

RESEARCH PAPER

 OPEN ACCESS



Vaccine hesitancy among parents and its influencing factors: a cross-sectional study in Guangzhou, China

Hongyue Zhang^{a*}, Peng Zheng^a, Jiayi Zhang^b, Qianwen Qiu^a, Bing Huang^a, Huiyao Feng^a, Yue Zhang^a, Xiongfei Chen^c, Jun Xu^d, and Xiaomei Dong^b

^aDepartment of Public Health and Preventive Medicine, School of Medicine, Jinan University, Guangzhou, Guangdong, China; ^bDepartment of Medical Record Statistic, The First Affiliated Hospital of Guangdong Pharmaceutical University, Guangzhou, Guangdong, China; ^cDepartment of Primary Public Health, Guangzhou Centers for Disease Control and Prevention, Guangzhou, Guangdong, China; ^dCollege of Foreign Studies, Jinan University, Guangzhou, Guangdong, China

ABSTRACT

Vaccine hesitancy is a major obstacle to the achievement of universal child vaccination, which has been studied extensively in Western countries but much less so in Asian countries, especially China. This cross-sectional survey is aimed to assess the prevalence of vaccine hesitancy and to explore the reasons for vaccine hesitancy among parents in Guangzhou. In January 2020, a questionnaire adapted to the Chinese setting from a widely-used hesitancy scale was administered to a sample of parents who brought their children aged <13 years to Community Health Service Centers for vaccination in Guangzhou. The incidence of vaccine hesitancy among those parents was 6.6% (50/755). Regression analysis showed that differences in socio-economic characteristics were not associated with the occurrence of vaccine hesitancy among parents in Guangzhou. However, strong distrust of domestic vaccine quality (OR = 10.9, 95% CI = 1.5–81.4), being required to have their children vaccinated for nursery and school entry (OR = 3.6, 95% CI = 1.7–7.7), and not being aware of which vaccines are officially required and which are optional (OR = 2.1, 95% CI = 1.1–4.3) were the risk factors significantly associated with vaccine hesitancy. In order to increase parents' trust in domestic vaccine quality and reduce the prevalence of vaccine hesitancy, it is essential to strengthen quality control in domestic vaccine manufacturing and to proactively disseminate clear and accurate information about vaccines to parents. Furthermore, advocating the value of vaccination among all citizens of Guangzhou is crucial.

ARTICLE HISTORY

Received 19 June 2021
Revised 29 August 2021
Accepted 14 September 2021

KEYWORDS





Vaccine hesitancy; Parents in Guangzhou (China); Influencing factors; Countermeasures

Introduction

Vaccination is recognized as the most important achievement in preventive medicine and the most reliable and economic public health intervention.¹ For example, since the launch of the National Immunization Programme (NIP) in 1978, China has been committed to serving children at risk of vaccine-preventable disease (VPD).² However, vaccine hesitancy, defined by WHO in 2012 as a refusal or delay of vaccination when such services are available, has been classified as one of the top ten global health threats, which has definitely caught the attention of the world.^{3,4}

Children are the main target population for vaccination,⁵ and around the globe many countries have been taking various measures to improve their children vaccination rates. Nonetheless, there has been an increase in the number of the parents who refuse or hesitate to get their children vaccinated. Data analysis on the joint report by the WHO and the UNICEF (2015–2017) show that more than 90% of the countries in the world have reported the occurrence of parental vaccine hesitancy.⁶ Thus parents' attitude toward vaccination has become the main focus in vaccine hesitancy research.⁷ In China, there are two types of childhood

vaccines, required¹ and optional,² officially available. The required vaccines are provided free of charge for all the children in China, and parents are obliged to get their children vaccinated with them. In contrast, optional vaccines are usually self-funded, and at the same time, vaccination with optional vaccines is not an essential prerequisite for children's admission to kindergarten or entry into school. Therefore, the coverage rates of optional vaccines are understandably lower than those of required vaccines.^{8,9} On the other hand, in recent years, there have been some news reports on the adverse events following immunization (AEFIs) in China. Such revelations have greatly impacted on the trust in vaccination. A case in point is what happened in 2013 in Hunan Province,¹⁰ in which three infants were reported to have suffered serious adverse reactions after having received hepatitis B vaccine and unfortunately two of them died in the end.^{11,12} Another case involving an illegal sale of optional vaccines in 2016 in Shandong Province further undermined parents' confidence in vaccination.¹³ Moreover, a survey conducted by Bian et al. (2018) showed that after the Changchun Changsheng vaccine safety incident, 151 (22.5%) out of 671 parents were hesitant to have their children vaccinated with Diphtheria Tetanus Pertussis

CONTACT Xiongfei Chen  11742513@qq.com  Guangzhou Centers for Disease Control and Prevention, Guangzhou, Guangdong, China; Xiaomei Dong  ntydxm@126.com  Department of Epidemiology, School of Medicine, Jinan University, No. 601 Huangpu Road West, Guangzhou, Guangdong 510632, China

*These authors contributed equally to this work.

