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Original article

Parental hesitancy towards vaccinating their children with a booster dose against COVID-19: Real-world evidence from Taizhou, China

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ABSTRACT

Introduction: Parental vaccine-hesitancy can lead to delays or refusal to vaccinate children despite the availability of vaccines. This is a population-based, cross-sectional study investigating whether parents in China are hesitant to vaccinate their children with a COVID-19 vaccine booster.
Methods: Parents in Taizhou, China, responded to a self-reported online questionnaire on their hesitancy to vaccinate their children with a COVID-19 vaccine booster. Of the 1252 parents who were invited to answer the structured questionnaire, 514 (41.1%) samples had valid data for data analysis.
Results: A total of 41.8% of participants were hesitant to give their children a COVID-19 vaccine booster. After adjusting for confounders, parental gender (female vs. male parent, OR=0.56 95% CI: 0.32–0.87), parental opinion (yes vs. no, OR=0.17, 95% CI: 0.09–0.30), parental attitudes (yes vs. no, OR=0.28, 95% CI: 0.16–0.50), the presence of people around them who are generally hesitant to receive COVID-19 booster vaccines for children (yes vs. no, OR=0.14, 95%CI: 0.08–0.23), the individual hesitancy of people around them to administer booster COVID-19 vaccines to children (yes vs. no, OR=0.02, 95%CI: 0.02–0.22), and parents' hesitancy to receive a booster vaccine for their children showed significant correlation. The disparity of factors related to booster vaccine-hesitancy for children between fathers and mothers was also found.
Conclusions: We found that a moderate proportion of parents reported that they were hesitant to give their children a COVID-19 vaccine booster. The results suggest that an in-depth, dynamic assessment and further health education planning are necessary to reduce Chinese parents' hesitancy to vaccinate their children.

Introduction

More than two years have passed since the start of the Coronavirus disease 2019 (COVID-19) pandemic, and vaccination against the causal virus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has also been ongoing for a year. However, with the emergence of the Delta and Omicron variants, the pandemic has continued and trends of infection have worsened [1,2]. Studies have shown that all recently developed SARS-COV-2 vaccines can effectively prevent the severity of COVID-19, and government agencies actively encouraged all age groups to vaccinate [2]. However, it has been reported that some fully vaccinated individuals still became infected with SARS-COV-2, needed hospitalization due to COVID-19, and even died [3]. A group of German tourists who received three doses of SARS-COV-2 vaccines from the beginning of November 2021 to early December, including at least two doses of mRNA vaccines still experienced breakthrough infections due to the Omicron variant [4]. This presents new challenges to the prevention and control of COVID-19.

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As of March 31 2022, 3.27 billion doses of the new crown vaccine have been administered in mainland China, with 1.28 billion people vaccinated in total; 1.24 billion people have been vaccinated throughout the whole process, covering 90.63% of the country's total population. The aggregate number of people vaccinated throughout the country is 88.11% of the population and the 690 million people who have completed booster immunization [5,6]. A recent study showed that vaccine efficacy after two doses of BNT162b2 was 65.5% (95% CI, 63.9–67.0) at 2–4 weeks, decreasing to 8.8% (95% CI, 7.0–10.5) at 25 weeks or more[7]. Among the youth aged 12–15 and 16–17, vaccine effectiveness is 14–149 days after the second dose is 92% and 94%, respectively [8]. Mass vaccination campaigns are needed, which include booster vaccinations as the effectiveness of the vaccine diminishes over time [9].

