


RESEARCH PAPER



## Parental acceptability of COVID-19 vaccination for children under the age of 18 years among Chinese doctors and nurses: a cross-sectional online survey

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### ABSTRACT

This study investigated parental acceptability of COVID-19 vaccination for children under the age of 18 years among Chinese parents who are healthcare workers. A closed online survey among full-time doctors or nurses employed by the five collaborative hospitals who had access to smartphones was conducted. Facilitated by the hospital administrators, prospective participants received an invitation sent by the research team via the existing WeChat/QQ groups to complete an online questionnaire. A total of 2,281 participants completed the survey. This study was a sub-analysis of 1332 participants who had at least one child under the age of 18 years. Among the participants, 44.5% reported that they would likely or very likely to have their children under the age of 18 years take up COVID-19 vaccination in the next six months. After adjusting for significant background characteristics, perceived higher vaccine efficacy, longer protection duration, perceived high/very high chance for China to prevent another wave of COVID-19 outbreak with vaccines in place and willingness to receive a COVID-19 vaccination for themselves were associated with higher parental acceptability of COVID-19 vaccination. At interpersonal level, higher frequency of information exposure through social media and direct interpersonal communication were associated with higher parental acceptability of COVID-19 vaccination, while knowing some people who experienced serious side effects following COVID-19 vaccination were associated with lower parental acceptability of COVID-19 vaccination. Despite their important roles in vaccination promotion, Chinese doctors and nurses showed low parental acceptability of COVID-19 vaccination. Effective health promotion is needed when COVID-19 vaccination become available.

### ARTICLE HISTORY

Received 30 December 2020  
Revised 24 March 2021  
Accepted 7 April 2021

### KEYWORDS

Parental acceptability; COVID-19 vaccination; doctors and nurses; personal experience related to COVID-19; perceptions related to COVID-19 vaccination; information exposure through social media; interpersonal communication; peer experiences

### Introduction

Some of the existing measures to control COVID-19 (e.g., physical distancing and lockdown) have negative impacts on the global economy<sup>1</sup> and may result in significant impairment in physical and psychological wellbeing.<sup>2</sup> There is hence a strong need for development of an effective vaccine to keep COVID-19 under control. According to the World Health Organization (WHO), 13 candidate vaccines have entered Phase III clinical trials.<sup>3</sup> As demonstrated by a randomized controlled trial, the COVID-19 vaccine developed by the BioNTech and Pfizer would have 95% protection against COVID-19<sup>4</sup>; the interim analysis of the phase III trials showed that one of the China candidate COVID-19 vaccines showed 86% vaccine efficacy against COVID-19 without serious safety concern.<sup>5</sup> Safety and efficacy of COVID-19 vaccines developed by Pfizer & BioNTech in subjects aged 12–15 years are being evaluated in the global Phase III study (NCT04368728), with data to be submitted to regulators in the second quarter of 2021. Pfizer & BioNTech are also planning for additional studies in children ages 5–11 years, and in children younger than 5 years old in 2021. On January 15, 2021, China National Biotech Group announced that the company tested their COVID-19 vaccine among children aged 3–17 years and submitted the data to China Food and Drug Administration for

approval. It is expected that the suitable age group for COVID-19 vaccination will be extended to children aged 3–17 years in China by March, 2021.<sup>6</sup>

During the study period (October to November, 2020), the following information regarding COVID-19 vaccination are available to people in China. On July 22, 2020, the National Health Commission of the People's Republic of China authorized the emergency use of the COVID-19 vaccine manufactured by Beijing Institute of Biological Product's inactivated vaccine/Sinopharm, and provided such vaccine to workers, students, and diplomatic personnel who need to travel aboard, as well as healthcare workers and personnel working for pandemic and border control.<sup>7,8</sup> According to the official press releases conducted from September to November 2020, there were at least 56000 Chinese people who had received the Sinopharm COVID-19 vaccine before traveling aboard. None of them reported SARS-Cov-2 infection and there was no serious safety concern.<sup>9,10</sup> According to an official press release on September 15, 2020, children are considered as one of the priority groups to receive COVID-19 vaccination in China.<sup>11</sup>

Simulation experiments showed that when the reproduction number ( $R_0$ ) of COVID-19 transmission was 2.5 and vaccination occurred when 5% of the population has been exposed to SARS-Cov-2, a vaccine with efficacy of 80% needs to achieve

75% coverage in the whole population in order to extinguish the ongoing pandemic without any other measures (e.g., social distancing).<sup>12</sup> It is noteworthy that in the absence of COVID-19 vaccination, children will likely become as a reservoir of the virus, which would undermine efforts to end the pandemic.<sup>13</sup> Moreover, it is difficult to recover the economy completely until the children can safely return to schools and parents can then resume full-time work.<sup>13</sup>

The effectiveness of pandemic vaccination campaigns depends on both the vaccines' effectiveness and people's willingness take up COVID-19 vaccination. For children and adolescents, parents are usually the decision makers or have strong influences regarding their vaccination. It is hence important to understand parental acceptability of their children's COVID-19 vaccination. To our knowledge, at least two studies have investigated parental acceptability of COVID-19 vaccination for their children. Among parents or guardians in the United Kingdom, 48.2% reported that they would have their children aged 18 months or under receive COVID-19 vaccination,<sup>14</sup> while 72.5% of Chinese factory workers reported that they would likely or very likely to vaccinate their children under the age of 18 years against COVID-19.<sup>15</sup> This study focused on healthcare workers. The risk of COVID-19 among healthcare workers was 9–11 times higher than the general population<sup>16</sup> and they usually have a very high priority to receive COVID-19 vaccination.<sup>17</sup> Studies conducted in high-, middle-, and low-income settings consistently showed that healthcare workers facilitate provision of guidance/recommendations to the general public and rectify misconceptions about newly developed vaccines.<sup>18,19</sup> The WHO vaccine advisory group also highlights healthcare workers' role in building up general public's confidence in vaccines.<sup>20</sup>

