and stimuli regarding COVID-19 vaccination acceptance and to compare the findings by occupation.

Methods We conducted a cross-sectional study of individuals vaccinated against COVID-19 between 1 April and 30 June 2021 in four metropolitan areas of China. A total of 20 863 participants completed questionnaires, 20 767 of which were eligible for analysis. We used ordered logistic regression to assess the association of vaccination concerns and stimuli with vaccination hesitancy according to occupation.

Results Farmers were mainly concerned about the quality of vaccines (adjusted OR (aOR): 3.18, 95% CI (CI): 1.83 to 5.54). Among civil servants, media publicity reduced hesitancy (aOR: 0.44, 95% CI: 0.21 to 0.92). Among medical staff, concerns about a short duration of protective effects increased hesitancy (aOR: 8.31, 95% CI: 2.03 to 33.99). For most occupations, concerns about side effects, poor protective effects and health status increased hesitancy. In contrast, protecting oneself and protecting others acted as a stimulus to decrease hesitancy. Interestingly, 'people around me have been vaccinated' was associated with higher vaccination hesitancy among farmers (aOR: 2.19, 95% CI: 1.20 to 4.00).

Conclusion The association of vaccination concerns and stimuli with vaccination hesitancy varied by occupation. The characteristics and concerns of specific target audiences should be considered when designing informational campaigns to promote vaccination against COVID-19.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ In this study, we made comparisons among various occupations and included both positive and negative factors of vaccination hesitancy in statistical models.
⇒ This was a multicentre and community-based study, conducted in several metropolitan areas of China.
⇒ We analysed data collected during the initial stage of a vaccine campaign, with no follow-up observation.
⇒ The results may not be generalisable to rural areas or other countries and regions.

INTRODUCTION

The emergence of highly transmissible SARS-CoV-2 variants has catalysed new pandemic waves globally. However, the efficacy of vaccines against new variants is more than 70%.[1] Vaccination effectively reduces hospitalisations and deaths,[2] and is essential in the fight against rapid virus evolution. Cessation of the pandemic requires the achievement of high vaccination coverage in every country.[3] The WHO called for a 40% vaccination rate in all countries by the end of 2021. However, some countries, mainly in Africa, had not yet achieved 10% by late November of that year.[4 5]

In addition to vaccines, countries have called for social distancing measures to reduce infection.[6] However, this strategy does not apply to individuals in the workplace owing to often unavoidable close contact. Unvaccinated individuals may exacerbate the spread of infection in the workplace,[7] notably in high-risk public sectors such as healthcare, service and education.[8–11] Thus, researchers worldwide have investigated the best ways to promote vaccination in occupational settings. Earlier research has focused on specific groups, for example, healthcare workers,[12] but comparisons of vaccination hesitancy according to occupation are limited.

Improved coverage of vaccination in working populations can only be ensured with sufficient public acceptance of COVID-19 vaccines because vaccination is non-compulsory and requires ethical consideration of individual autonomy.[13 14] Vaccination hesitancy may prolong the pandemic.[15] The SAGE Working Group on Vaccine Hesitancy

defined vaccination hesitancy as 'delay in acceptance or refusal of vaccination despite the availability of vaccination services'.[16] Most studies on reducing this hesitancy have targeted the general population and reasons for the reluctance to be vaccinated,[17] which stems from concerns regarding vaccine safety and efficacy.[14] Less attention has been paid to increasing vaccination acceptance by explaining that the vaccines offer personal and family protection against COVID-19 infection.[18] Although studies focusing on occupational groups are limited, available studies have been concerned with vaccine efficacy and safety.[19 20] Considering the varied characteristics of information sources and lifestyles among occupational groups, disparities in attitudes regarding vaccination may be attributed to the job setting. Thus, identification of which professional groups are most vaccine hesitant and whether reasons vary according to occupation may help in developing a more targeted strategy to increase vaccination coverage.