The booster dose helps prevent infection, and current research on COVID-19 booster vaccination focuses on the effectiveness of the booster dose in adult populations and individual willingness to vaccinate [10,11]. Research has also shown that aggregated Omicron variant infections have occurred [12]. However, vaccine-hesitancy is an ongoing major challenge for intensifying booster dose promotion and epidemic prevention and control [13]. vaccine-hesitancy refers to the delay or refusal to receive a vaccine despite its availability [14]. The reluctance of healthcare workers to be vaccinated, in particular, could have widespread negative consequences, as it affects the behavior of the entire population [15]. A study showed that hesitant groups were more likely to be unvaccinated than non-hesitant groups (62.6% vs 12.9%) and did not intend to vaccinate their children (86.1% vs. 27.5%) [16]. As a research investigating vaccine-hesitancy in parents, this study aimed to understand the hesitancy of parents to vaccinate their children with COVID-19 vaccine booster shots. The purpose is to provide first-hand data for the development of relevant strategies for vaccinating children with booster shots.

Methods

Study design and data collection

An anonymous, cross-sectional, population-based online survey was prepared using the Wen-Juan-Xing platform (Changsha Ranxing Information Technology Co., Ltd, Hunan, China), which is the largest online survey platform in China, and distributed through WeChat. The researcher created the questionnaire on the Internet survey platform, and generated a URL link and a QR code. After obtaining consent from the associated institution, the researcher sent the questionnaire link or QR code to the hospital nursing department, medical department, and president's office, who forwarded it to the staff of the institution.

The target population was parents who had at least one child under the age of 18 (n = 1252). Participation in the survey was considered informed consent due to the anonymity provided and voluntary nature of participation, and participants did not sign a written informed consent form. Participants responded to the questionnaire from February 19 to March 21 2022. Ineligible questionnaires that contained inaccurate information or were answered too quickly (less than 120 s) were excluded. Finally, 514 samples with valid data were included, a response rate of 41.1% (514/1252). This study was approved by the Ethics Committee of Taizhou First People's Hospital, Zhejiang Province, China (approval number: 2022-KY009–01). All procedures were performed in accordance with the guidelines of the authors' institutional ethics committee and adhered to the principles of the Declaration of Helsinki.

Structured questionnaires and assessment of hesitancy

We designed a self-administered questionnaire based on previous research and the framework of surveys evaluating related factors, such as expert consensus on childhood COVID-19 vaccination and willingness to vaccinate against COVID-19 [11,17,18]. The initial questionnaire was tested first and then revised according to the feedback from the test population to ensure comprehensiveness, scientificity, and clarity of the final questionnaire.

The questionnaire consisted of 35 questions that explored three areas relevant to respondents: (1) general demographic information, including gender, age, long-term residence, education level, number of children under 18 in the household, and occupational roles in the institution; (2)medical histories and vaccination status of parents and children, including a parental history of food and drug allergy, vaccination against COVID-19, child food and drug allergy history, and vaccination against COVID-19; (3) Awareness, attitudes, and willingness to vaccinate their child with COVID-19 boosters, including his/her perception of the effectiveness of the booster dose, measured on a five-point Likert scale (1 =strongly disagree to 5 = Strongly agree).

Participants were also asked about their likelihood of accepting a booster dose of the COVID-19 vaccine for their children and selected all applicable reasons for deciding from the predefined responses. The methods for this study were constructed referencing the questionnaire structure and content of similar studies [11].

Quality control

First, the preamble to the questionnaire introduces the background, purpose and content of the questionnaire and explains that responding to the questionnaire is anonymous and voluntary. Second, in order to ensure the quality of the survey, each item is set as a mandatory question in the online platform to avoid missed questions, and the range of values, such as age in the questionnaire is limited. Third, we conducted a pilot questionnaire with 26 random individuals to assess comprehension of questions and answers. Those who participated in the pretest were not included in the results. Finally, we performed a logical check before data analysis to eliminate outliers. Parents under 18 or over 70 were excluded. Questionnaires completed in less than 60 s were also excluded. Data analysis was performed on 514 questionnaires; the average time required to complete the questionnaire was 322 s, with a median of 249 s (ranging from 121 to 2684 s).