Understanding the factors associated with parental acceptability of COVID-19 vaccination is important in developing effective health promotion. As the interventions addressing factors at multiple levels are more likely than others to be successful in changing behaviors,<sup>21</sup> we considered factors at both the individual level and interpersonal level. At individual level, work experience related to COVID-19 influenced healthcare workers' decision to take up COVID-19 vaccination. One study among nurses showed that working in infection isolation wards and insufficient personal protective equipment were associated with higher work stress and higher intention to take up COVID-19 vaccination.<sup>22</sup> Perceptions related to COVID-19 vaccination may also affect healthcare workers' decision to vaccinate their children. Previous studies targeting parents or guardians in the United Kingdom and Chinese factory workers showed that the beliefs that COVID-19 vaccination could protect their children and other family member<sup>14,15</sup> and facilitate them return to normal life,<sup>14,15</sup> perceived support provided by family member and perceived behavioral control related to children's COVID-19 vaccination<sup>15</sup> were associated with higher parental acceptability. Concerns related to vaccine safety and effectiveness were negatively associated with parental acceptability of COVID-19 vaccination.<sup>14</sup>

At interpersonal level, it is common to obtain vaccination-related information on social media.<sup>23</sup> Previous studies showed that over 60% of the people in the United States used social media as a common source to obtain information related to HPV and influenza vaccination.<sup>24,25</sup> During the pandemic, people have also been actively seeking information about COVID-19 vaccination

from various social media platforms.<sup>26</sup> One study showed that higher exposure to positive information related to COVID-19 vaccination (e.g., new vaccines entering clinical trials, promising efficacies of the vaccines, and vaccines will enter the market soon) was associated with higher parental acceptability of COVID-19 vaccination among Chinese factory workers.<sup>15</sup> Exchange of information related to COVID-19 vaccination also occurs through interpersonal communication. Previous studies suggested that interpersonal communication was likely to disseminate false and unverified information during the pandemic,<sup>27</sup> and was associated with lower compliance to personal preventive measures among Chinese population.<sup>28</sup> In addition, parents' decision whether to vaccinate their children against COVID-19 may be influenced by other social network-related factors such as their peers' experiences and behaviors. Previous studies suggested that Chinese people usually prefer to seek information from peers, who are perceived as providing more credible information than other potential sources.<sup>29</sup> To our knowledge, there was no study investigating associations of interpersonal communication and peers' experience with parental acceptability of COVID-19 vaccination.

This study investigated parental acceptability of COVID-19 vaccination for children/adolescents aged < 18 years among doctors and nurses in China. We examined associated factors including background characteristics, individual-level factors (personal experiences related to COVID-19 and perceptions of COVID-19 vaccination), and interpersonal-level factors (information exposure through social media, direct interpersonal communication and peers' experience related to COVID-19 vaccination).

## Materials and methods

### Study design

This manuscript is a sub-analysis of a cross-sectional closed online survey investigating willingness to receive COVID-19 vaccination among healthcare workers conducted from October 19 to November 26, 2020. According to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES), a closed online survey is only open to a sample which the investigator knows.<sup>30</sup> Healthcare workers who had a children under the age of 18 years were asked some additional questions about their likelihood to vaccinate their children against COVID-19.

### Participants and data collection

Participants of the closed online survey were full-time doctors or nurses employed by the five collaborative hospitals during the COVID-19 pandemic (since January 2020) who had access to smartphones. The conveniently selected study sites included five hospitals located in three Chinese provinces (i.e., two in Guangdong, two in Hunan, and one in Yunnan). Guangdong Province has the second largest number of COVID-19 cases in China. Hunan and Yunnan are less affected by COVID-19 pandemic. As of December 10, 2020, the number of reported COVID-19 cases in these Chinese provinces was 2013 in Guangdong, 1020 in Hunan, and 222 in Yunnan.<sup>31</sup>

In the participating hospitals, WeChat/QQ groups used for daily work-related communications were established for each department; these groups included all doctors and nurses.

WeChat and QQ are the most commonly used instant messaging applications in China, which have over 1.2 and 0.7 billion users. We developed an online questionnaire using Questionnaire Star, a commonly used web-based survey platform in China, and the link to the questionnaire could be shared using WeChat and QQ social media platforms. Facilitated by the hospital administrators, prospective participants received an invitation letter sent by the research team via the existing WeChat/QQ groups. The letter briefed the participants about the study's background, anonymity, the right to quit at any time, refusal to participate would have no effect on them, the survey would not collect personal contacts and identifying information, and data would be kept strictly confidential and would only be used for research purposes. The invitation also stated that completing the survey implied informed consent. The survey contained 120 items and required approximately 30 minutes to complete. The Questionnaire Star tool performed completeness check before the questionnaire was submitted. Participants were able to review and change their responses using a Back button. No incentives were given to the participants. All data were stored in the Questionnaire Star server and protected by a password. Only the corresponding author had access to the database.

