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Research paper

Parental psychological distress and attitudes towards COVID-19 vaccination: A cross-sectional survey in Shenzhen, China

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ABSTRACT

Background: Parental attitudes towards the vaccines play a key role in the success of the herd immunity for the COVID-19. Psychological health seems to be a controversial determinant of vaccine hesitancy and remains to be investigated. This study attempted to measure parental psychological distress, attitudes towards the COVID-19 vaccine, and to explore the potential associations.

Methods: An online survey using convenience sampling method was conducted among parents within the school public health network of Shenzhen. Demographic information and attitudes towards COVID-19 vaccination were collected. The Patient Health Questionnaire (PHQ-4) was applied to measure psychological distress.

Results: Overall, 4,748 parents were included (average age: 40.28, standard deviation: 5.08). More than one fifth of them demonstrated psychological distress, in which only 3.3% were moderate to severe symptom. The proportions of COVID-19 vaccine hesitancy for themselves, their spouses, and their children were 25.2%, 26.1%, and 27.3%, respectively. Parents with psychological distress were more likely to suffer vaccine hesitancy for themselves (OR: 1.277, 95%CI: 1.091–1.494), for their spouses (OR:1.276, 95%CI: 1.088–1.496) and children (OR:1.274, 95%CI: 1.092–1.486). These associations tended to be more significant among parents with mild or severe psychological distress.

Limitation: Non-random sampling limited the generalization of our findings to all parents.

Conclusion: Parents had a low level of psychological distress but relatively high willingness of COVID-19 vaccination when there was no local epidemic but persistent risk of imported cases. Targeted health education and intervention strategies should be provided to people with vaccine hesitancy, especially for those who are susceptible to psychological distress.

1. Introduction

The Coronavirus Disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has reached global pandemic status since March, 2020 and led to a heavy disease burden. As of 13 April 2021, there were over 135.05 million reported cases and 2.91 million deaths occurred worldwide since the start of the pandemic according to the World Health Organization (WHO). An effective and safe vaccine is urgent in need to control the pandemic of this novel coronavirus. Nowadays, numerous COVID-19 vaccine

candidates have been in development, some of which had been evaluated in phase III clinical trials with positive results (Dai and Gao, 2021). In December 2020, the Chinese government launched a COVID-19 vaccination plan and provided two domestic vaccines to high-risk populations for free, including customs and immigration inspection officers, medical and CDC staffs, seafood market staffs, public transportation staffs, etc. This official action was not implemented among the general public temporarily owing to a shortage of vaccines. Before the vaccine becomes available for public use, understanding the public acceptability of COVID-19 vaccine is urgently needed in vaccine promotion. Despite

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the accessibility of vaccination services, a substantial minority of people may present delay in acceptance or even refusal of vaccines, which is identified with vaccine hesitancy (Salmon et al., 2015). As a reflection of concerns about the decision to vaccinate one's children or oneself, vaccine hesitancy may lead to a reduction in vaccine coverage and eventually an increasing risk of infectious disease outbreaks and epidemics (Dubé et al., 2013). Therefore, parental attitudes towards the vaccines could play a key role in the success of the herd immunity, particularly for the infectious diseases that affect both adults and children, e.g. COVID-19.

A broad range of factors has been reported to influence vaccination intentions. Notably, psychological health seems to be a controversial determinant of vaccine hesitancy for infectious diseases. For example, researchers found that healthcare workers who had a high level of state anxiety tended to believe that influenza vaccination was unsafe (Savas and Tanriverdi, 2010). On the contrary, studies among people needed to be vaccinated showed that depressive and anxious symptoms were associated with more acceptability of influenza vaccination (Chan et al., 2015; Lawrence et al., 2020; Mohammed et al., 2020). It was consistent that one recent survey in Turkey revealed a positive association between anxiety level and the public willingness to get COVID-19 vaccination (Akarsu et al., 2021). Current opinions believed that the widespread psychological distress caused by the pandemic of COVID-19 have impacted health behaviors and vaccination intentions (Chou and Budenz, 2020), however, population-based researches that linked psychological health with COVID-19 vaccination intentions remain scant, especially from the perspective of parents. Further evidence is required to address this problem.