Statistical analysis

Categorical variables regarding the underlying characteristics were expressed as numbers and percentages. In addition, respondents' hesitancy about COVID-19 booster vaccinations was measured using the question, 'Are you hesitant about boosting your kid's Covid-19 vaccine?' The response options were strongly hesitancy, hesitancy, unhesitancy or strongly unhesitancy. In the final analysis, the first two options were combined as hesitancy, and the other options were combined as unhesitancy. Initially, chi-square tests were used assess differences in demographic and personal background variables between participants who received and were not willing to receive booster doses of vaccination. Binary logistic regression models were used to determine factors influencing parental vaccine-hesitancy, and the odds ratio (OR) and corresponding 95% confidence interval (CI) were calculated. All data were analyzed using IBM SPSS statistics 25.0 software (SPSS Inc., Chicago, IL, USA), with two-tailed p values less than 0.05($P < 0.05$) considered statistically significant.

Results

A total of 549 parents completed the questionnaire. Of these, 26 were excluded from analysis as they were pilot questionnaires, six were excluded due to the participants' ages being less than 18, or

Table 1
Characteristics of parents' hesitancy to receive booster COVID-19 vaccine for their children (n = 514).

		Parents (n = 514)			Mother (n = 380)			Father (n = 134)		
		No Hesitation Vaccine Booster (n = 299)	Hesitant vaccine booster (n = 215)		No Hesitation Vaccine Booster (n = 210)	Hesitant vaccine booster (n = 170)		No Hesitation Vaccine Booster (n = 89)	Hesitant vaccine booster (n = 45)	
Variables	Categories	n (%)	n (%)	*P*	n (%)	n (%)	*P*	n (%)	n (%)	*P*
Sex				**0.032**						
	Women	210 (70.2)	170 (79.1)		–	–		–	–	
	Men	89 (29.8)	45 (20.9)		–	–		–	–	
Age, Median (IQR)		37.0 (34.0, 43.0)	36.0 (33.0, 40.0)	**0.008**	37.0 (33.0, 41.0)	36.0 (33.0, 39.8)	0.131	39.0 (36.0, 46.0)	37.0 (33.0, 43.0)	0.071
Residence				0.355			1.000			0.139
	Rural/Town	101 (33.8)	82 (38.1)		78 (37.1)	64 (37.6)		23 (25.8)	18 (40.0)	
	Urban	198 (66.2)	133 (61.9)		132 (62.9)	106 (62.4)		66 (74.2)	27 (60.0)	
Education level				0.321			0.69			0.192
	College and below	75 (25.1)	45 (20.9)		53 (25.2)	39 (22.9)		22 (24.7)	6 (13.3)	
	University and above	224 (74.9)	170 (79.1)		157 (74.8)	131 (77.1)		67 (75.3)	39 (86.7)	
Profession				0.348			0.597			0.924
	doctor	82 (27.4)	47 (21.9)		25 (11.9)	19 (11.2)		57 (64)	28 (62.2)	
	nurse	156 (52.2)	119 (55.3)		148 (70.5)	114 (67.1)		8 (9)	5 (11.1)	
	others	61 (20.4)	49 (22.8)		37 (17.6)	37 (21.8)		24 (27)	12 (26.7)	
food/drug allergic reaction				0.941			0.94			1.000
	NO	261 (87.3)	186 (86.5)		181 (86.2)	145 (85.3)		80 (89.9)	41 (91.1)	
	Slight	31 (10.4)	23 (10.7)		24 (11.4)	20 (11.8)		7 (7.9)	3 (6.7)	
	Serious	7 (2.3)	6 (2.8)		5 (2.4)	5 (2.9)		2 (2.2)	1 (2.2)	
Allergic reaction to vaccine				0.398			0.920			**0.045**
	No	287 (96)	201 (93.5)		199 (94.8)	160 (94.1)		88 (98.9)	41 (91.1)	
	Slight	11 (3.7)	12 (5.6)		10 (4.8)	9 (5.3)		1 (1.1)	3 (6.7)	
	Serious	1 (0.3)	2 (0.9)		1 (0.5)	1 (0.6)		0 (0.0)	1 (2.2)	