The present study aimed to identify barriers to and stimuli of vaccination acceptance, including concerns about vaccination and reasons behind the decision to receive the vaccine. We then compared these factors according to occupation in large cities of China. The findings of our study can be helpful in designing effective COVID-19 vaccination campaigns.

METHODS

Study design

We conducted a cross-sectional study among individuals vaccinated against COVID-19 between 1 April and 30 June 2021 in four metropolitan areas of China. These cities were selected from three different city tiers, based on China's City-Tier Classification:[21] Shanghai and Shenzhen (tier 1), Chengdu (emerging tier 1) and Fuzhou (tier 2). The required sample size was estimated from the proportion of individuals who were highly hesitant to receive vaccination in the previous study, using the following formula.[22 23]

$$N = \frac{Z^2_{\alpha/2}(1-p)}{\varepsilon^2 p} \times (1+20\%) = \frac{1.96^2 \times (1-0.10)}{0.05^2 \times 0.10} \times 1.2 = 16596$$

where N is the minimum sample size, z is the standard normal variate with 5% type I error= 1.96, p is the estimate of extreme hesitancy in the population from previous research =0.10, the acceptable margin of error is 0.05 and the estimated ineligibility rate is 20%.

Data collection

We randomly selected 24 community health service centres as investigation sites, with two in each selected district (downtown, suburban and rural) for each city. Nurses and general practitioners there supported the survey. The eligibility criterion was adults receiving COVID-19 vaccination during the research period because vaccination for individuals under age 18 years was not approved at the time of the interviews. Pregnant women were also excluded from vaccination. During the postvaccination observation period at community health service centres, investigators provided individuals whose vaccination identification number ended in eight with a link to an online questionnaire and informed consent forms. After providing informed consent, participants completed the questionnaires via smartphone, with investigators present to explain the study and answer questions. Investigators assisted participants who could not read or write in completing the questionnaires. Participants without a smartphone were provided with a printed version. Altogether, we recruited 20 863 participants. The complete questionnaire and response options used in this study are provided in online supplemental table 1.

Variables

The primary outcome variable was vaccination hesitancy, separated into five levels. The major explanatory variables included two aspects. The first was concerns about vaccination that were assumed to increase hesitancy, including concerns about side effects, poor or short duration of protective effects and the quality of vaccines, as well as concerns about ill health (poor personal health status) and the risk of infection at vaccination sites. The other aspect was stimuli, that is, reasons that hypothetically contributed to the decision to be vaccinated, including self-protection, protection for others, participants observing that most individuals around them had been vaccinated, participants observing that vaccinated people around them did not experience side effects, media publicity and community mobilisation. Participants' occupations were mainly categorised according to the Occupational Classification of the People's Republic of China.[24] Categories of education level and household income were developed based on the classification of Chinese official research.[25] The following covariates were included in the analysis as potential confounders: age, sex, education level, monthly household income, disability status, vaccination with a first or second dose of COVID-19 vaccine and chronic diseases. Previous research on vaccination hesitancy and influencing factors was referred to in developing the questionnaire.[26 27] Before the formal survey, we invited experts to evaluate all questions and conducted a pilot study for questionnaire validation.

Patient and public involvement

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

Statistical analyses

We used IBM SPSS V.24.0 to conduct all the statistical analyses. After removing the records of individuals with uncorrectable errors (N=96), such as age formatting, 20 767 eligible participants were included (eligibility rate: 99.54%). Descriptive indices (mean and SD or percentage) were selected according to the variable type. Charts were used to visually illustrate variations in the proportions of concerns and stimuli according to occupation. ORs and 95% CIs were calculated using ordered

Table 1 Population characteristics and the associations with vaccination hesitancy