© 2021 The Author(s). Published with license by Taylor & Francis Group, LLC.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

vaccine (DTP) in addition to the 65 (9.7%) parents who flatly refused it, with the incidence of hesitation totaling 32.2%.¹⁴ It can be concluded that due to the large number of reported AEFIs, Chinese parents may have lost their trust in domestic vaccine quality, and their willingness to get their children vaccinated on time may have declined, which result in a reduction in vaccine coverage.¹⁵

In 2011 Opel et al. developed the Parent Attitudes about Childhood Vaccines (PACV) scale,^{16,17} which was tested thereafter by scholars in such countries as the United States, Italy, Malaysia and Spain and found highly reliable and valid.^{18–20} Up to now the PACV scale has been widely used to identify and evaluate parents' attitude about vaccine hesitancy.^{21,22} In view of the absence of effective and reliable monitoring indicators of parents' vaccine hesitancy, a Chinese version of the PACV scale, with Chinese cultural factors included, was developed and subsequently applied in a cross-sectional survey on parents' attitudes and behaviors about child vaccination in Guangzhou. The research was intended to discover the distribution of parents' vaccine hesitancy and explore the risk factors involved for the sake of the improvement and formulation of intervention measures.

Material and methods

The study was designed and implemented in two phases. In the first stage, the reliability and validity of the Chinese version of the PACV scale were tested; in the second stage, a cross-sectional survey was conducted in Guangzhou to observe parents' hesitation in childhood vaccination and analyze its influencing factors.

Phase I: translation and reliability and validity test of the Chinese version of PACV scale

With the formal authorization from the author of the original PACV scale, four translators and two recorders are invited to apply 'forward and backward' method to the translation work. First, one Chinese-English bilingual translator with vaccination-related knowledge and one Chinese-English bilingual translator with no vaccination-related knowledge are required to literally translate the English scale into Chinese. Then, one bilingual recorder with vaccination-related knowledge compared and assessed the two versions of translated manuscripts to form the PACV Chinese version 1.0. Next, another two translators without knowledge of the original scale were selected to back-translate the PACV Chinese version 1.0, and then another bilingual recorder helped determine the back-translation version 1.1. The team, after discussing and comparing the PACV Chinese version 1.0 and the back-translation version 1.1, developed the PACV Chinese version 1.2. Thereafter six immunization experts were invited to make proper adaptations and adjustments to the PACV Chinese version 1.2 and subsequently the PACV Chinese version 1.3 was developed. In May 2019, a small sample of 30 parents who met the inclusion criteria were pre-tested at a community health service center in Guangzhou. Based on their feedbacks, the content of the PACV Chinese version 1.3 was appropriately revised and hence the PACV Chinese version 2.0 was completed.

The reliability and validity test of the PACV Chinese version 2.0 was conducted as follows: first, a questionnaire was designed in accordance with the PACV scale Chinese version 2.0. Then online and offline investigations were carried out in kindergartens, hospitals and community health service centers in Guangzhou from May to September 2019. The subjects were parents having under-13 children, who had lived in Guangzhou for more than half a year and voluntarily participated in the questionnaire survey. The sample size was 20 times the PACV scale items, with 300 subjects included.

Phase II: investigation on the childhood vaccine hesitancy among parents in Guangzhou

Setting and sample

Both random sampling and nonrandom sampling were adopted with the specifics as follows: In the first stage, six districts of the Guangzhou city were chosen and divided into high-income, middle-income and low-income according to the average housing price of each district. Among them, Yuexiu and Tianhe were classified as high-income districts; Haizhu and Liwan, middle-income districts; Baiyun and Huangpu, low-income districts. In the second stage, the community health service center where the housing price was closest to the average was singled out in each district. Then their informed consent was acquired. Nevertheless, there are some adaptations worthy of note. Huangpu District where housing prices were fluctuating greatly was replaced by Panyu District where housing prices were much more stable. Besides, since informed consent from Zhanqian Community Health Service Center in Liwan District was denied, it was decided to twice the sample size of Fengyang Community Health Service Center in Haizhu District, that is, around 220 samples were taken from Fengyang while there were only 110 samples taken from any of the other community health service centers. Altogether five centers eventually agreed to help conduct the questionnaire survey (Figure 1 for details). The research subjects were those parents who took their children under 13 years of age to the community health service center for vaccination in Guangzhou and at the same time voluntarily participated in the questionnaire survey. The sample size was determined by the sample size formula of the cross-sectional study:²³ with 95% of school-age children in Guangdong Province vaccinated with required vaccines according to information published by the government,²⁴ in order to obtain a representative sample of the population with a 98% confidence and an absolute error of 5%, a sample size of 641 subjects was required. During the operation of the vaccination clinics at selected community health service centers from 2 to 20 January 2020, investigators conducted a face-to-face questionnaire survey on parents in waiting and observation rooms. All investigators were recruited and trained graduate students in the medical profession who were required to work conscientiously and voluntarily. On receiving the finished questionnaire, qualitative interviews were conducted with parents who opted for 'except for illness and allergy, postponed/refused to vaccinate their children with certain required vaccines' to find the reasons for their postponement/rejection of required vaccines for their children.