COVID-19 vaccine booster				0.213			0.578			0.230
	No	36 (12.0)	35 (16.3)		28 (13.3)	27 (15.9)		8 (9.0)	8 (17.8)	
	Yes	263 (88.0)	180 (83.7)		182 (86.7)	143 (84.1)		81 (91.0)	37 (82.2)	
Number of underage children				0.394			0.148			0.520
	One	216 (72.2)	147 (68.4)		155 (73.8)	113 (66.5)		61 (68.5)	34 (75.6)	
	Two or more	83 (27.8)	68 (31.6)		55 (26.2)	57 (33.5)		28 (31.5)	11 (24.4)	
Do you think your child needs a booster vaccine against COVID-19?				**< 0.001**			**< 0.001**			**< 0.001**
	No	34 (11.4)	124 (57.7)		25 (11.9)	96 (56.5)		9 (10.1)	28 (62.2)	
	Yes	265 (88.6)	91 (42.3)		185 (88.1)	74 (43.5)		80 (89.9)	17 (37.8)	
Do you agree with your child's booster vaccination against COVID-19?				0.130			0.331			0.133
	No	41 (13.7)	41 (19.1)		25 (11.9)	27 (15.9)		16 (18.0)	14 (31.1)	
	Yes	258 (86.3)	174 (80.9)		185 (88.1)	143 (84.1)		73 (82.0)	31 (68.9)	
How long do you think the protective effect after strengthening the needle will last? 0.659							0.839			0.368
	Six months and under	178 (59.5)	133 (61.9)		119 (56.7)	99 (58.2)		59 (66.3)	34 (75.6)	
	More than six months	121 (40.5)	82 (38.1)		91 (43.3)	71 (41.8)		30 (33.7)	11 (24.4)	
Your attitude to whether your child is boosting the Covid-19 vaccine?				**< 0.001**			**< 0.001**			**< 0.001**
	No	33 (11.0)	126 (58.6)		20 (9.5)	103 (60.6)		13 (14.6)	23 (51.1)	
	Yes	266 (89.0)	89 (41.4)		190 (90.5)	67 (39.4)		76 (85.4)	22 (48.9)	
How about people around you hesitant about boosting children's Covid-19 vaccines? **< 0.001**							**< 0.001**			**< 0.001**
	No	34 (11.4)	6 (2.8)		22 (10.5)	4 (2.4)		12 (13.5)	2 (4.4)	
	Rarely hesitate	186 (62.2)	47 (21.9)		138 (65.7)	38 (22.4)		48 (53.9)	9 (20.0)	
	General hesitation	79 (26.4)	162 (75.3)		50 (23.8)	128 (75.3)		29 (32.6)	34 (75.6)	

more than 80 years, and three were excluded as they were answered in under 60 s. Finally, 514 samples with valid data were included in this study.

Median age was 37.0 (34.0, 43.0), of which 73.93% were female. The majority of respondents (n = 443 [86.18%]) received three doses of COVID-19 vaccines. Table 1 summarizes the characteristics of parental vaccine-hesitancy. There were no statistically significant differences in their residence, education level, occupational category, history of food and drug allergy, history of vaccine allergy, number of minor children between hesitant parents and not hesitant counterparts to vaccinate their children with COVID-19 boosters (P > 0.05).

As shown in Fig. 1, about half of the respondents (n = 215 [41.8%]) were hesitant to receive a COVID-19 booster shot for their children, with 178 (34.6%) responses indicating hesitance and 37 (7.2%) indicating strong hesitation. Among the 71 who did not complete the booster vaccination, 27 (38.0%) displayed hesitation and 8 (11.3%) displayed strong hesitation. Of the 443 who had completed booster vaccinations, 151 (34.1%) displayed hesitation and 29 (6.5%) displayed strong hesitation. It is worth noting that there was no statistically significant difference between the parents' vaccination status and their vaccine-hesitancy towards their children (P = 0.169).