Variables	N(%) or mean±SD	OR (95% CI)	P value
Age	30.65±10.64	0.99 (0.99 to 0.99)	<0.001
Gender			
Male	11 948 (57.53)	Ref	
Female	8819 (42.47)	1.41 (1.34 to 1.49)	<0.001
Education			
Illiteracy and primary school	304 (1.46)	Ref	
Junior high school	3645 (17.55)	0.70 (0.57 to 0.87)	0.001
Senior high school	4192 (20.19)	0.75 (0.60 to 0.92)	0.006
University and junior college	11 225 (54.05)	0.77 (0.63 to 0.95)	0.013
Master and above	1401 (6.75)	0.85 (0.68 to 1.06)	0.149
Occupation			
Farmer	550 (2.65)	Ref	
Civil servant	277 (1.33)	1.41 (1.09 to 1.84)	0.010
Teacher/student	6452 (31.07)	1.19 (1.02 to 1.40)	0.031
Medical staff	181 (0.87)	0.87 (0.64 to 1.19)	0.384
White-collar/worker	9471 (45.61)	1.21 (1.03 to 1.41)	0.018
Unemployment and else	3836 (18.47)	1.05 (0.89 to 1.24)	0.537
Monthly household income (¥)			
<5000	6246 (30.08)	Ref	
≥5000 and <10 000	6247 (30.08)	0.91 (0.86 to 0.97)	0.005
≥10 000 and <20 000	3499 (16.85)	0.93 (0.86 to 1.00)	0.063
≥2000 and <50 000	2366 (11.39)	0.90 (0.82 to 0.98)	0.015
≥50 000	2409 (11.60)	0.79 (0.72 to 0.86)	<0.001
Disability			
No	20 523 (98.83)	Ref	
Yes	244 (1.17)	1.35 (1.07 to 1.69)	0.011
Chronic disease			
No	16 949 (81.62)	Ref	
Yes	3818 (18.38)	1.26 (1.18 to 1.34)	<0.001
Shots			
First shot	15 929 (76.70)	Ref	
Second shot	4838 (23.30)	0.66 (0.62 to 0.70)	<0.001

logistic regression to assess the relationship between vaccination hesitancy and related concerns or stimuli, also stratified by occupation. The level of statistical significance was p<0.05 (two sided).

RESULTS

Descriptive statistics

The sample totalled 20 767 participants. Table 1 summarises the characteristics of the participants. The mean age was 30.65 years old (SD 10.64). More men (57.53%) than women were included in the study. More than half of the participants (54.05%) reported graduating from university or junior college and having a monthly household income below ¥10 000 (60.16%). The main occupations were teacher or student (31.07%) and white-collar worker (45.61%). Additionally, most participants did not have any disability (98.83%) or chronic disease (81.62%).

Figure 1 illustrates the distribution of vaccination hesitancy according to six occupations. The proportion with 'very low hesitancy' was highest in five out of the six occupations. The proportion of participants with 'somewhat low' and 'medium' hesitancy ranged from 18.73% to 38.27% and 20.99% to 27.47%, respectively. No medical staff reported 'very high hesitancy' for COVID-19 vaccination.

Figure 2 demonstrates the distribution of concerns about and stimuli for vaccination. Self-protection was

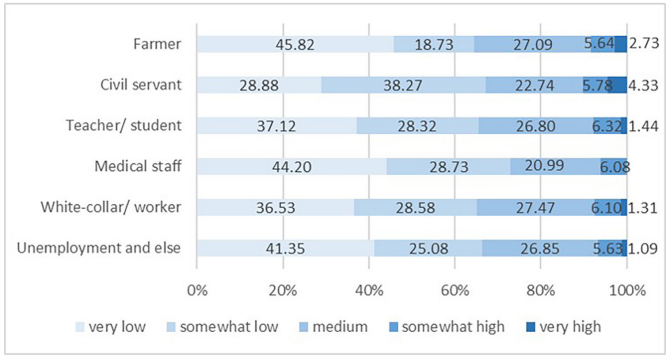


Figure 1 Occupational distribution of COVID-19 vaccination hesitancy (%).

the most cited stimulus (>84%) across all six occupations, and 'people around me have been vaccinated' was the least cited (19.09%–36.52%). The most common concerns about COVID-19 vaccination were side effects, poor protective effect and short protective effect.