There is a high possibility that both parents and children will be confronted with a lasting pandemic of COVID-19 until the popularization of effective treatment options and vaccines. In addition to figure out

the public views regards to COVID-19 vaccine, the impacts on psychological health by the pandemic should be also monitored continuously. Hence, this study aimed to measure psychological distress and attitudes towards the COVID-19 vaccine through a school-based survey among parents in Shenzhen city. Of particular interest was whether parental psychological distress associate with vaccine hesitancy from the perspective of different family roles. In post-pandemic era, these investigations will be helpful to deliver coping strategies for COVID-19 vaccine hesitancy with the use of psychological health interventions.

2. Material and methods

2.1. Study design and participants

An online cross-sectional survey using convenience sampling method was conducted in Shenzhen, from December 18th to December 31st 2020. Based on the school public health network of Futian District Center for Disease Control and Prevention, a recruitment notice of this survey was distributed to all primary and middle schools in the Futian District of Shenzhen city. People whose children studied in these schools were invited to read this notice and further to participate in our survey by school doctors. The study objectives, survey contents, risks and benefits were explained formally, and a two-dimensional code linked with an electronic questionnaire was attached at the end of the recruitment notice. The electronic questionnaire was developed based on a popular survey website named WenJuanXing (Changsha Haoxing Information Technology Co., Ltd., China). The parents, who confirmed their willingness to participate, accessed the link with WeChat (a commonly used messaging and social media platform in China) in their smartphones. A question of voluntary participation was required to answer for informed consent in front of the survey contents. Moreover,

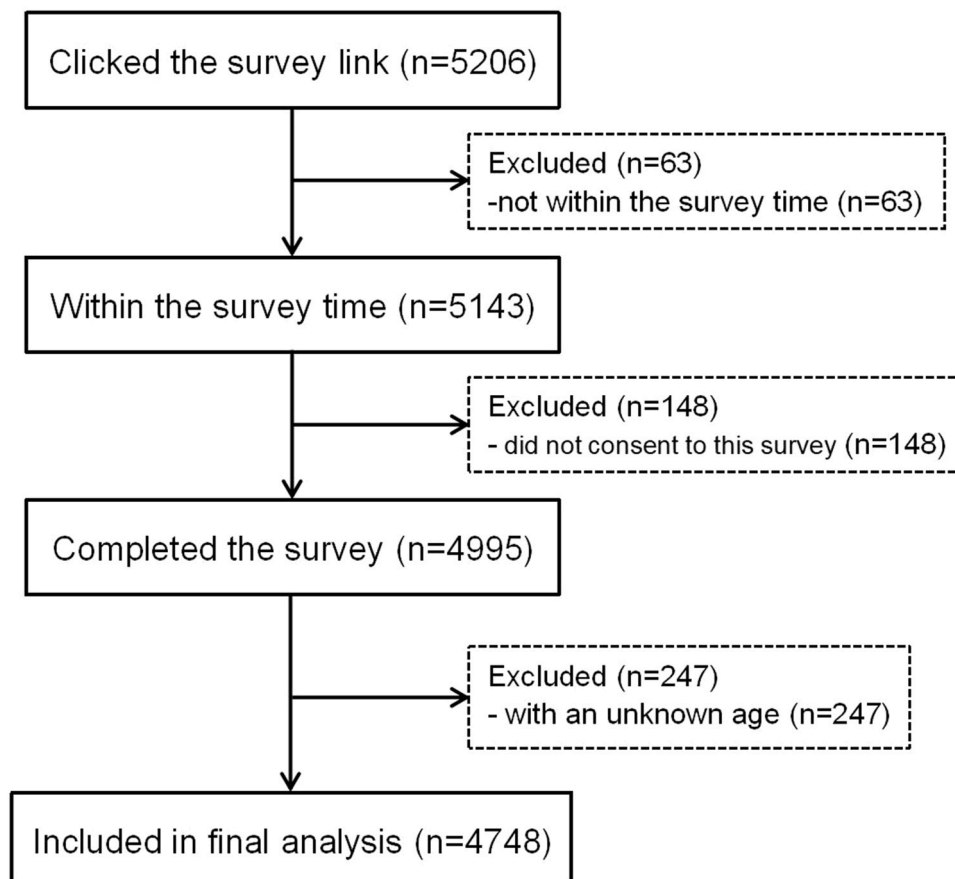


Fig. 1. The flow chart of the survey.

the survey was restricted to one phone device to prevent the probability of repeat participation. During the survey time period, 5143 parents clicked the link, and 4995 did consent and complete the survey, among which 247 parents were excluded due to unknown age (Fig. 1). This study was approved by the Institutional Review Board of Futian District Center for Disease Control and Prevention in Shenzhen.