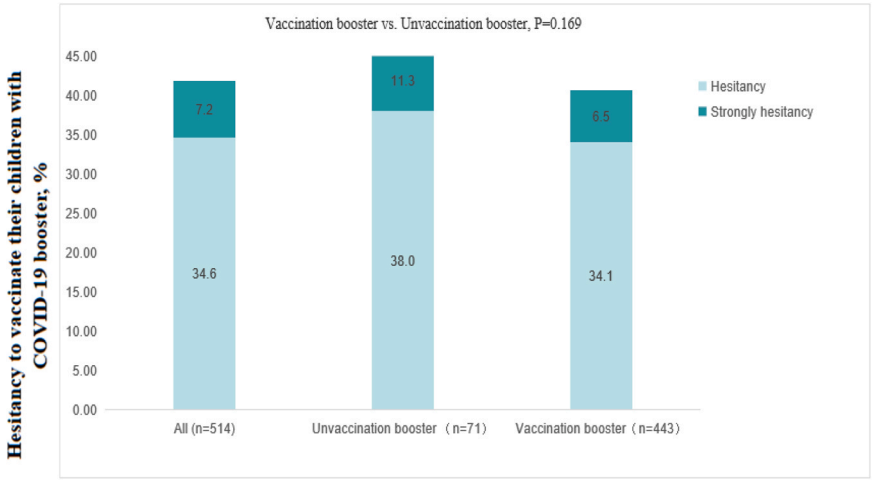

Fig. 1. Hesitancy to vaccinate their children with a COVID-19 booster in vaccination booster and unvaccination booster parents.

Table 1 shows parents' vaccine-hesitancy, gender (χ^2 =5.066, P = 0.032), opinions (χ^2 =125.947, P < 0.001), attitudes (χ^2 =132.457, P < 0.001), and people around him were hesitant to strengthen the needle (χ^2 =120.601, P < 0.001). In addition, mothers' opinions on vaccine-hesitancy and mothers' opinions (χ^2 =85.975, P < 0.001) on vaccinating their children with the COVID-19 booster vaccine, mothers' attitudes (χ^2 =111.905, P < 0.001), and people around them were hesitant about their children's booster vaccines (χ^2 =100.361, P < 0.001). Father's hesitancy to vaccinate his children with COVID-19 booster vaccine and father's opinion (χ^2 =40.604, P < 0.001), father's attitude (χ^2 =20.217, P < 0.001), and people around him hesitate to boost their child (χ^2 =22.166, P < 0.001) there is a correlation.

A binary logistic regression model was used to examine the effect of independent factors on the degree of parental vaccine-hesitancy. As shown in Table 2, after adjusting for confounders, parental gender (male vs. female, OR=0.56, 95% CI: 0.32–0.97), parental opinion (yes vs. no, OR=0.17, 95%CI: 0.09–0.30), parental attitudes (yes vs. no, OR=0.28, 95%CI: 0.16–0.50), vaccine-hesitancy of people around them (rare hesitation vs. general hesitation, OR=0.14, 95%CI: 0.08–0.23), and the hesitancy of those around them to vaccinate children against COVID-19 (no hesitation vs. general hesitation, OR=0.07, 95%CI: 0.02–0.22) were significantly associated with parental vaccine-hesitancy. Following stratification by sex, risk factors associated with maternal hesitancy were similar to overall parental risk factors. Parents' disapproval of the importance, effectiveness, and protection of their children's booster vaccination strongly influenced their vaccine-hesitancy.