Association between concerns or stimuli and vaccination hesitancy

Table 2 presents multivariate analysis of the concerns and stimuli relevant to vaccination hesitancy. Concerns about side effects, poor protective effects, the quality of vaccines, ill health and risk of infection at vaccination sites all significantly increased vaccination hesitancy. Stimuli, such as self-protection, others' protection, media publicity and community mobilisation efforts, decreased vaccination hesitancy. Factors that did not diminish vaccine hesitancy included 'people around me have been vaccinated' and 'vaccinated people around me did not experience side effects'.

Table 3 lists the results of multivariate analysis by occupation. Increased vaccination hesitancy was observed among farmers, who had concerns about side effects

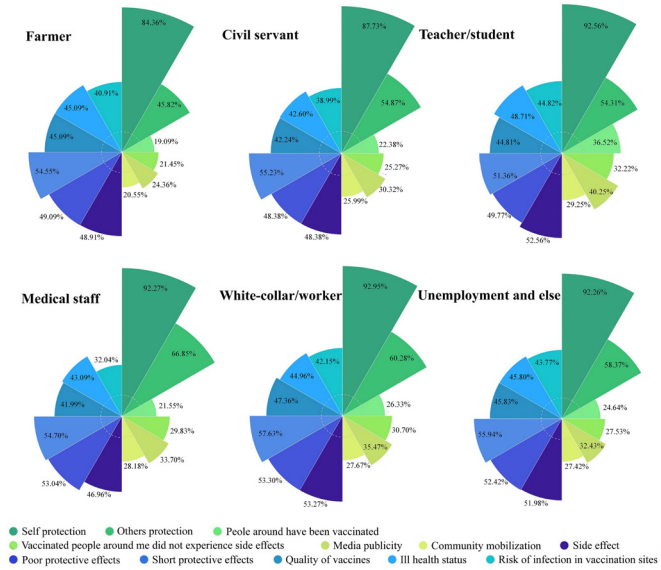


Figure 2 Occupational distribution of concerns about (blue) and stimuli for (green) COVID-19 vaccination (%).

Table 2 Adjusted associations between concerns or stimuli and vaccination hesitancy

Variables	aOR	95% CI lower bound	95% CI upper bound
Concerns (ref—not worry)			
Side effect	2.54	2.36	2.74
Poor protective effects	1.30	1.18	1.44
Short protective effects	1.10	1.00	1.21
Quality of vaccines	1.81	1.67	1.98
Ill health status	1.38	1.29	1.48
Risk of infection in vaccination sites	1.29	1.19	1.40
Stimuli (ref—no)			
Self-protection	0.58	0.52	0.64
Others protection	0.62	0.58	0.66
People around have been vaccinated	1.66	1.53	1.80
Vaccinated people around me did not experience side effects	1.11	1.02	1.20
Media publicity	0.75	0.69	0.81
Community mobilisation	0.70	0.65	0.76