Out of 3,104 healthcare workers being invited, 2,287 completed the questionnaire (response rate: 73.7%), 6 participants were excluded due to invalid responses to questions assessing key socio-demographics (e.g., age), and the other 2,281 were included in the data analysis. The present report was based on the subsample of 1332 participants who had at least one child under the age of 18 years. Ethics approval was obtained from the Survey and Behavioral Research Ethics Committee of corresponding author's affiliated institution (Reference No. SBRE-20-094).

## Measures

### *Development of the questionnaire*

A panel consisting of one behavioral health expert, two health psychologists, two public health researchers, and two healthcare workers was formed to develop the questionnaire used in the current study.

### *Background characteristics*

Participants were asked to report socio-demographics (age, gender, relationship status, and education level), professions (being doctors or nurses), departments, professional ranks, and whether they lived with an elderly. In mainland China, full-time doctors have three different professional ranks, from residents (primary technical job title), doctors-in-charge (middle rank technical job title), and deputy chief doctor or chief doctor (advanced technical job title). The professional rank of residents is equivalent to residents in the United States or commonwealth countries, while the deputy chief/chief doctor is equivalent to attending doctor in the United States or associate consultant/consultant doctor in commonwealth countries. The professional ranking of full-time nurses in mainland China is from nurse practitioner (primary technical job title), nurse-in-charge (middle rank technical job title), to deputy

chief nursing officer or chief nursing officer (advanced technical job title). The nurse practitioner is equivalent to enrolled nurses (in Hong Kong) or nursing associate (in the United Kingdom) or certified nursing assistant/licensed practical nurse (in the United States), nurse-in-charge is equivalent to registered nurses (in Hong Kong or the United States) or staff/senior staff nurses (in the United Kingdom), while deputy chief/chief nursing officer is equivalent to nursing officer (in Hong Kong) or charge nurse/nurse manager (in the United Kingdom) or advanced registered nursing practitioner (in the United States).

### *Parental acceptability of COVID-19 vaccination for children under the age of 18 years*

Participants were asked about the likelihood of having their children under the age of 18 years taken up COVID-19 vaccination, if it is available in China in the next six months (response categories: 1 = very unlikely, 2 = unlikely, 3 = neutral, 4 = likely, and 5 = very likely). Parental acceptability of COVID-19 vaccination was defined as "likely" or "very likely." Such definition was commonly used in previous studies.<sup>15,32</sup>

### *Individual-level factors*

#### *Personal experience related to COVID-19*

Participants were asked to report their job duties related to COVID-19 prevention and control, including treatment and/or care for COVID-19 patients, testing and/or examination for suspected/confirmed COVID-19 patients, epidemiology survey and quarantine arrangement, and other tasks related to COVID-19 prevention and control. Participants also reported history of mandatory centralized/home quarantine and SARS-Cov-2 infection, and whether they had any coworkers or family members/friends infected with SARS-Cov-2. In addition, they were asked whether they had received COVID-19 vaccination.

#### *Perceptions related to COVID-19 vaccination*

Five items were used to measure perceived risk of SARS-Cov-2 (e.g., 'perceived one's risk of SARS-Cov-2 infection in the next year' and 'perceived chance of having another wave of COVID-19 outbreak in China in the next year'). The Risk Perception Scale was constructed by summing up individual item scores (response categories: from 1 = very low to 5 = very high), with higher score indicated perceived high risk of SARS-Cov-2. Two single items were used to measure perceived vaccine efficacy (response categories: 1 = 10%, 2 = 20%, 3 = 30%, 4 = 40%, 5 = 50%, 6 = 60%, 7 = 70%, 8 = 80%, 9 = 90%, 10 = 100%, 11 = not sure) and duration of protection of the COVID-19 vaccination (response categories: 1 = less than 6 months, 2 = 6–12 months, 3 = 1–2 years, 4 = 2–5 years, 5 = more than 5 years, 6 = lifelong, and 7 = not sure). In addition, participants were asked about chance for China to prevent another wave of COVID-19 outbreak with COVID-19 vaccines in place (response categories: from 1 = very low to 5 = very high). Furthermore, participants were about their likelihood of receiving COVID-19 vaccination, if it is available for free in China in the next six months (response categories: 1 = very unlikely, 2 = unlikely, 3 = neutral, 4 = likely, and

5 = very likely). Willingness to receive a COVID-19 vaccination for themselves was defined as “likely” or “very likely”.

### **Interpersonal-level factors**

#### **Information exposure through social media**

Participants were asked to report the frequency of performing the following activities on social media in the past month, including: 1) reading information related to COVID-19 vaccination posted by official social media accounts, 2) reading information related to COVID-19 vaccination posted by other social media accounts, and 3) active searching information related to COVID-19 vaccination through social media. The Information Exposure through Social Media Scale was formed by summing up individual item scores (response categories: from 1 = very low to 5 = very high).

#### **Interpersonal communication**

Participants reported frequency of direct interpersonal communication with coworkers and other people who were not health professionals related to COVID-19 vaccination (response categories: 1 = almost never, 2 = seldom, 3 = sometimes, and 4 = always). The Interpersonal Communication Scale was constructed by summing up individual item scores.

#### **Peer's experiences related to COVID-19 vaccination**

Participants were asked whether they had a peer who received COVID-19 vaccination and knew peers who experienced serious side effects of COVID-19 vaccination.