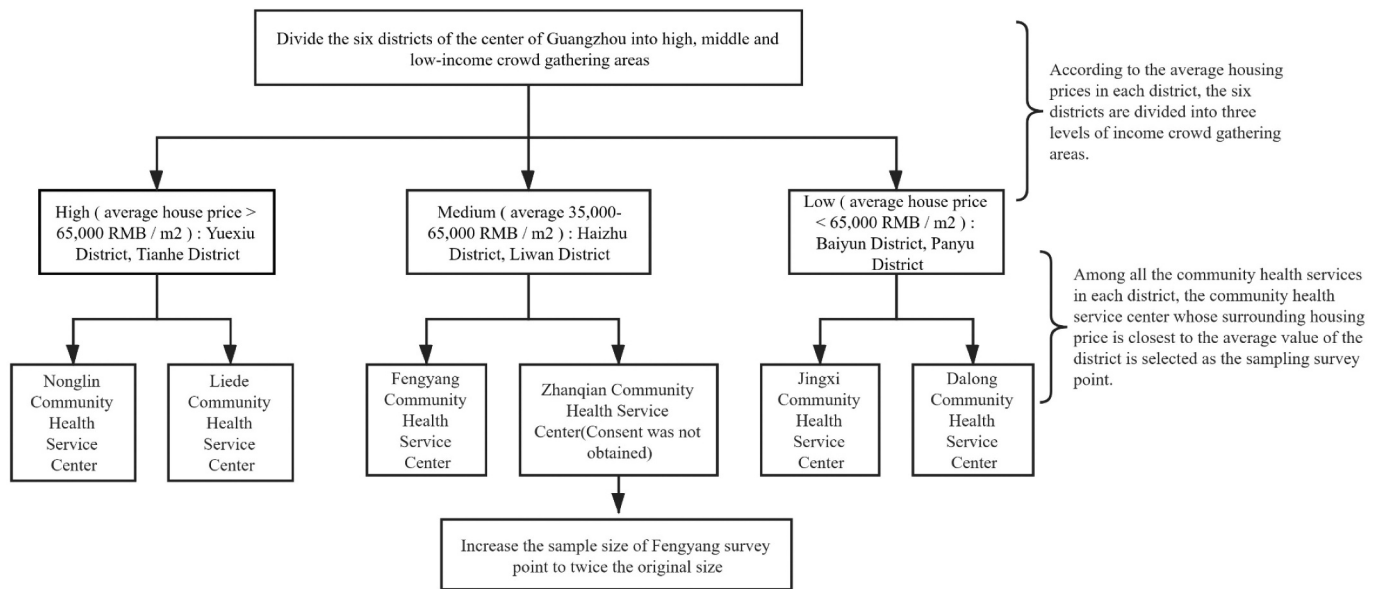


Figure 1. Cascade chart of sampling method for cross-sectional survey.

Study instrument

Based on the feedback from participants in the pre-survey, some items of the PACV scale Chinese version 2.0 were revised to upgrade the version 2.0 to 3.0. Included in the PACV scale Chinese version 3.0 were the general information of the respondents (sex, age, educational background, economic status, etc.), vaccine-related knowledge, access to vaccine knowledge, parents' trust in domestic vaccines and parental support of interventions which were intended to improve vaccination trust. The respondents were classified into two types: those who scored 50 points or more are labeled as being hesitant about childhood vaccination and those who scored below 50 points as being not hesitant.

Ethical consideration

This study has been approved by the Scientific Research Ethics Committee of the First Affiliated Hospital of Jinan University. The Ethics Committee, after a thorough review, concluded that the research content and research methods comply with the norms and requirements of medical ethics. The well-trained investigators, in full compliance with the medical ethics, obtained verbal consent from the respondents before distributing the questionnaires to them. At the beginning of the questionnaire was a brief description of the study to further inform the respondents.