We found that parental attitudes towards child vaccination were inconsistent with the corresponding vaccine-hesitancy when they were vaccinated themselves. Parents' attitudes (yes vs. no, OR=0.28, 95% CI: 0.16–0.50, P < 0.001) were significantly associated with parental vaccine-hesitancy; similarly, mothers' attitudes (yes vs. no, OR=0.18, 95%CI: 0.09–0.36, P < 0.001) displayed a statistically significant difference in vaccine-hesitancy, while the father's attitude (yes vs. no, OR=0.80, 95%CI: 0.24–2.72, P = 0.725) showed no significant difference in vaccine-hesitancy. In addition, parents, fathers', or mothers' perceptions of the importance, efficacy, and protection of booster vaccines for their children were also inconsistent with the effects of their vaccination status on vaccine-hesitancy. The parents' viewpoint (yes vs. no, OR=0.95, 95%CI: 0.89–1.02, P > 0.05) showed no significant difference in their vaccine-hesitancy; similarly, the mother's opinion (yes vs. no, OR=0.99, 95%CI: 0.91–1.09, P > 0.05) showed no significant difference in their vaccine-hesitancy. The father's opinion (Yes vs. No, OR=0.87, 95%CI: 0.76–0.99, P < 0.05) showed a significant difference in vaccine-hesitancy. There may be a relationship with the proportion of the number of parents (father vs. mother, 26.07% vs. 73.93%).

Discussion

Clinical implications

Parental vaccine-hesitancy is a major public health problem that requires successful strategies to address [19]. The World Health Organization's (WHO) Strategic Advisory Group of Experts on Immunization (SAGE) defines vaccine hesitancy as "delay in the acceptance or refusal of vaccination despite the availability of vaccination services" [14]. Vaccine hesitant participants are a mixed subgroup who are, to varying degrees, unable to quickly decide whether to receive a specific vaccine or a vaccine in general [20]. Previous studies have shown that parental vaccine hesitancy is significantly associated with children's vaccination against COVID-19, and the main factors affecting children's vaccination against COVID-19 are parental refusal and hesitancy [21]. This cross-sectional study revealed that 41.8% of Chinese parents were hesitant to vaccinate their minor children with COVID-19 vaccine boosters, and the factors related to this decision. Little is known about parental hesitancy for their children to receive COVID-19 vaccine boosters during the Omicron variant pandemic, especially in countries that are not currently providing childhood vaccine boosters. Understanding parental vaccine-hesitancy can provide a source of data for relevant institutions and policies involved in the promotion of childhood vaccine boosters and epidemic prevention and control.

This study aimed to investigate the hesitancy of parents to vaccinate their children with COVID-19 vaccine boosters in a sample of Chinese healthcare workers. The results indicate that parents may not believe that vaccine boosters had a considerable effect or had little benefit from them. Influenced by gender, mothers had a greater, statistically significant effect on vaccine-hesitancy than fathers; both fathers and mothers were significantly affected by the vaccine-hesitancy of people around them. This means that communication and guidance for mothers should be focused on while promoting children's vaccine booster injections so that they can reach a family consensus. Group publicity and education can achieve a multiplier effect, with a community or an entire institution receiving the benefits of COVID-19 vaccine boosters at the same time.

In addition to the biological differences, a growing evidences support that sex-based social/behavioral differences in vaccine response, such as different comorbidity rates, smoking and drinking habits, educational levels, and societal roles [22]. Sex differences also

Table 2
Multiple logistic regression of factors associated with parental hesitancy to receive covid-19 vaccine boosters for their children (n = 514).