### **Statistical analysis**

Parental acceptability of COVID-19 vaccination was used as the dependent variable. Univariate logistic regression model first assessed the significance of the association between each of the background characteristics and the dependent variable. Background variables with  $P < .05$  in univariate analysis (i.e., departments and professional ranks of the participants) were adjusted in multivariate logistic regression models. Each adjusted odds ratios (AOR) was obtained by fitting a single logistic regression model, which involved one of the independent variable of interest (i.e., personal experiences related to COVID-19, perceptions related to COVID-19 vaccination, and interpersonal-level factors) and the two significant background variables. Similar approach was used in numerous published studies.<sup>33,34</sup> Principal component analysis with varimax rotation was used to perform explanatory factor analysis (EFA). EFA is generally used to discover the factor structure of a measure and to examine its internal validity.<sup>35</sup> EFA is often recommended when researchers have no hypotheses about the nature of the underlying factor structure of the measures.<sup>35</sup> In this study, the Risk Perception Scale, the Information Exposure through Social Media Scale and the Interpersonal Communication Scale were new instruments developed by the research team. The items were generated by literature review<sup>15,28,36–38</sup> and interviewing healthcare workers in China. SPSS version 26.0 for Windows (SPSS, Inc, Chicago, IL, the United States) was used for data analysis, with  $P < .05$  considered statistically significant.

## **Results**

### **Background characteristics**

Majority of the participants were 40 years old or younger (89.9%,  $n = 1198$ ), female (89.4%,  $n = 1191$ ), married or cohabited with a partner (95.9%,  $n = 1278$ ), did not obtain postgraduate education (82.4%,  $n = 1098$ ), and were nurses (82.2%,  $n = 1095$ ). Among the participants, 33.5% ( $n = 446$ ) were working in the internal medicine departments, 37.1% possessed primary technical job title ( $n = 494$ ), and 81.8% ( $n = 1089$ ) living with an elderly (Table 1).

### **Parental acceptability of COVID-19 vaccination for children under the age of 18 years**

Among the participants, 44.5% ( $n = 593$ ) reported that they would likely or very likely to have their children under the age of 18 years take up COVID-19 vaccination in the next six months (Table 2).

### **Individual-level and interpersonal-level factors**

During the pandemic, 17.4% ( $n = 232$ ) of the participants had provided treatment and/or care for COVID-19 patients, 30.3% ( $n = 404$ ) had performed testing and/or examination to suspected/confirmed COVID-19 patients, 35.4% ( $n = 471$ ) had engaged in epidemiology survey and quarantine arrangements, and 52.6% ( $n = 701$ ) performed other tasks related to COVID-19 prevention and control. About 15% of the participants reported a history of mandatory quarantine (7.3% experienced mandatory centralized quarantine and 8.0% experienced mandatory home quarantine), and 5% ( $n = 66$ ) had history of SARS-Cov-2 infection. Very few participants had coworkers (1.6%,  $n = 21$ ) infected with SARS-Cov-2, and none of them received COVID-19 vaccination. The Cronbach's alpha of the Risk Perception Scale was 0.93, one factor was identified by exploratory factor analysis, explaining for 79.8% of total variance. At the time of the survey, only 16.4% ( $n = 218$ ) perceived efficacy of COVID-19 vaccines of over 80%. Over 70% ( $n = 964$ ) of the participants willing to receive a COVID-19 vaccination for themselves. Individual item responses and mean (standard deviation, SD) of the scale related to parental perception of COVID-19 vaccination were presented in Table 2.

Regarding interpersonal-level factors, about 30% of the participants reported high/very high frequency of performing the following activities on social media in the past month, including reading information related to COVID-19 vaccination posted by official social media accounts (37.2%,  $n = 495$ ) or other social media accounts (32.9%,  $n = 438$ ), and active searching information related to COVID-19 vaccination through social media (27.5%,  $n = 367$ ). The Cronbach's alpha of the Information Exposure through Social Media Scale was 0.92, one factor was identified by exploratory factor analysis, explaining for 86.3% of total variance. Over half of the participants sometimes/always communicated with coworkers (61.2%,  $n = 815$ ) or people who were not health professionals (53.5%,  $n = 713$ ) about COVID-19 vaccination. The Cronbach's alpha of the Interpersonal Communication Scale was 0.78, one factor was identified by exploratory factor analysis, explaining for 82.2% of total variance. Among the participants, 84 (6.3%) had a peer colleague having

**Table 1.** Background characteristics of the healthcare workers who had at least one child under the age of 18 years (n = 1332).

	N	%
Age group		
18–30	381	28.6
31–40	817	61.3
> 40	134	10.1
Gender		
Male	141	10.6
Female	1191	89.4
Relationship status		
Married or cohabited with a partner	1278	95.9
Currently single	54	4.1
Highest education level attained		
University or below	1098	82.4
Postgraduate	234	17.6
Professions		
Doctors	237	17.8
Nurses	1095	82.2
Departments		
Internal medicine	446	33.5
Surgery	325	24.4
Obstetrics & gynecology	49	3.7
Pediatrics	171	12.8
Infectious diseases	67	5.0
Emergency	75	5.6
Others	199	14.9
Professional ranks <sup>a</sup>		
Primary technical job title	494	37.1
Middle rank technical job title	704	52.9
Advanced technical job title	131	9.8
Others	3	0.2
Living with an elderly people		
No	243	18.2
Yes	1089	81.8

<sup>a</sup>Professional ranks.

For doctors:

Primary technical job title = residents (mainland China, the United States, and commonwealth countries).

Middle rank technical job title = doctor-in-charge (mainland China).

Advanced technical job title = deputy chief/chief doctor (mainland China) or attending doctor (the U.S) or associate consultant/consultant doctor (commonwealth countries).