2.2. Measure

2.2.1. Demographic characteristics

Parents were asked to provide demographic information, including age, gender, registered local permanent residence, marital status, education level, and occupation type. The details of their children were also collected, such as the number of children they owned, the age and gender of the present child in school.

2.2.2. Parental psychological distress

Parental psychological distress was assessed using the Patient Health Questionnaire (PHQ-4), with four items asking mood disorder symptoms, including two items for depression and other two items for anxiety (Löwe et al., 2010). The PHQ-4 has been applied in Chinese population previously, suggesting good validity and reliability (Tam et al., 2021; Zhang et al., 2020b). It assessed the frequency of the following symptoms that participants experienced in the past two weeks (e.g. “little interest or pleasure in doing things”, “feeling down, depressed, or hopeless”, “feeling nervous, anxious, or on edge” and “not being able to stop or control worrying”). For each item, participants answered how often they had been bothered on a four-point scale, which was scored as 0 (not at all), 1 (several days), 2 (more than half the days), or 3 (nearly every day). The sum score of the PHQ-4 ranged from 0 to 12. Different levels of psychological distress were defined with distinct scores: normal (0–2), mild (3–5), moderate (6–8), and severe (9–12) (Kroenke et al., 2009). Here, parents who rated a score of 3 or higher were considered with psychological distress (range from mild to severe symptoms) in accordance with previous research (Schlax et al., 2020). In our study, the Cronbach's α of the PHQ-4 was 0.865.

2.2.3. Parental attitudes towards COVID-19 vaccination

The awareness of COVID-19 and its vaccine were evaluated by asking “Before the survey time, have you ever heard of COVID-19 (or its vaccine)?” (yes/no). People who answered “yes” to these two questions were regarded to be aware of COVID-19 and its vaccine. Furthermore, parents were asked to express their willingness to get COVID-19 vaccination for their families, with a subjective question: “At this moment, are you willing to receive COVID-19 vaccination for yourself (your spouse, or your child)?”. Three possible options (yes/no/uncertain) were provided. Here, people who selected “no” or “uncertain” were considered with vaccine hesitancy. Parents were asked to offer their thoughts targeted only one in-school child with the guidance of school doctors if they had two or more children. In addition, if parents demonstrated vaccine hesitancy for any one of above three roles, they were required to give the main reason of not receiving vaccination.

2.3. Statistical analyses

Continuous variables were described by means and standard deviation, while categorical variables were displayed by numbers and percentages. Distributed difference of categorical and continuous variables was detected by the Chi-square test and the t-test, respectively. Different logistic regression models were established to explore the associations between parental psychological distress and vaccine hesitancy. We establish three models as the following order: unadjusted (model 1), adjusted for age, gender, registered permanent residence, marital status, education level, and occupation type (model 2), and further adjusted for the number of children in the family, age and gender of the present child based on model 2 (model 3). Odds ratios (OR) and 95% confident

intervals (CI) were calculated. Two-tailed tests with p values less than 0.05 were assumed to be statistically significant. All statistical analyses were performed by using SPSS 21.0 (IBM SPSS Statistics, New York, United States).

3. Results

Overall, 4,748 parents of primary and middle school students were included. Demographic characteristics of all respondents were shown in Table 1. The average age of them were 40.28 years old (Standard deviation: 5.08), with a gender ratio of 1:3.17 (male to female). Among the participants, nearly two thirds (64.7%) had local permanent residence and the majority were married (96.7%). In this survey, 42.2% of the respondents were well-educated (college or higher). Two thirds (66.7%) of the parents had more than one child. Regards to their present children in school, approximately half were aged 10 to 14 years old (49.5%) and girls (47.6%).