Variables	Categories	Parents				Mothers				Fathers			
		β value	SE	*P* value	OR (95%CI)	β value	SE	*P* value	OR (95%CI)	β value	SE	*P* value	OR (95%CI)
Parents	Father vs. Mother	-0.580	0.282	**0.040**	0.56 (0.32–0.97)	–	–	–	–	–	–	–	–
Do you think your child needs a booster vaccine against COVID-19?													
	Yes vs. No	-1.798	0.306	**< 0.001**	0.17 (0.09–0.30)	-1.478	0.351	**< 0.001**	0.23 (0.12–0.45)	-3.028	0.726	**< 0.001**	0.48 (0.01–0.20)
Do you agree with your child's booster vaccination against COVID-19?													
	Yes vs. No	-0.047	0.036	0.189	0.95 (0.89–1.02)	-0.004	0.044	0.927	0.99 (0.91–1.09)	-0.140	0.066	**0.034**	0.87 (0.76–0.99)
Your attitude to whether your child is boosting the Covid-19 vaccine?													
	Yes vs. No	-1.278	0.299	**< 0.001**	0.28 (0.16–0.50)	-1.705	0.354	**< 0.001**	0.18 (0.09–0.36)	-0.218	0.621	0.725	0.80 (0.24–2.72)
How about people around you hesitant about boosting children's Covid-19 vaccines?													
	Rarely vs. General	-1.995	0.259	**< 0.001**	0.14 (0.08–0.23)	-1.967	0.290	**< 0.001**	0.14 (0.08–0.25)	-2.405	0.640	**< 0.001**	0.09(0.03–0.32)
	No vs. General	-2.648	0.571	**< 0.001**	0.07 (0.02–0.22)	-2.653	0.683	**< 0.001**	0.07 (0.02–0.27)	-3.031	1.109	**< 0.001**	0.05 (0.01–0.42)
How long do you think the protective effect after strengthening the needle will last?													
	More than six months vs. Less than six months	0.056	0.406	0.874	0.96 (0.58–1.59)	0.030	0.425	0.759	1.04 (0.59–1.86)	0.146	0.393	0.709	1.16 (0.54–2.50)

have been indicated to be one of significant factors during the COVID-19 pandemic [23]. Our results revealed that mothers showed higher hesitation for child booster vaccination. Taking a vaccine may be viewed as a risk and based on a psychological evaluation of risk personality, findings about decision making and risk choosing among men and women imply that women are more careful and take longer to assess potential damages [24].

An interesting finding was that there was no difference in hesitancy, regardless of whether parents received a COVID-19 vaccine booster or not χ^2 = 1.888, P = 0.169). Parents are reluctant to give their children a booster shot even though they have received the booster shot and have not experienced any other serious adverse reactions. This means that the main reasons why participants objected to receiving a COVID-19 booster may include mild side effects following previous vaccinations, the belief that the strain is constantly mutating and no further vaccination is warranted, and uncertainty about the safety of vaccine boosters [25].

Table 2 shows that if fathers agree with giving their children a COVID-19 vaccine booster, they will not hesitate to do so, which is not the same for mothers. However, the reverse is true regarding attitudes. If mothers have a positive attitude towards getting their children a COVID-19 vaccine booster, they face no hesitation, which is not true for fathers. There is a certain connection between the behavior of an individual, such as a father or a mother, and the individual's behavioral intentions. We can use the Theory of Rational Action to explain this connection [26]. Therefore, to reduce vaccine-hesitancy, fathers should increase their subjective aggress towards their children's vaccine booster vaccination, and mothers should strengthen their attitude support for their children's COVID-19 vaccine booster vaccination, resulting in positive behavioral changes.

In addition, the findings of this study help examine the objective assessment of parents as guardians of their harm to themselves and their children in the COVID-19 pandemic. The results collected in this study were suitable for revealing the underlying characteristics of factors associated with parental acceptance of child vaccine boosters differentiated by parental gender, parental views, parental attitudes, and the influence of those around them, due to the concurrent Omicron variant outbreak.

Clinical practices

The results of this study show that parents' opinions on whether their children need booster vaccinations significantly influence their vaccine-hesitancy. That is, the more parents think that their child needs a booster vaccination; the less hesitant they are to vaccinate their child with a booster shot.