For nurses:

Primary technical job title = nurse practitioner (mainland China) or enrolled nurses (in Hong Kong) nursing associate (in the U.K.) or certified nursing assistant/licensed practical nurse (in the U.S.).

Middle rank technical job title = nurse-in-charge (mainland China) or registered nurses (in Hong Kong or the U.S.) or staff/senior staff nurses (in the U.K.).

Advanced technical job title = deputy chief/chief nursing officer (mainland China) or nursing officer (in Hong Kong) or charge nurse/nurse manager (in the U.K.) or advanced registered nursing practitioner (in the U.S.).

taken up COVID-19 vaccination, and 12.9% (n = 172) knew of some people who experienced serious side effects following COVID-19 vaccination (Table 2).

### Factors associated with parental acceptability of COVID-19 vaccination for children under the age of 18 years

In the univariate logistic regression analysis, participants who worked in the infectious disease departments showed higher parental acceptability of COVID-19 vaccination (OR: 1.96, 95% CI: 1.16, 3.28,  $p = .01$ ; reference group: internal medicine departments), while those had middle rank technical job title reported lower parental acceptability of COVID-19 vaccination (OR: 0.76, 95% CI: 0.61, 0.96,  $p = .02$ ; reference group: primary technical job title). (Table 3)

After adjusting for these significant background characteristics, perceived higher vaccine efficacy (60–80%: AOR: 2.32,

95% CI: 1.64, 3.28,  $p < .001$ ; > 80%: AOR: 6.40, 95% CI: 4.18, 9.80,  $p < .001$ ; not sure: AOR: 2.82, 95% CI: 1.70, 4.69,  $p < .001$ ; reference group:  $\leq 50\%$ ) and longer protection duration (6–12 months: AOR: 2.03, 95%CI: 1.31, 3.16; 1–2 years: AOR: 2.28, 95%CI: 1.45, 3.59; 2–5 years: AOR: 2.61, 95%CI: 1.55, 4.38; > 5 years: AOR: 3.34, 95%CI: 1.91, 5.84; lifelong: AOR: 3.13, 95%CI: 1.88, 5.19; reference group: <6 months) were positively associated with the dependent variable. Perceived high/very high chance for China to prevent another wave of COVID-19 outbreak with COVID-19 vaccines in place (AOR: 1.46, 95% CI: 1.17, 1.83,  $p = .001$ ) and willingness to receive a COVID-19 vaccination for themselves (AOR: 5.74, 95%CI: 4.25, 7.75,  $p < .001$ ) were also associated with higher parental acceptability of COVID-19 vaccination. Regarding interpersonal-level factors, higher frequency of information exposure through social media (AOR: 1.08, 95% CI: 1.04, 1.13,  $p < .001$ ) and interpersonal communication (AOR: 1.24, 95% CI: 1.15, 1.34,  $p < .001$ ) related to COVID-19 vaccination were associated with higher parental acceptability of COVID-19 vaccination, while knowing some people who experienced serious side effects following COVID-19 vaccination (AOR: 0.68, 95% CI: 0.49, 0.95,  $p = .02$ ) were negatively associated with this dependent variable (Table 4).

### Discussion

Healthcare workers always serve as ambassadors in promoting vaccine acceptance.<sup>39</sup> Their roles had never been more important during the COVID-19 pandemic. However, the prevalence of parental acceptability of COVID-19 vaccination (44.5%) among doctors and nurses was much lower than that of factory workers in China (72.6%),<sup>15</sup> which may undermine the efforts to promote COVID-19 vaccination among children. The impact of COVID-19 on general population and other groups differs and may cause different responses to COVID-19 vaccination. Given their training background, doctors and nurses are more familiar with the conventional vaccine development process and the disease course of COVID-19 than the general population. However, they might also be more critical. Previous study indicated that concerns about the expedited vaccine development of COVID-19 vaccines have led to their vaccination hesitancy.<sup>40</sup> Moreover, compared to the general public, they might be more aware about that the risk of death caused by COVID-19 was low among children, and most of infected children would not be symptomatic.<sup>13</sup> Given the relatively low parental acceptability and the gap between acceptability and actual behavior,<sup>41</sup> effective health promotion is needed for healthcare workers achieve a high vaccine coverage among their children.

Our findings provided empirical insights to inform health promotion development. Doctors/nurses of the infectious diseases departments showed higher parental acceptability of COVID-19 vaccination than those of the internal medicine departments, possibly because the former group was more likely than the latter to engage in patient treatment and thus felt higher risk of transmitting the virus to their children. Furthermore, attention should be given to those with higher job titles, as they reported lower parental acceptability of COVID-19 vaccination. It is noteworthy that such senior

**Table 2.** Parental acceptability of COVID-19 vaccination, and individual-level and interpersonal-level factors related to COVID-19 vaccination (n = 1332).