Of all respondents, the mean score of PHQ-4 was 1.22 (standard deviation: 1.93), with the prevalence of psychological distress of 21.2% (mild: 17.9%, moderate: 2.4%, and severe: 0.9%, respectively). Female parents demonstrated higher prevalence of psychological distress than male counterparts (23.2% vs.15.0%, $P < 0.001$) (Table 2).

In our survey, nearly all parents had heard of COVID-19 (99.1%) and the vaccine against COVID-19 (97.7%), without gender variations. Nearly three quarters of them were willing to receive COVID-19 vaccination for themselves, 15.9% were not, and the remaining 9.3% were uncertain. Similar results were observed when considering vaccination for their spouses and children (Table 2). The proportions of vaccine hesitancy for themselves, their spouses, and their children were 25.2%, 26.1%, and 27.3%, respectively. Male parents had a higher willingness to get vaccination than females, no matter for themselves or their spouses and children (all P values < 0.001). Among who refused to get

Table 1
Characteristics of the parents and their children (N=4748).

Characteristics	Number	Percentage (%)
Age (year)		
<30	59	1.2
30-40	1965	41.4
≥40	2724	57.4
Gender		
Male	1138	24.0
Female	3610	76.0
Registered permanent residence		
Yes	3074	64.7
No	1674	35.3
Marital status		
Married	4591	96.7
Single/divorced	157	3.3
Education level		
College or above	2002	42.2
Senior high school or below	2746	57.8
Occupation type		
Administrative staff	1090	23.0
Professionals	664	14.0
Industrial/agricultural worker	125	2.6
Business/services	1262	26.6
Housewife	878	18.5
Unemployed	49	1.0
Others	680	14.3
The number of children in the family		
One	1579	33.3
Two or more	3169	66.7
Age of the present child in school (year)		
<10	1324	27.9
10-14	2349	49.5
≥14	1075	22.6
The gender of the present child in school		
Male	2490	52.4
Female	2258	47.6

Table 2
Parental psychological distress and attitudes towards COVID-19 vaccination (N=4748).

Variables	Male, n (%)	Female, n (%)	P value	Overall, n (%)
Psychological distress				
Normal	967 (85.0)	2773 (76.8)	<0.001	3740 (78.8)
Mild	147 (12.9)	704 (19.5)		851 (17.9)
Moderate	17 (1.5)	95 (2.6)		112 (2.4)
Severe	7 (0.6)	38 (1.1)		45 (0.9)
Heard of COVID-19				
Yes	1129 (99.2)	3575 (99.0)	0.583	4704 (99.1)
No	9 (0.8)	35 (1.0)		44 (0.9)
Heard of COVID-19 vaccine				
Yes	1112 (97.7)	3526 (97.7)	0.934	4638 (97.7)
No	26 (2.3)	84 (2.3)		110 (2.3)
Willing to receive vaccination for themselves				
Yes	920 (80.8)	2630 (72.9)	<0.001	3550 (74.8)
No	125 (11.0)	632 (17.5)		757 (15.9)
Uncertain	93 (8.2)	348 (9.6)		441 (9.3)
Willing to receive vaccination for their spouses				
Yes	901 (79.2)	2608 (72.2)	<0.001	3509 (73.9)
No	154 (13.5)	650 (18.0)		804 (16.9)
Uncertain	83 (7.3)	352 (9.8)		435 (9.2)
Willing to receive vaccination for their children				
Yes	899 (79.0)	2552 (70.7)	<0.001	3451 (72.7)
No	174 (15.3)	805 (22.3)		979 (20.6)
Uncertain	65 (5.7)	253 (7.0)		318 (6.7)
The main reason of parental vaccine hesitancy				
Considering no risk of COVID-19 infection	55 (4.8)	93 (2.6)	0.003	148 (3.1)
Considering the vaccine not being widely used yet	195 (17.1)	615 (17.0)		810 (17.1)
Considering the vaccine being expensive	61 (5.4)	156 (4.3)		217 (4.6)
Worries about the safety	602 (52.9)	2068 (57.3)		2670 (56.2)
Worries about the effectiveness	70 (6.2)	210 (5.8)		280 (5.9)
Distrust of the supplying source	17 (1.5)	53 (1.5)		70 (1.5)
Other unknown reasons	138 (12.1)	415 (11.5)		553 (11.6)

vaccination, the main reason of vaccine hesitancy was worries about the safety of the vaccine (56.2%), following by considering the vaccine not being widely used yet (17.1%) and other unknown reasons (11.6%).