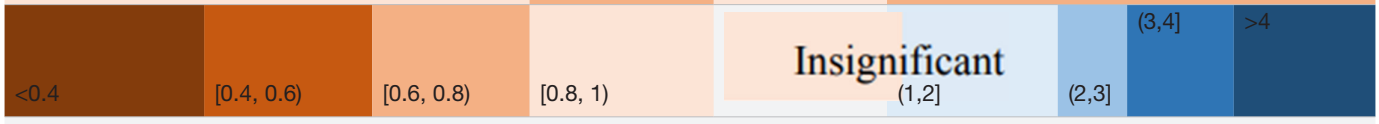
(adjusted OR (aOR) 2.62, 95% CI 1.54 to 4.48), the quality of vaccines (aOR 3.18, 95% CI 1.83 to 5.54) and ill health (aOR 2.10, 95% CI 1.33 to 3.32). The prospect of protecting others decreased vaccination hesitancy among farmers (aOR 0.64, 95% CI 0.42 to 0.96), whereas 'people around me have been vaccinated' doubled the likelihood of vaccination hesitancy in this group (aOR 2.19, 95% CI 1.20 to 4.00). Among civil servants, concerns about side effects tripled the likelihood of hesitancy (aOR 3.50 95% CI 1.80 to 6.81), whereas the influence of media publicity reduced hesitancy (aOR 0.44, 95% CI 0.21 to 0.92). The significant factors for teachers and students were nearly the same as those for the whole sample population (table 2), except for 'vaccinated people around me did not experience side effects'. Among medical personnel, concerns about vaccine side effects (aOR 4.19, 95% CI 1.46 to 12.01) and a short protective effect (aOR 8.31, 95% CI 2.03 to 33.99) increased vaccination hesitancy, and self-protection reduced hesitancy (aOR 0.23, 95% CI 0.07 to 0.80). The effects of concerns were the same as those for the total sample population (table 2) among workers, white-collar workers, unemployed participants and those in other occupations.

DISCUSSION

We conducted this cross-sectional survey in several Chinese metropolitan areas during a large-scale COVID-19 vaccination campaign. To our knowledge, our study is the first to characterise vaccination hesitancy and stimuli for

Table 3 Adjusted associations between concerns or stimuli and vaccination hesitancy stratified by occupation

	Farmer	Civil servant	Teacher/ student	Medical staff	Worker/white-collar	Unemployment and else
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Concerns						
Side effect	2.62 (1.54 to 4.48)	3.50 (1.80 to 6.81)	2.16 (1.88 to 2.47)	4.19 (1.46 to 12.01)	2.80 (2.51 to 3.12)	2.56 (2.14 to 3.06)
Poor protective effects	1.11 (0.62 to 1.99)	0.94 (0.39 to 2.29)	1.38 (1.14 to 1.67)	1.14 (0.25 to 5.23)	1.26 (1.10 to 1.46)	1.40 (1.11 to 1.77)
Short protective effects	0.75 (0.42 to 1.34)	1.53 (0.61 to 3.80)	0.97 (0.80 to 1.18)	8.31 2.03 to 33.99	1.14 (1.00 to 1.31)	1.01 (0.8 to 1.27)
Quality of vaccines	3.18 (1.83 to 5.54)	1.46 (0.67 to 3.21)	1.85 (1.57 to 2.17)	0.91 0.36 to 2.31	1.80 (1.59 to 2.04)	1.74 (1.43 to 2.12)
Ill health	2.10 (1.33 to 3.32)	1.16 (0.58 to 2.29)	1.49 (1.31 to 1.71)	0.94 0.36 to 2.46	1.32 (1.19 to 1.46)	1.39 (1.17 to 1.64)
Risk of infection in vaccination sites	1.23 (0.73 to 2.08)	1.50 (0.73 to 3.11)	1.24 (1.07 to 1.44)	1.16 0.49 to 2.76	1.27 (1.13 to 1.41)	1.47 (1.23 to 1.76)
Stimuli						
Self-protection	0.72 (0.44 to 1.17)	0.94 (0.44 to 1.98)	0.48 (0.40 to 0.58)	0.23 (0.07 to 0.80)	0.53 (0.45 to 0.62)	0.81 (0.64 to 1.03)
Others protection	0.64 (0.42 to 0.96)	0.67 (0.38 to 1.19)	0.66 (0.59 to 0.75)	0.91 (0.40 to 2.05)	0.57 (0.52 to 0.63)	0.61 (0.52 to 0.7)
People around have been vaccinated	2.19 (1.20 to 4.00)	1.80 (0.71 to 4.55)	1.64 (1.43 to 1.89)	0.84 (0.27 to 2.61)	1.78 (1.57 to 2.01)	1.55 (1.28 to 1.89)
Vaccinated people around me did not experience side effects	1.16 (0.67 to 2.01)	0.51 (0.22 to 1.17)	1.12 (0.96 to 1.30)	1.08 (0.43 to 2.75)	1.11 (0.99 to 1.25)	1.06 (0.88 to 1.28)
Media publicity	0.68 (0.39 to 1.18)	0.44 (0.21 to 0.92)	0.70 (0.60 to 0.80)	1.83 (0.75 to 4.49)	0.75 (0.67 to 0.84)	0.84 (0.70 to 1.01)
Community mobilisation	0.74 (0.42 to 1.30)	1.07 (0.53 to 2.19)	0.71 (0.61 to 0.82)	0.95 (0.38 to 2.38)	0.69 (0.61 to 0.78)	0.72 (0.60 to 0.86)