	N (%)	Mean (SD)
Parental acceptability of COVID-19 vaccination for children under the age of 18 years		
Likelihood of having the children taken up free COVID-19 vaccination if the vaccines become available in China in the next six months		
Very unlikely	24 (1.8)	
Unlikely	206 (15.5)	
Neutral	509 (38.2)	
Likely	412 (30.9)	
Very likely	181 (13.6)	
Individual-level factors		
Personal experiences related to COVID-19		
Participants' job duties related to COVID-19 prevention and control		
Treatment and/or care for COVID-19 patients		
No	1100 (82.6)	
Yes	232 (17.4)	
Testing and/or examination for suspected/confirmed COVID-19 patients		
No	928 (69.7)	
Yes	404 (30.3)	
Epidemiology survey and quarantine arrangement		
No	861 (64.6)	
Yes	471 (35.4)	
Other work related to COVID-19 prevention and control		
No	631 (47.4)	
Yes	701 (52.6)	
History of mandatory centralized/home quarantine		
No	1128 (84.7)	
History of mandatory centralized quarantine	97 (7.3)	
History of mandatory home quarantine	107 (8.0)	
History of SARS-Cov-2 infection		
No	1266 (95.0)	
Yes	66 (5.0)	
Having at least one coworker infected with SARS-Cov-2		
No	1311 (98.4)	
Yes	21 (1.6)	
Uptake of COVID-19 vaccination		
No	1332 (100.0)	
Yes	0 (0.0)	
Perceptions related to COVID-19 vaccination		
Risk perceptions		
Perceived one's risk of SARS-Cov-2 infection in the next year		
Very low/low/moderate	1090 (81.9)	
High/very high	242 (18.1)	
Perceived one's risk of exposure to SARS-Cov-2 in the next year		
Very low/low/moderate	980 (73.6)	
High/very high	352 (26.4)	
Perceived coworkers' risk of SARS-Cov-2 infection in the next year		
Very low/low/moderate	1025 (77.0)	
High/very high	307 (23.0)	
Perceived chance of having another wave of COVID-19 outbreak in China in the next year		
Very low/low/moderate	1094 (82.1)	
High/very high	238 (17.9)	
Perceived chance of having another wave of COVID-19 outbreak in the city you are living in the next year		
Very low/low/moderate	1179 (88.5)	
High/very high	153 (11.5)	
<i>Risk Perception Scale<sup>a</sup></i>		13.8 (4.1)
Perceived efficacy of the COVID-19 vaccines		
≤50%	213 (16.0)	
60–80%	800 (60.1)	
> 80%	218 (16.4)	
Not sure	101 (7.6)	
Perceived protection duration of the COVID-19 vaccines		
<6 months	134 (10.1)	
6–12 months	333 (25.0)	
1–2 years	267 (20.0)	
2–5 years	130 (9.8)	
> 5 years	99 (7.4)	
Lifelong	148 (11.1)	
Not sure	221 (16.6)	
The chance for China to prevent another wave of COVID-19 outbreak with COVID-19 vaccines in place		
Very low/low/moderate	812 (61.0)	
High/very high	520 (39.0)	
Likelihood of receiving a COVID-19 vaccination for themselves, if it is available for free in China in the next six months		
Very unlikely/unlikely/neutral	368 (27.6)	
Likely/very likely	964 (72.4)	

(Continued)

Table 2. (Continued).

	N (%)	Mean (SD)
Interpersonal-level factors		
Exposure to information related to COVID-19 vaccination through social media		
Frequency of reading information related to COVID-19 vaccination posted by official social media accounts		
Very low/low/moderate	837 (62.8)	
High/very high	495 (37.2)	
Frequency of reading information related to COVID-19 vaccination posted by other social media accounts		
Very low/low/moderate	894 (67.1)	
High/very high	438 (32.9)	
Frequency of active searching information related to COVID-19 vaccination through social media		
Very low/low/moderate	965 (72.5)	
High/very high	367 (27.5)	
<i>Information Exposure through Social Media Scale<sup>b</sup></i>		
Interpersonal communication related to COVID-19 vaccination		9.5 (2.5)
Frequency of direct communication with coworkers		
Almost never/seldom	517 (38.8)	
Sometimes/always	815 (61.2)	
Frequency of direct communication with people who are not healthcare professionals		
Almost never/seldom	619 (46.5)	
Sometimes/always	713 (53.5)	
<i>Interpersonal Communication Scale<sup>c</sup></i>		
Peers' experience related to COVID-19 vaccination		5.3 (1.4)
Having at least one peer who had taken up COVID-19 vaccination		
No	1248 (93.7)	
Yes	84 (6.3)	
Knowing of some people who experienced serious side-effects following COVID-19 vaccination		
No	1160 (87.1)	
Yes	172 (12.9)	

<sup>a</sup>Risk Perception Scale: 5 items, Cronbach's alpha: 0.93, one factor was identified by exploratory factor analysis, explaining for 79.8% of total variance.

<sup>b</sup>Information Exposure through Social Media Scale: 3 items, Cronbach's alpha: 0.92, one factor was identified by exploratory factor analysis, explaining for 86.3% of total variance.

<sup>c</sup>Interpersonal Communication Scale: 2 items, Cronbach's alpha: 0.78, one factor was identified by exploratory factor analysis, explaining for 82.2% of total variance.

Table 3. Associations between baseline characteristics and parental acceptability of COVID-19 vaccination for children under the age of 18 years.

	OR (95%CI)	P value
Age group		
18–30	1.0	
31–40	1.00 (0.78, 1.28)	1.00
> 40	1.32 (0.89, 1.96)	.17
Gender		
Male	1.0	
Female	1.03 (0.72, 1.46)	.89
Relationship status		
Married or cohabited with a partner	1.0	
Currently single	0.79 (0.45, 1.37)	.40
Highest education level attained		
University or below	1.0	
Postgraduate	0.79 (0.59, 1.05)	.11
Professions		
Doctors	1.0	
Nurses	1.17 (0.88, 1.56)	.28
Departments		
Internal medicine	1.0	
Surgery	1.22 (0.91, 1.63)	.18
Obstetrics & gynecology	0.95 (0.52, 1.73)	.85
Pediatrics	1.41 (0.99, 2.01)	.06
Infectious diseases	1.96 (1.16, 3.28)	.01
Emergency	0.89 (0.54, 1.47)	.65
Others	1.51 (1.08, 2.11)	.02
Professional ranks		
Primary technical job title	1.0	
Middle rank technical job title	0.76 (0.61, 0.96)	.02
Advanced technical job title	0.77 (0.52, 1.13)	.18
Others	N.A.	N.A.
Living with an elderly people		
No	1.0	
Yes	1.07 (0.81, 1.41)	.65

OR: crude odds ratios.