Different distributions of vaccine hesitancy were observed across distinct levels of psychological distress (Fig. 2). We further explored the association of parental psychological distress with vaccine hesitancy in different logistic regression models. After adjusting for potential confounding variables, parents with psychological distress were more likely to suffer vaccine hesitancy for themselves (OR: 1.277, 95%CI: 1.091~1.494) (Table 3). When categorized according to the severity of psychological distress, its contribution to vaccine hesitancy was more evident among parents with mild symptom (OR: 1.293, 95%CI: 1.085~1.517). Moreover, the odds of vaccine hesitancy increased with per PHQ-4 score (OR:1.062, 95%CI: 1.028~1.097). Analogous associations of parental psychological distress with vaccine hesitancy for their spouses and children were also found (Tables 4 and 5). Parental psychological distress was positively associated with vaccine hesitancy for their spouses (OR:1.276, 95%CI: 1.088~1.496) and children (OR:1.274, 95%CI: 1.092~1.486). These associations tended to be more significant

among parents with mild or severe psychological distress.

4. Discussion

This study was conducted after the domestic epidemic of COVID-19 has been under control in China. During the survey time period, there were only 265 incident cases of COVID-19 reported in mainland China, a majority of which were imported from abroad. Simultaneously, a government-led COVID-19 vaccination plan was implemented among high-risk occupational populations. In this context, our study revealed low level of parental psychological distress but high willingness of COVID-19 vaccination in Shenzhen, reflecting public healthcare needs in the post-pandemic era. It was noteworthy that parental psychological distress was positively associated with vaccine hesitancy for themselves, their spouses, and their children. Potential impacts of psychological health status on public attitudes towards COVID-19 vaccine should be taken into consideration for vaccine promotion.

The COVID-19 pandemic has triggered great threat to both human's psychical and psychological health. A wide variety of psychological symptoms related to the pandemic has been detected, such as anxiety, depression, panic attack, etc (Hossain et al., 2020). During the outbreak period of COVID-19 in China, a nationwide survey reported that nearly 35% of the respondents suffered psychological distress (Qiu et al., 2020). Nowadays, the domestic epidemic of COVID-19 has been under control with the efforts of the Chinese government, but the psychological impacts may still persist. Nearly one year passed since the onset of COVID-19, the prevalence of psychological distress among parents in our study was 21.2%, in which only 3.3% were moderate to severe symptom. Using the cut-off point of 6 in PHQ-4, our result was greatly lower than the prevalence of moderate to severe symptom in Germany and Austria (19.0%) (Schnell and Krampe, 2020), America (11.2%–11.3%) (Kämpfen et al., 2020; Pan et al., 2021), and Saudi Arabia (14.5%) (Joseph et al., 2021). In addition to the disparities of the cultural, social, and economic backgrounds, the environment people live may also play an essential role in stabilizing their emotions. Shenzhen has ended the local epidemic of COVID-19 in late April 2020, and citizens return to normal life with required protection measures. Therefore, the low level of psychological distress among Shenzhen parents might result from a relatively safe and stable living environment to some extent. Moreover, we also noticed a higher prevalence of psychological distress in females, which was consistent with previous evidence that females were psychologically vulnerable in response to the COVID-19 pandemic (Vindegaard and Benros, 2020; Xiong et al., 2020). It's urgently needed that the development of psychological health care and promotion strategies should be adjusted on the basis of gender difference. Nevertheless, the present study only provided preliminary screening findings of psychological health, future explorations with clinical diagnosis and intervention tools should be conducted, especially targeting people with abnormal screening results.