Statistical analysis

As to reliability and validity test of the PACV scale Chinese version 3.0, a total of 421 valid questionnaires were retrieved, which met the sample size requirements. EpiData3.1 was applied to input the data collected from printed questionnaires, which, together with online data, were statistically analyzed with the software SPSS 23.0 (Chicago, IL, USA). The statistical methods included two independent sample t-tests, exploratory factor analysis, content validity and reliability test. In addition, AMOS 21.0 was used for confirmatory factor analysis in this study.

Analysis of the status and influencing factors of parental vaccine hesitancy in Guangzhou is as follows: a total of 791 questionnaires were collected in the survey. According to the PACV scale score requirements, 36 questionnaires with more than 2 missing items were excluded, hence 755 valid questionnaires were finally obtained. Meanwhile, EpiData 3.1 was used to input data and SPSS 23.0 (Chicago, IL, USA) was used for descriptive statistical analysis, univariate analysis (chi-square test) as well as multivariate logistic regression analysis of the 755 valid questionnaires. All odds ratios (ORs) were interpreted with a reference category, and significance was assessed at an alpha of 0.05.

Results

Phase I

The PACV scale Chinese version contained three dimensions: behaviors on the National Immunization Programme (two items), beliefs about vaccine safety and effectiveness (four items), and overall attitude toward the National Immunization Programme (nine items). The fit indices of the factor analysis met the requirements, and the revised Chinese version of the PACV scale had good structural validity. The content validity index of the scale (scale-level CVI, S-CVI), which reflects the degree of agreement between what a scale actually measures and what it is intended to measure, was 0.955, which was above 0.9 and indicated good content validity. On the other hand, the Cronbach's α coefficient, which indicates the internal consistency of the scale, was 0.705 for the total scale, which was above 0.7 and indicated good internal consistency of the scale.

Phase II

Demographic characteristics of participants

Among the 755 parents surveyed, 193 (25.6%) were fathers, 562 (74.4%) were mothers, and nearly three-quarters (540/755) of them were younger than 35 years of age. Parents with college/

Table 1. Socio-demographic characteristics of participants (N = 755).

Socio-demographic characteristics	N (%)
Sex	
Male	193(25.6)
Female	562(74.4)
Age group (years)	
<25	43(5.7)
25–34	497(66.4)
≥35	209(27.9)
Registered residence	
Local people	432(57.6)
Nonlocal people	318(42.4)
Religion	
No	587(84.5)
Yes	108(15.5)
Educational background	
High school/technical secondary school and below	249(33.0)
Bachelor degree/college degree	412(54.6)
Master degree and above	93(12.3)
Employment status	
Employed	590(78.7)
Unemployed	160(21.3)
Monthly per capita disposable income of the household (Chinese Yuan)	
≤3000	48(6.5)
3001–5000	155(20.8)
5001–7000	161(21.6)
7001–10000	165(22.2)
>10000	215(28.9)

junior college education accounted for 54.6% (412 persons); those with high school/secondary vocational school education or below, 33.0% (249 persons); those with a master's degree or above, 12.3% (93 persons). Other demographic characteristics are presented in Table 1.

Results of parents' attitudes toward childhood vaccine in Guangzhou (PACV scale)

The survey results, with the application of the PACV scale, showed that among the 755 parents, 705 (93.4%) parents scored less than 50 points on the PACV scale, and 50 (6.6%) parents scored 50 points and even more which indicated vaccine hesitancy. Among them, 153 (20.5%) parents postponed vaccination of their children in the National Immunization Programme for reasons other than illness and allergies; 20 (2.7%) parents refused vaccination of their children in the National Immunization Programme. More than half (66.2%) of the parents said they were worried about serious side effects after their children were vaccinated. Likewise, more than half (54.7%) of the parents worried that every vaccination might be unsafe, and nearly half (48.1%) of the parents worried that the vaccination could not effectively prevent the corresponding diseases. In general, 13.6% of the parents expressed hesitation about their children's vaccination, but 88.8% of the parents still agreed to have their children vaccinated under the National Immunization Programme. The other specific PACV scale results are shown in Table 2.

Univariate analysis of vaccine hesitancy among parents in Guangzhou

With parents' attitudes toward children's vaccines to be the dependent variable, univariate analysis (chi-square test) was performed with such independent variables as 'demographic characteristics,' 'reason for vaccination,' 'trust in domestic

vaccines,' and 'classification of vaccines in China.' The results show that the parents did not trust domestic vaccines, as well as the parents had their children receive required vaccines just because such vaccination is a prerequisite for the entry into nursery and school were more likely to be hesitant about required vaccines. Moreover, those who did not know the classification of vaccines in China tend to have higher vaccine hesitancy rates, while other demographic variables such as sex, age, educational background and employment status had no significant correlation with parents' hesitancy toward childhood vaccines ($P > .05$). See Table 3 for further details.