CI: confidence interval.

doctors/nurse are authorities in China<sup>42</sup> and might influence parental acceptability of their juniors.

At individual level, perceived higher efficacy of COVID-19 vaccines was associated with higher parental acceptability. However, at the time of the survey, only a 16.4% perceived efficacy of COVID-19 vaccines of over 80%. About half of the participants believed that protection duration of COVID-19 vaccines would last for more than one year. Perceived longer duration of protection was also a facilitator of parental acceptance. It is hence important to update doctors and nurses regularly about new evidences of COVID-19 vaccines to correct their misconceptions. Only less than 40% of the healthcare workers perceived a high/very high chance of China to prevent another wave of COVID-19 outbreak with the COVID-19 vaccines in place. Since the existing COVID-19 control measures (universal testing and community lockdown) have been very successful in controlling COVID-19 in mainland China, many healthcare workers might believe COVID-19 prevention would not solely dependent on vaccination. Perceptions about the importance of COVID-19 vaccination in preventing COVID-19 outbreak was associated with higher parental acceptability. Health communication messages should explain the cost-effective of COVID-19 vaccination compared to the use of other existing control measures. Similar to previous studies among parents, healthcare workers who were willing to receive a COVID-19 vaccination were more likely to vaccinate their children against COVID-19.<sup>43</sup> In contrast to our hypothesis, personal experience related to COVID-19, such as job duties, history of mandatory quarantine or COVID-19, or having

**Table 4.** Associations of individual-level and interpersonal-level factors with parental acceptability of COVID-19 vaccination.

	OR (95%CI)	P values	AOR (95%CI)	P values
<b>Individual-level factors</b>				
Personal experiences related to COVID-19				
Participants' job duties related to COVID-19 prevention and control				
Treatment and/or care for COVID-19 patients				
No	1.0		1.0	
Yes	1.02 (0.76, 1.35)	.92	0.94 (0.69, 1.27)	.68
Testing and/or examination for suspected/confirmed COVID-19 patients				
No	1.0		1.0	
Yes	1.09 (0.86, 1.38)	.46	1.04 (0.81, 1.33)	.76
Epidemiology survey and quarantine arrangement				
No	1.0		1.0	
Yes	1.15 (0.92, 1.44)	.23	1.15 (0.92, 1.45)	.23
Other work related to COVID-19 prevention and control				
No	1.0		1.0	
Yes	1.20 (0.97, 1.49)	.10	1.23 (0.99, 1.54)	.06
History of mandatory centralized/home quarantine				
No	1.0		1.0	
History of mandatory centralized quarantine	1.01 (0.67, 1.54)	.96	0.84 (0.52, 1.34)	.46
History of mandatory home quarantine	1.25 (0.84, 1.85)	.28	1.21 (0.81, 1.81)	.36
History of SARS-Cov-2 infection				
No	1.0		1.0	
Yes	1.43 (0.87, 2.35)	.16	1.45 (0.88, 2.40)	.15
Having at least one coworker infected with SARS-Cov-2				
No	1.0		1.0	
Yes	0.76 (0.31, 1.86)	.55	0.77 (0.32, 1.89)	.58
Perceptions related to COVID-19 vaccination				
Risk Perception Scale				
Perceived efficacy of the COVID-19 vaccines	0.98 (0.96, 1.01)	.22	0.98 (0.96, 1.01)	.23
≤50%	1.0		1.0	
60–80%	2.35 (1.66, 3.31)	< .001	2.32 (1.64, 3.28)	< .001
> 80%	6.41 (4.20, 9.78)	< .001	6.40 (4.18, 9.80)	< .001
Not sure	2.92 (1.77, 4.81)	< .001	2.82 (1.70, 4.69)	< .001
Perceived protection duration of the COVID-19 vaccines				
<6 months	1.0		1.0	
6–12 months	2.05 (1.32, 3.17)	.001	2.03 (1.31, 3.16)	.002
1–2 years	2.31 (1.47, 3.61)	< .001	2.28 (1.45, 3.59)	< .001
2–5 years	2.70 (1.62, 4.51)	< .001	2.61 (1.55, 4.38)	< .001
> 5 years	3.28 (1.89, 5.67)	< .001	3.34 (1.91, 5.84)	< .001
Lifelong	3.26 (1.98, 5.36)	< .001	3.13 (1.88, 5.19)	< .001
Not sure	1.55 (0.97, 2.47)	.07	1.51 (0.94, 2.43)	.09
The chance for China to prevent another wave of COVID-19 outbreak with COVID-19 vaccines in place				
Very low/low/moderate	1.0		1.0	
High/very high	1.40 (1.12, 1.75)	.003	1.46 (1.17, 1.83)	.001
Likelihood of receiving a COVID-19 vaccination for themselves, if it is available for free in China in the next six months				
Very unlikely/unlikely/neutral	1.0		1.0	
Likely/very likely	5.65 (4.20, 7.59)	< .001	5.74 (4.25, 7.75)	< .001
<b>Interpersonal-level factors</b>				
Information Exposure through Social Media Scale				
Interpersonal Communication Scale	1.08 (1.04, 1.13)	< .001	1.08 (1.04, 1.13)	< .001
Having at least one peer who had taken up COVID-19 vaccination	1.25 (1.16, 1.35)	< .001	1.24 (1.15, 1.34)	< .001
No	1.0		1.0	
Yes	1.47 (0.95, 2.30)	.08	1.49 (0.95, 2.33)	.08
Knowing of some people who experienced serious side-effects following COVID-19 vaccination				
No	1.0		1.0	
Yes	0.65 (0.47, 0.91)	.01	0.68 (0.49, 0.95)	.02

OR: crude odds ratios.