Of notable importance, over 70% of the respondents in our survey reported a positive attitude to get COVID-19 vaccination for themselves, their spouses and children. This vaccination willingness was much higher than those among parents in England (55.8% for themselves and 48.2% for children) (Bell et al., 2020), Turkey (33.9%–62.6% for themselves, 28.9%–56.8% for children) (Yigit et al., 2021), Kuwait (44.2% for children) (AlHajri et al., 2021), and multinational surveys (65.0%–69.2%for children) (Goldman et al., 2020; Skjefte et al., 2021), but lower than that in Italy (over 90% for children) (Pierantoni et al., 2021). Despite the difference of study sites, the willingness to vaccinate children in our survey were in line with a previous survey among factory workers in Shenzhen (72.6%) (Zhang et al., 2020a). When concentrating on the surveys in mainland China, the willingness of vaccination reported in the general population were relatively higher (over 80%) (Chen et al., 2021; Lin et al., 2020; Liu et al., 2021), suggesting that a demanded progress of vaccine promotion remains to be made in Shenzhen. A high vaccination coverage is indispensable to achieve herd

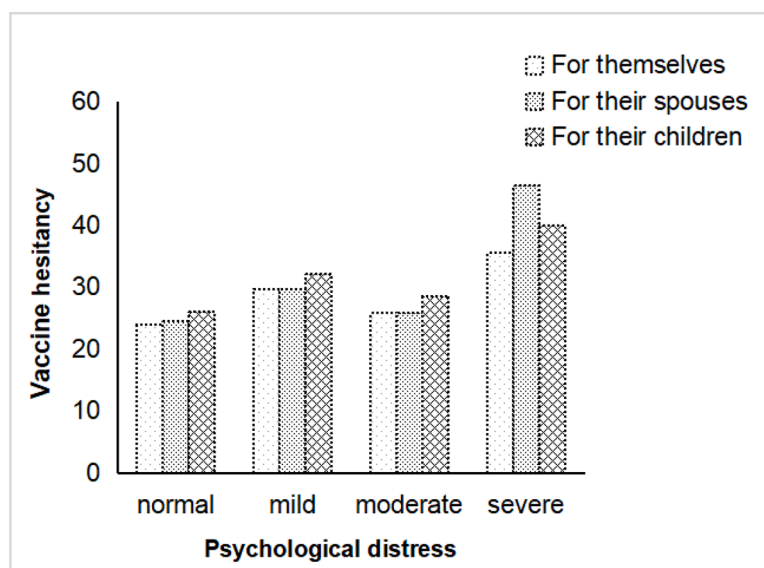


Fig. 2. Distributions of parental vaccine hesitancy across distinct levels of psychological distress.

Table 3

Association between parental psychological distress and vaccine hesitancy for themselves (N=4748).

Psychological distress	Vaccine hesitancy		P-value*	Model 1 OR (95%CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)
	Yes, n (%)	No, n (%)				
Two-category variable						
No	899 (24.0)	2841 (76.0)	<0.001	1.000 (reference)	1.000 (reference)	1.000 (reference)
Yes	299 (29.7)	709 (70.3)		1.333 (1.142, 1.555)	1.279 (1.094, 1.496)	1.277 (1.091, 1.494)
Four-category variable						
Normal	899 (24.0)	2841 (76.0)	0.002	1.000 (reference)	1.000 (reference)	1.000 (reference)
Mild	254 (29.8)	597 (70.2)		1.345 (1.140, 1.586)	1.284 (1.086, 1.517)	1.293 (1.085, 1.517)
Moderate	29 (25.9)	83 (74.1)		1.104 (0.719, 1.696)	1.098 (0.712, 1.693)	1.078 (0.698, 1.665)
Severe	16 (35.6)	29 (64.4)		1.744 (0.943, 3.225)	1.690 (0.908, 3.143)	1.719 (0.923, 3.200)
Continuous variable	1.42±0.06	1.15±0.03	<0.001	1.071 (1.037, 1.105)	1.062 (1.028, 1.097)	1.062 (1.028, 1.097)

*Chi-square test (categorical variables) and the t-test (continuous variable) were applied to detect distributed difference of psychological distress.

Model 1: unadjusted

Model 2: adjusted for age, gender, registered permanent residence, marital status, education level, and occupation type

Model 3: adjusted for age, gender, registered permanent residence, marital status, education level, occupation type, the number of children in the family, age and gender of the present child.