Multivariate analysis of vaccine hesitancy among parents in Guangzhou

All variables with $P < .25$ in the univariate analysis were introduced into the multivariate logistic regression model. Forward: The LR method (forward stepwise regression method based on maximum likelihood estimation) was used to screen variables. The standard for including variables in the equation was 0.10, and the standard for eliminating the independent variables was 0.15. The results showed that parents who had their children receive the required vaccines due to kindergarten and school enrollment requirements were 3.6 times more likely to be vaccine hesitant than other parents ($OR = 3.6$, 95% $CI = 1.7-7.7$). Compared to parents who trusted domestic vaccines very much, parents who did not really trust domestic vaccines and did not trust at all were more hesitant about childhood vaccines ($OR = 6.6$, 95% $CI = 1.8-24.1$; $OR = 10.9$, 95% $CI = 1.5-81.4$). Parents who were not aware of which vaccines are required and which are optional in China were twice as likely to be hesitant about childhood vaccines than those who know ($OR = 2.1$, 95% $CI = 1.1-4.3$). See Table 3 for further details.

The correlation between parents' vaccine cognition and vaccine hesitancy in Guangzhou

Knowledge about vaccine among parents in Guangzhou. The assessment of parents' awareness rate of vaccine-related knowledge was based on their knowledge about the dos and don'ts before and after vaccination, about the general minor reactions after vaccination, about the types of immunization planning of vaccines, and about the preventable diseases. The results showed that the awareness rate of parents' vaccine knowledge in Guangzhou was 54.16% (6905/12749). Meanwhile, only 58 parents knew that sore swelling of lymph nodes occurring within 24 hours after inoculation was a generally mild reaction, thus the awareness rate in this respect was 7.7%, which ranked with the lowest among all knowledge items. Furthermore, less than 50% of the parents were aware that such diseases as tuberculosis, diphtheria, measles, and hepatitis A could be prevented with immunization programme vaccines. For instance, in respect of hepatitis A their awareness rate was only 25.6%, and of tuberculosis, only 33.6%. See Table 4 for further details. According to these parents, the suggested measures to improve their trust in vaccination mainly included strengthening supervision, intensifying efforts to crack down on illegal operations, accelerating relevant legislation, criminalizing the offenders, upgrading vaccine quality standards and improving vaccine quality control.

Table 2. Individual PACV statements and 755 participants' responses.

No	Item	Not hesitant, N(%)	Unsure, N (%)	Hesitant, N (%)
1	Have you ever delayed having your child get a shot (free vaccines from the National Immunization Program) for reasons other than illness or allergy?	595 (79.5)	-	153 (20.5%)
2	Have you ever decided not to have your child get a shot (free vaccines from the National Immunization Program) for reasons other than illness or allergy?	727 (97.3)	-	20 (2.7)
3	How sure are you that following the recommended shot schedule is a good idea for your child?	669 (88.8)	24 (3.2)	60 (8.0)
4	Children get more shots than are good for them.	174 (23.2)	292 (39.0)	283 (37.8)
5	I believe that many of the illnesses that shots prevent are severe.	291 (38.7)	158 (21.0)	302 (40.2)
6	It is better for my child to develop immunity by getting sick than to get a shot.	407 (54.1)	181 (24.0)	165 (21.9)
7	It is better for children to get fewer vaccines at the same time.	404 (53.9)	242 (32.3)	104 (13.9)
8	How concerned are you that your child might have a serious side effect from a shot?	211 (27.9)	44 (5.8)	500 (66.2)
9	How concerned are you that any one of the childhood shots might not be safe?	274 (36.4)	67 (8.9)	411 (54.7)
10	How concerned are you that a shot might not prevent the disease?	250 (33.4)	139 (18.6)	360 (48.1)
11	If you had another infant today, would you want him/her to get all the recommended shots?	688 (91.2)	21 (2.8)	45 (6.0)
12	Overall, how hesitant about childhood shots would you consider yourself to be?	605 (80.1)	47 (6.2)	103 (13.6)
13	I trust the information I receive about shots.	653 (86.5)	98 (13.0)	4 (0.5)
14	I am able to openly discuss my concerns about shots with my child's doctor.	660 (88.6)	73 (9.8)	12 (1.6)
15	All things considered, how much do you trust your child's doctor?	622 (83.3)	12 (1.6)	113 (15.1)

Table 3. Univariate and multivariate analysis of parents' attitudes toward child vaccines in Guangzhou.