AOR: adjusted odds ratios, odds ratios adjusted for significant background characteristics (i.e., departments and professional ranks).

CI: confidence interval.

a coworker infected with SARS-Cov-2, was not associated with parental acceptability. Thus, similar health promotion strategies may be applied to doctors and nurses with different personal experiences related to COVID-19.

Interpersonal-level factors, such as information exposure through social media, interpersonal communication and peers' experiences related to COVID-19 vaccination, also had significant influences on healthcare workers' acceptance of COVID-19

vaccination for their children. COVID-19 vaccination triggered intensive responses on social media both internationally<sup>26</sup> and locally.<sup>15</sup> About 30% of the healthcare workers reported high/very high frequency of exposure to COVID-19 vaccination-related information through social media. Higher frequency of information exposure was associated with higher parental acceptability. A sufficient amount of information exposure related to COVID-19 vaccination, regardless of topics and valence, could potentially



cultivate a global sense of vaccine development among healthcare workers, and hence increase their acceptance of COVID-19 vaccination for their children. Higher frequency of interpersonal communication was also positively associated with parental acceptability. Interpersonal communication may be another important information source for healthcare providers. Since the general population and healthcare workers in China were positive about COVID-19 vaccines,<sup>44</sup> frequent interpersonal communication may have positive influence on parental acceptability. Awareness of occurrence of serious side effects of COVID-19 vaccination among colleagues was associated with lower parental acceptability. Peers were considered as credible information sources by Chinese people.<sup>29</sup> Side effects are among the greatest concerns affecting Chinese parents' parental decisions to let their children taking up vaccinations.<sup>45,46</sup> In literature, many healthcare workers worried about the safety of COVID-19 vaccines.<sup>40</sup> Therefore, healthcare workers should be updated regularly about new evidences related to COVID-19 vaccination, including both short-term and long-term safety, as well as ways to manage side effects.

This is one of the first studies investigating parental acceptability of COVID-19 vaccination among healthcare workers. However, it has a number of limitations. First, we did not ask participants about the exact age of their children. Children's age would influence parents' willingness to have children take up COVID-19 vaccination, as one previous study showed that Chinese parents with children aged 6 years or below reported lower willingness to vaccinate their children against COVID-19.<sup>15</sup> Second, we did not capture knowledge related to COVID-19 and COVID-19 vaccination among the participants. Such knowledge had significant influences on willingness to receive COVID-19 vaccination in literature. Third, we included healthcare workers in five conveniently selected hospitals, generalization should be made cautiously to healthcare workers in other places in China. This study only focused on doctors/nurses, and the findings cannot be generalized to other types of health workers and parents of other occupations. Fourth, since the study was anonymous and did not collect participants' identification, we were not able to collect information of those who refused to join the study. Healthcare workers who refused to participate in the study might have different characteristics as compared to participants. Selection bias existed. Our response rate was relatively high as compared to other online surveys of similar topics.<sup>44</sup> Fifth, some potentially important information about participants' children, such as age and living arrangement, were not included in this study. Sixth, we did not apply any theory as framework of our study. Meta-analysis suggested that theory-based interventions are more effective than non-theory-based.<sup>47</sup> Moreover, data were self-reported and verification was not feasible. Recall bias might exist. Participants might over-report their acceptability due to social desirability. Furthermore, items and scales used in this study were self-constructed. The internal reliability of these scales was high but such scales may require external validation. In addition, this was a cross-sectional study and could not establish causal relationship.

In sum, despite their important roles in vaccination promotion, Chinese healthcare workers showed relatively low parental acceptability of COVID-19 vaccination for children under the

age of 18 years. Effective health promotion is needed for healthcare workers when COVID-19 vaccination become available in order to achieve high vaccine coverage among children. Updated healthcare workers regularly about new evidences related to COVID-19 vaccination development may be a useful strategy to enhance parental acceptability for this group.

## Acknowledgments

The study was supported by the internal research funding of the Centre for Health Behaviours Research. We would like to thank, Lihui Zhu of Hunan Children's Hospital, Huifang Tan of the First Affiliated Hospital of Nanhua University, Xiaojun Chen of the First Affiliated Hospital of Shantou University Medical College, Ling Guo of Yunnan Kungang Hospital, Lijun Zhu of Dali Bai Autonomous Prefecture People's Hospital, and Huixia Lu of the First Affiliated Hospital of Dali University for their assistance in data collection.

## Disclosure of potential conflicts of interest

No potential conflicts of interest were disclosed.

## Contributor

Author RS, XC, LLP, LLJ, ZH, and JTFL designed the study and wrote the protocol. Author RS and JTFL designed the questionnaire. ZW developed the analytical plan. Author RS, XC, LLP, LLJ, ZH supervised the data collection process. Author ZW analyzed and interpreted the data and wrote the manuscript. Author JTFL revised the manuscript critically and finalized the paper. All authors contributed to and approved the final manuscript.

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