Table 4

Association between parental psychological distress and vaccine hesitancy for their spouses (N=4591).

Psychological distress	Vaccine hesitancy		P-value*	Model 1 OR (95%CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)
	Yes, n (%)	No, n (%)				
Two-category variable						
No	887 (24.5)	2732 (75.5)	<0.001	1.000 (reference)	1.000 (reference)	1.000 (reference)
Yes	292 (30.0)	680 (70.0)		1.323 (1.131, 1.547)	1.278 (1.090, 1.497)	1.276 (1.088, 1.496)
Four-category variable						
Normal	887 (24.5)	2732 (75.5)	<0.001	1.000 (reference)	1.000 (reference)	1.000 (reference)
Mild	244 (29.7)	577 (70.3)		1.302 (1.101, 1.540)	1.250 (1.055, 1.481)	1.249 (1.054, 1.481)
Moderate	28 (25.9)	80 (74.1)		1.078 (0.696, 1.669)	1.082 (0.696, 1.681)	1.060 (0.681, 1.649)
Severe	20 (46.5)	23 (53.5)		2.678 (1.464, 4.900)	2.675 (1.453, 4.925)	2.736 (1.485, 5.040)
Continuous variable	1.44±0.06	1.14±0.03	<0.001	1.079 (1.044, 1.115)	1.072 (1.038, 1.109)	1.073 (1.038, 1.109)

*Chi-square test (categorical variables) and the t-test (continuous variable) were applied to detect distributed difference of psychological distress.

Model 1: unadjusted

Model 2: adjusted for age, gender, registered permanent residence, marital status, education level, and occupation type

Model 3: adjusted for age, gender, registered permanent residence, marital status, education level, occupation type, the number of children in the family, age and gender of the present child.

immunity to COVID-19 (at least 60%) (Anderson et al., 2020). Understanding the main obstacle of vaccine hesitancy does help to change the stereotypes and improve the acceptability of vaccination. Here we found more than half of parents most worried about the safety of COVID-19

vaccines, which was also implied by other researchers (Bell et al., 2020). Besides, the vaccine's novelty was also a common concern of parents as they thought it "not enough testing" (Goldman et al., 2020). It's inevitable to call into question by the public when a novel vaccine

Table 5

Association between parental psychological distress and vaccine hesitancy for their children (N=4748).

Psychological distress	vaccine hesitancy		P-value*	Model 1 OR (95%CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)
	Yes, n (%)	No, n (%)				
Two-category variable						
No	974 (26.0)	2766 (74.0)	<0.001	1.000 (reference)	1.000 (reference)	1.000 (reference)
Yes	323 (32.0)	685 (68.0)		1.339 (1.151, 1.558)	1.274 (1.093, 1.486)	1.274 (1.092, 1.486)
Four-category variable						
Normal	974 (26.0)	2766 (74.0)	0.001	1.000 (reference)	1.000 (reference)	1.000 (reference)
Mild	273 (32.1)	578 (67.9)		1.341 (1.141, 1.576)	1.266 (1.074, 1.492)	1.267 (1.075, 1.494)
Moderate	32 (28.6)	80 (71.4)		1.136 (0.749, 1.723)	1.132 (0.742, 1.728)	1.117 (0.732, 1.705)
Severe	18 (40.0)	27 (60.0)		1.893 (1.038, 3.453)	1.876 (1.018, 3.456)	1.890 (1.026, 3.483)
Continuous variable	1.42±0.06	1.15±0.03	<0.001	1.073 (1.040, 1.108)	1.063 (1.030, 1.098)	1.063 (1.029, 1.098)

*Chi-square test (categorical variables) and the t-test (continuous variable) were applied to detect distributed difference of psychological distress.