Significant factors (p<0.05) are marked in blue if they increased vaccination hesitancy and in orange if they decreased vaccination hesitancy.

vaccination in diverse occupational groups of China. We identified target groups for vaccine promotion, specific concerns and stimuli that increase or decrease hesitancy. This information may be instructive for policy and practices.

The research indicated that COVID-19 vaccination acceptance and hesitancy vary among different occupations.[28 29] Previous studies have suggested that health workers have lower hesitancy and higher acceptance of vaccination than workers in other fields.[30 31] Our findings are consistent with this evaluation, perhaps because of the urgency involved, with medical personnel being directly exposed to virus carriers.[32] We also examined attitudes among individuals with other occupations. Hesitancy was relatively high among civil servants and office workers and relatively low among farmers and teachers/students. A descriptive study among adults in the USA found high vaccination hesitancy in the construction or extraction field, and relatively low hesitancy among educators, healthcare practitioners or technicians, as well as computer and mathematics professions.[29] A study in Hong Kong showed that clerical, service and sales workers were more likely to refuse the vaccine.[19] Although various occupational categories were adopted by different studies, some general commonalities applied. Individuals with occupational exposure to COVID-19 and those with professional knowledge were associated with less vaccination hesitancy.[33] The differences in vaccination hesitancy among occupations reinforces that vaccination campaigns should tailor their messages according to target audiences.[34]

Studies in the USA,[35 36] France, Germany[37 38] and Egypt[39] have reported that vaccine efficacy and safety concerns are associated with a reduced likelihood of being vaccinated. Our study adds new insight into the problem of vaccination hesitancy by identifying the stimuli for receiving vaccination. The most important stimulus for vaccination was the protection of oneself and others. Community mobilisation and media publicity reduced vaccination hesitancy. These findings suggest the importance of publicising vaccine efficacy and safety in health education.[40] The media[41] and the community[42] are vital platforms for sharing such information.

The association of concerns and stimuli with vaccination hesitancy also varied by occupation. Concerns about side effects increased hesitancy among participants in all occupations. Previous research has indicated that concerns about side effects are the primary reason for hesitancy regarding vaccines against COVID-19[43] and other infectious diseases.[44 45] Except for civil servants and medical staff, the extent of hesitancy increased with concerns about vaccine quality. Concerns about poor protective effects increased hesitancy among teachers and students, office workers and the unemployed individuals. Concerns about the short duration of protective effects of the vaccine were most significantly associated with hesitancy among medical staff. The importance of vaccine efficacy in hesitancy has been previously noted.[46] Most concerns focused on the safety or efficacy of vaccines, perhaps because of the accelerated development processes of COVID-19 vaccines.[47] Thus, information on safety and efficacy should be provided and emphasised when addressing hesitancy.[48]

Concerns about the risk of infection at vaccination sites increased hesitancy among teachers and students, office workers and the unemployed individuals, but not among medical staff. Vaccination sites are usually within a hospital or community health centre, which are patient care facilities; this may lead to the assumption that there is a higher risk of infection than in workplaces or residences.[49] Therefore, it is necessary to strengthen the protocols for preventing and controlling infections at vaccination sites.[50] Concerns about infection may be reduced by situating vaccination sites outside patient care facilities, for instance, at universities, factories and community centres. Concerns about personal health also increased hesitancy. For example, a history of allergic reactions to other vaccines may lead to vaccine refusal or hesitancy.[51] Therefore, information about vaccine contraindications should be publicised.