We also found that parents' attitudes about giving their children booster shots had a significant impact on their vaccine-hesitancy. In other words, the more determined a parent's attitude toward booster vaccinations for their children, the less hesitant they were to give their children booster vaccinations. The effect of maternal attitudes on vaccination hesitancy was consistent with the effect of parental attitudes. However, the effect of paternal attitudes on vaccine-hesitancy was inconsistent compared with the effect of maternal attitudes. Fathers' attitudes about whether to give their children a COVID-19 vaccine booster had no significant or statistical effect on vaccine-hesitancy.

The analysis of the results shows that the mother's attitude plays a decisive role in family decision-making regarding vaccinating the children. However, we should also note that mothers accounted for 73.9%, while fathers accounted for only 26.1% of the participants. Unbalanced numbers can lead to deviations in the results, and thus these results can only be used as necessary reference. vaccine-hesitancy is a dynamic measurement process that may peak during a particular period of parental hesitancy and may ease as vaccine experience is gained [27].

The following interventions may be considered to reduce parental vaccine-hesitancy. First, health education advocacy departments need to provide accurate information on childhood vaccine boosters in an effective and accessible manner. Second, building an interactive vaccine website hosted by experts can provide an open communication platform for parents to express their concerns about vaccines and ask questions. Third, providing customized information education for vaccine-hesitancy parents so that they can receive useful information relevant to them as soon as possible. The father's education should be inclined towards subjective identity, while the mother's education should be inclined towards positive attitude support, to produce positive behavior intention. Vaccine-related herd immunity in the entire population is needed as soon as possible. There is still a long way to go in terms of health education and promotion.

Methodological considerations

This study has certain methodological advantages. First, the questionnaire structure and content of this cross-sectional survey refer to existing questionnaire designs that have been used extensively. Therefore, this questionnaire can potentially capture respondents' opinions and the effectiveness of preventive interventions accurately.

Second, the investigation period of this study was concurrent with the outbreak of the Omicron variant in China. Investigation results could present parents' hesitant psychological thoughts more vividly, and the results obtained had greater credibility. Third, a logistic regression model was used to analyze the data in this study, which controlled possible confounding factors associated with COVID-19 vaccine boosters that may have produced biased estimates.

However, this study also has certain limitations. First, although comparative larger sample sizes made us still have sufficiently statistical power to evaluate the parental hesitancy, a lower response rate (41.1%) in this population-based study are more likely to increase selection bias. Second, the selection of the study population was based on convenient sampling and voluntary, which may have introduced selection bias. Third, the survey site selected was Taizhou, which is a coastal city in China. Therefore, the research results may not be representative, that is, the generality of the research results is low. Fourth, we were unable to determine the accurate change in parental vaccine-hesitancy due to limited survey duration. Further in-depth epidemiological and longitudinal investigations are needed to gain a better understanding of parental knowledge, attitudes, and vaccine-hesitancy. This research would help reduce potential resistance toward COVID-19 vaccine boosters and the resulting public health concerns.

Conclusion

Our findings show that a relatively low proportion of parents report that they are hesitant to give their children a COVID-19 vaccine booster dose. The findings suggest that in-depth and dynamic assessments, along with education programs, are necessary to reduce the hesitancy of Chinese parents towards vaccinating their children. Public health management departments and projects need comprehensive evaluation and analysis and overall management of health education resources, providing convenient and effective consultation and communication services to parents as much as possible to reduce the risk of outbreaks among children.

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Author contributions

L,-LH, Y-PY, H-PM, W-WH, Y-HJ, ZL-J and T-HT conducted the study and drafted the manuscript. L-LH, Y-PY, H-PM, W-WH, Y-HJ and ZL-J participated in the design of the study and performed data synthesis. T-HT conceived the study and participated in its design and coordination. All of the authors read and approved the final manuscript.

Data Availability

All data underlying the findings are within the paper.

Disclosure of interest

The authors have no proprietary interest in any aspect of this study.

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