Model 1: unadjusted

Model 2: adjusted for age, gender, registered permanent residence, marital status, education level, and occupation type

Model 3: adjusted for age, gender, registered permanent residence, marital status, education level, occupation type, the number of children in the family, age and gender of the present child.

has been developed in a rush without sufficient evidence to prove safety and effectiveness in real-world application. In spite of substantial progress in the development of COVID-19 vaccines, the negative attitude towards vaccination remain to be a challenge to the prevention and elimination of the disease. Recent repeated surveys conducted in Hong Kong demonstrated that the willingness of vaccination decreased but the concerns on vaccine safety increased between the first and third waves of the local epidemic (Wang et al., 2021). Hence, authoritative information needs to be disclosed to the public by conveying the safety and stringent standards enforced in vaccine development process (Chou and Budenz, 2020). In addition, a strong parental willingness of vaccination in our study may be not equal to the actual vaccine uptake, according to previous experience in influenza vaccination (Zeng et al., 2019). More efforts should be placed in transformation of attitudes and knowledge into practices along with COVID-19 vaccination promotion.

In this study, psychological distress was positively associated with COVID-19 vaccine hesitancy, which was in keeping with the results among Israelite vaccinated individuals (Palgi et al., 2021). The possible mechanism may lie in the link of psychological distress with vaccine worries, since we detected a higher proportion of safety concern among distressed parents than non-distressed counterparts (59.0% vs. 55.5%, data not shown). A similar clue was detected in influenza vaccination that anxious symptom correlated with pessimistic opinions of vaccine safety (Savas and Tanriverdi, 2010). However, there was also a discordance voice that depression (but not stress or anxiety) had slightly positive influence on the willingness of COVID-19 vaccination among Polish healthcare workers (Szmyd et al., 2021). Necessities exist to clarify whether these psychological symptoms are specific to COVID-19 or not. COVID-19 related psychological responses may reflect one's fear to the disease and eager to protect oneself. As Turkish and British scientists found, COVID-19 related anxiety could facilitate vaccination acceptance (Salali and Uysal, 2020; Yurttas et al., 2021). Due to the inconsistencies in the study background, subjects and measurement tools, the contribution of psychological factors to vaccination willingness remains to be duplicated in other countries and regions.

There is a view that anti-vaccination groups commonly appeal to emotions (Bean, 2011). Such emotionally driven sentiments are likely to induce vaccine hesitancy and declines in vaccine uptake (Chou and Budenz, 2020). Various emotional response have been aroused and make the public prone to negative psychological outcomes during the COVID-19 pandemic. More emotionally compelling content should be included in COVID-19 vaccine promotion, accompanying by strengthen the trust and credibility of government organizations and experts. Furthermore, psychological factors like stress and depression were believed to impair the immune system's response and exacerbate side effects to vaccines, which could be aggravated by the COVID-19 pandemic (Madison et al., 2021). Early evidence has suggested that

psychological interventions may improve the antibody response to vaccines (Vedhara et al., 2019). Thus, unpromising situations may exist when facilitating people with psychological distress to receive vaccination, as psychological factors act as barriers to both vaccination intention and efficacy.

There were some limitations in our study. Firstly, an online survey based on the local school public health network could not guarantee the recruitment process of study subjects to be random, which limited the generalization of our findings to all parents in this city. But the identities of the parents were verified by the school doctors, ensuring no involvement of irrelevant persons. Besides, respondents might be more careless in answering online questionnaire than face-to-face interviews. We then set required logical questions to exclude contradictory answers in this survey. Secondly, this study did not take other psychiatric symptoms as well as previous mental disorders into account. COVID-19 related knowledge was also not measured among the parents, which may largely influence the attitudes towards COVID-19 vaccination. Potential confounding biases could not be avoided when exploring the impact of psychological distress. Thirdly, as a cross-sectional design, causal associations were restricted be concluded to a great extent. Further prospective studies are warranted to confirm the effect of psychological distress in the contribution to COVID-19 vaccination promotion, in which above limitations should be considered.

In conclusion, this study identified a low level of parental psychological distress but relatively high willingness of COVID-19 vaccination in Shenzhen when there was no local epidemic but persistent risk of imported cases. Importantly, parental psychological distress was positively associated with COVID-19 vaccine hesitancy. Appropriate screening for psychological distress should be continued as the pandemic lasts, in particular along with the COVID-19 vaccination promotion. Targeted health interventions should be provided to people with psychological distress promptly, which may contribute to the reduction of vaccine hesitancy.

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Declaration of Competing Interest

The authors declare that they have no conflict of interest.

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