Variable	N	Hesitancy (%)	Univariate analysis		Multivariate analysis	
			χ^2	P value	aOR (95% CI)	P value
Sex			2.003	.179		
Male	193	17 (8.8)				
Female	562	33 (5.9)				
Age group (years)			1.531	.465		
<25	43	2 (4.7)				
25–34	497	29 (5.8)				
≥35	209	17 (8.1)				
Number of children			0.229	.640		
1	319	18 (5.6)				
≥2	384	25 (6.5)				
Educational background			1.975	.388		
High school/technical secondary school and below	249	21 (8.4)				
Bachelor degree/college degree	412	24 (5.8)				
Master degree and above	93	5 (5.4)				
Employment status			0.014	.905		
Employed	590	39 (6.6)				
Unemployed	160	11 (6.9)				
Monthly per capita disposable income of the household (Chinese Yuan)			1.538	.825		
≤3000	48	4 (8.3)				
3001–5000	155	11 (7.1)				
5001–7000	161	8 (5.0)				
7001–10000	165	13 (7.9)				
>10000	215	13 (6.0)				
Registered residence			0.929	.371		
Local people	432	25 (5.8)				
Nonlocal people	318	24 (7.5)				
Religion			1.015	.382		
No	587	34 (5.8)				
Yes	108	9 (8.3)				
Reason for vaccination			17.568	<.001*		
Vaccination certificate system	113	17 (15.0)			3.6 (1.7–7.7)	.001*
Not the vaccination certificate system	622	29 (4.7)			1 ^b	
Trust in domestic vaccines			-	.006 ^a *		
Very trusting	126	2 (2.4)			1 ^b	
Mostly trusting	416	22 (5.3)			2.4 (0.7–8.5)	.176
Not very trusting	145	16 (11)			6.6 (1.8–24.1)	.004*
Very distrustful	11	3 (18.2)			10.9 (1.5–81.4)	.020*
Classification of domestic vaccines			8.909	.003*		
Know	426	18 (4.2)			1 ^b	
Don't know	296	29 (9.8)			2.1 (1.1–4.3)	.034*

Bold values indicate significant difference (* $P < .05$).

^aFisher's exact probability method.

^bReference category.

(aOR: Adjusted odds ratio, CI: confidence interval, OR: odds ratio).

Table 4. Awareness of vaccine-related knowledge among parents in Guangzhou.

No	Item	Number of answers	Number of knowers	Awareness rate (%)
1	Children with fever or diarrhea cannot be vaccinated.	729	640	87.8
2	Children should stay at the vaccination site for 30 minutes after vaccination.	728	656	90.1
3	Redness and pain at the injection site after vaccination are generally mild reactions.	755	586	77.6
4	Low fever within 24 hours after vaccination is a generally mild reaction.	755	506	67.0
5	Lymph node swelling and pain within 24 hours after vaccination is a generally mild reaction.	755	58	7.7
6	BCG vaccine belongs to required vaccine.	755	490	64.9
7	Hepatitis B vaccine belongs to required vaccine.	755	488	64.6
8	Japanese encephalitis vaccine belongs to required vaccine.	755	321	42.5
9	Poliomyelitis vaccine belongs to required vaccine.	755	405	53.6
10	Tuberculosis can be prevented by required vaccines.	755	254	33.6
11	Hepatitis B can be prevented by required vaccines.	755	488	64.6
12	Poliomyelitis can be prevented by required vaccines.	755	416	55.1
13	Diphtheria can be prevented by required vaccines.	755	267	35.4
14	Measles can be prevented by required vaccines.	755	331	43.8
15	Hepatitis A can be prevented by required vaccines.	755	193	25.6
16	Meningococcal meningitis can be prevented by required vaccines.	755	380	50.3

Spearman rank correlation analysis between vaccine knowledge and the three dimensions of the PACV scale. The results of the Spearman rank correlation analysis between the score in vaccine knowledge and the three dimensions of the PACV scale showed that only the correlation between parents' overall attitude to childhood vaccines and their scores in vaccine knowledge was statistically significant ($p < .05$). The overall attitude was negatively correlated with vaccine knowledge ($r = -0.212$, $p < .001$), that is, the higher degree of vaccine hesitancy, the lower score in parents' vaccine knowledge.

Qualitative interview

The results showed that 35 families had delayed vaccination due to insufficient supply of vaccines at vaccination sites, 27 parents said that their children were not vaccinated on time because of their busy work schedule and forgetfulness, and 25 parents did not have their children vaccinated on time as they were not in Guangzhou then (being on business trips, returning to their hometowns, etc.). Among the four parents who refused to have their children vaccinated with required vaccines, one explained that his child had severe vomiting and syncope after the injection of a dose of polio vaccine at the age of 3 months, after which the injection was stopped. He also said that he would take his child to Hongkong to receive the rest of needed vaccinations. The other three parents refused to revaccinate their children after a failed BCG vaccination, and one of the children experienced severe post-vaccination vomiting.