As for stimuli to receive vaccination, participants in most occupations were motivated by protecting themselves and protecting others. Media publicity was most influential in promoting vaccination among civil servants. The characteristics of civil servants may lead them to focus more on the media and their public image. Media influence has been shown to contribute to rapid decisions by government officials.[52 53] Teachers and students, office workers and unemployed participants were motivated by community mobilisation. Shanghai and other metropolitan areas are gradually establishing functional communities, which provide exceptional health services according to diverse community characteristics and needs, achieving improvements in healthcare.[54] Thus, promoting vaccination should involve strategies tailored to the occupation and setting.

In our primary hypothesis, 'people around me have been vaccinated' would be a stimulus for vaccination according to the social network theory.[55] Interestingly, however, this factor was not a stimulus to vaccination among our participants. We assume these participants believed that vaccination would be unnecessary if enough individuals in their vicinity were vaccinated, suggesting a misunderstanding of the concept of herd immunity.[56] Another unexpected finding was that 'vaccinated people around me have not experienced side effects' was not associated with hesitancy, as we had assumed, suggesting that our participants did not look to others to dispel their concerns about the side effects of vaccination.

The present study has several limitations that may affect the interpretation of our findings. First, this was a cross-sectional study; therefore, no firm conclusion could be reached regarding concerns or stimuli as a cause of COVID-19 vaccination hesitancy. We merely analysed data collected during the initial stage of a vaccine campaign without follow-up observation. However, participants' attitudes toward COVID-19 and vaccination may change over time. Second, we recruited study participants from four representative metropolitan areas in China. Occupation, concerns and stimuli in rural areas, other regions or countries were not assessed; these may differ from our findings in large cities of China. Moreover, our focus was on factors affecting vaccination hesitancy among broad occupational categories. A more detailed classification of professions could be used in future work to help support the rationale for more targeted interventions. Finally, specific interventions were mentioned but not tested in the present study. Future studies could assess the efficacy of interventions associated with those above or even more factors, such as concerns about side effects and the influence of media, in reducing vaccination hesitancy of among specific occupational groups.

CONCLUSIONS

Promoting COVID-19 vaccination is urgent, and vaccination hesitancy must be addressed. In this study, we found that vaccination hesitancy varied by occupation and was relatively low among medical staff, farmers and teachers/students but relatively high among civil servants and office workers. Concerns about side effects, poor protective effects, risk of infection at vaccination sites, the quality of vaccines and health status increased hesitancy. In contrast, protecting oneself and others acted as a stimulus to receive vaccination in most occupations. Medical staff, in particular, were concerned about short protective effects. The positive influence of media publicity was most

notable among civil servants, and community mobilisation was effective among office workers. Interestingly, 'people around me have been vaccinated' and 'vaccinated people around me have not experienced side effects' were not factors that promoted vaccination. These findings suggest that informational campaigns encouraging vaccination should use strategies tailored to the target audience.

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Acknowledgements The authors thank the research team members and participants for their contribution to this research.

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Funding The study was funded by grant nos. 22692192300 and 21692190200 from the Science and Technology Commission of Shanghai Municipality, grant no. WK2102 from Shanghai Jiao Tong University School of Medicine, grant nos. 71904145 and 72274122 from National Natural Science Foundation of China and grant no. 19X100040062 from Shanghai Jiao Tong University.

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 This study involves human participants and was approved by Fengxian District Central Hospital medical ethics committee (approval no. 2021-ethic approve-02) 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.

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