Discussions

After the reliability and validity test, the Chinese version of the PACV scale was found to have good reliability and validity and it could be used as an evaluation tool to reflect parents' vaccination attitudes and vaccine hesitancy.

It can be seen from the results of the study that Guangzhou parents showed a favorable attitude toward the China's Immunization Programme. A total of 88.8% of parents agreed to have their children vaccinated under the National Immunization Programme, which, on the other hand, reflects that China has done quite well in the publicity and implementation of the law on the prevention and control of infectious

diseases.²⁵ However, 6.6% of parents in Guangzhou still hesitated to have their children vaccinated. More than half of these hesitant parents were reported to have had 'behavior of delaying vaccination under the immunization programme,' whereas 16% of them had 'refusal behavior.' The attitude and behavior of parents about children's vaccines, reflected by the Chinese version of the PACV scale score, were consistent. Though incidence of vaccine hesitancy varies from country to country,²⁶ the vaccine hesitancy rate of parents in Guangzhou (6.6%), compared with the statistics from other studies conducted in countries other than China, was quite low. It might in part be attributed to the fact that the China's Immunization Programme has achieved the goal of 90% coverage (township as a unit) since 2013 and thus fulfilled the purpose of the Universal Child Immunization simultaneously.²⁷ In contrast, in 2019 a study on vaccine hesitancy among parents was conducted by the WHO in Saudi Arabia, and collected data showed that up to 20% of the 500 parents were hesitant to have their children vaccinated;²⁸ in another vaccine hesitancy survey conducted in the European Union, 35% of parents in the Czech Republic considered measles vaccine unsafe and 19% considered measles vaccine unnecessary;²⁹ in 2020, among the 956 parents surveyed in Indonesia, 152 parents (15.9%) were hesitant about vaccination.³⁰ The low vaccine hesitancy rate of Guangzhou parents may be chiefly related to the effective implementation of vaccination-relevant policies and regulations in China, and another contributing factor might be the great economic support for the immunization programme from the government.

With all other variables adjusted, multivariate analysis revealed that parental mistrust of domestic vaccines was one of the main risk factors for vaccine hesitancy in Guangzhou. A study on the factors affecting childhood vaccination in Galkayo District, Puntland, Somalia showed that parents' low trust in vaccines could not be ignored,³¹ while vaccine safety was one of the main factors that affected parents' trust in vaccines. From 2016 to 2018, the reported vaccine safety incidents attracted significant attention in China. Nonstandard production processes, falsified production records, and substandard transportation and storage conditions may contribute to vaccine safety risks.^{32,33} These loopholes in vaccine management in China were believed to have greatly undermined parents' confidence in domestic vaccines. Moreover, once

children's vaccine safety issues arise, the confidence crisis can hardly be resolved in a short time, which may make parents more hesitant about vaccination.

China's government has done a lot to promote public trust in domestic vaccines. For instance, the Law on Vaccine Management, which was passed and took effect in 2019, stipulated strict management by requiring a whole-process supervision system and toughening penalties on producing and selling fake or substandard vaccines. Besides, in some cities reliable insurers were introduced to offer insurance against abnormal/adverse post-vaccination reactions.³⁴ The above measures might be responsible for the relatively low vaccine hesitancy, but another fact that could not be ignored was that in Guangzhou as many as 22.3% (156/698) of parents did not trust China-made vaccines. Despite their distrust of domestic vaccines, these parents still had their children vaccinated because vaccination under the National Immunization Programme was a basic prerequisite for their children's entry into nursery or school. On registering schooling, children vaccination certificates were required, and those who were found not to have been vaccinated with required vaccines would be denied entry into nursery or school. Furthermore, they would be reported to the local vaccination department to urge them to get vaccinated, with the exception of a very small number of parents who might leave their children unvaccinated for the reason of allergy or poor/improper physical health.³⁵ Though the mandatory provisions of the law might promote children's vaccination rate to a certain extent, the fundamental risk factors for parents' vaccine hesitancy were not controlled yet. Therefore, with intent to improve public confidence in vaccines and vaccination services, it was still advisable for China's public health sector to tighten the whole-process supervision to ensure vaccine quality and vaccination safety.

Similarly, it was found that parents who could not make clear which were required vaccines and which were optional ones were more likely to have child vaccine hesitancy than parents who could. Previous studies have shown that parents' knowledge of vaccination is an important factor influencing children's immunization status.³⁶ Among all the knowledge items included in the scale, knowledge about the classification of vaccines, that is, about which were required and which were optional in China, was believed to be the most important, more decisive and influential than any other item. A lack of understanding of this knowledge item might lead to parents' misunderstanding of vaccines, ultimately resulting in vaccine hesitancy. According to the survey, in Guangzhou parents' knowledge of childhood vaccines mainly came from media push (66.3%), messages from medical staff (64.5%), and community health education (54.7%). It could be concluded that media push has become the main channel for parents to acquire vaccine knowledge. However, some media demonized vaccination in the reported vaccine incidents, in which the dissemination of irrational information could affect parents' attitudes and behaviors about vaccination to varying degrees. Therefore, to lessen the negative effects of distorted or untruthful media reports, it was suggested that the authority concerned improve their communication and

cooperation with the media, standardize the mechanism of vaccine information release, and specifically strengthen the regulation on we-media.³⁷ On the other hand, medical staff, as an important and reliable source of vaccine-related information for the public,^{38,39} could receive further training on professional ethics and specialist knowledge so as to better help raise the awareness of the parents.⁴⁰ Moreover, under the premise of ensuring the safety and effectiveness of vaccines, vaccination clinics and the Centers for Disease Prevention and Control (CDC) at all levels could do more in the publicity of vaccine-related knowledge to decrease their distrust of domestic vaccines as well as improve the vaccination coverage.

The cross-sectional findings of this study were derived from the self-reports of the respondents and might be subject to some degree of recall bias and reporting bias, but this study conducted in Guangzhou cannot be considered representative of the case of Guangdong province or even China. The Chinese version of the PACV scale was only applied to the investigation into parents' hesitancy in having their children vaccinated with required vaccines in Guangzhou. If applied to the populations in areas other than Guangzhou or to children vaccination with optional vaccines, the content and the design of the scale items need adapting to the characteristics of the population and the purpose of the study.

Conclusions

There were 6.6% of parents in Guangzhou showed vaccine hesitancy according to their evaluation scores on the Chinese version of the PACV scale. Out of the 755 respondents, 50 were vaccine hesitant; among the hesitant parents, 78% had not refused to get their children the required vaccine, 16% had refused, and 6% were unsure. In addition, 20 (2.7%) out of 755 respondents had refused to give their children the required vaccines for reasons other than illness or allergy. Among these 20 parents, vaccine hesitancy incidence was 40%. It can be concluded that children vaccine hesitancy among parents in Guangzhou is related to their vaccine cognition and trust in domestic vaccines. Thus more work can be done to help improve parents' vaccine cognition and their trust in domestic vaccines to reduce the occurrence of vaccine hesitancy.

Notes

1. Required vaccines: Hepatitis B Vaccine (HepB), Bacillus Calmette-Guérin vaccine (BCG), Inactivated polio vaccine (IPV), Live Attenuated Oral Poliomyelitis Vaccine (OPV), DTaP (Diphtheria, Tetanus, Pertussis), DT (Diphtheria, Tetanus), MMR (Measles, Mumps, Rubella), Live attenuated Japanese encephalitis vaccine (JE-L), Inactivated Japanese encephalitis vaccine (JE-I), Group A Meningococcal polysaccharide vaccine (MPSV-A), Group A and Group C Meningococcal Polysaccharide Vaccine (MPSV-AC), Live attenuated Hepatitis A vaccine (HepA-L), Inactivated hepatitis A vaccine (HepA-I).
2. Optional vaccines: In addition to the required vaccines, other vaccines are administered at citizens' own expense and on a voluntary basis.

Acknowledgments

The authors would like to thank the Ethics Committee of Scientific Research in the First Affiliated Hospital of Jinan University for approving this study. We thank all the parents who participated in this study. We appreciate Professor Douglas J. Opel and his team for providing us with the authorization of the original PACV scale, the final version of the questionnaire form, the scale scoring mechanism, and a related research on the PACV scale. We are also grateful to all staff who assisted during the study.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

ORCID

Xiaomei Dong  <http://orcid.org/0000-0002-3832-038X>

References

- Bunker JP, Frazier HS, Mosteller F. Improving health: measuring effects of medical care. *Milbank Q.* 1994;72:225–58. doi:10.2307/3350295.
- Hu Y, Luo S, Tang X, Lou L, Chen Y, Guo J. Comparative assessment of immunization coverage of migrant children between national immunization program vaccines and non-national immunization program vaccines in East China. *Hum Vaccin Immunother.* 2015;11:761–68. doi:10.1080/21645515.2015.1012015.
- MacDonald NE. Vaccine hesitancy: definition, scope and determinants. *Vaccine.* 2015;33:4161–64. doi:10.1016/j.vaccine.2015.04.036.
- World Health Organization. Ten threats to global health in 2019; 2019 [accessed 2021 Jan 15]. <https://www.who.int/news-room/spot-light/ten-threats-to-global-health-in-2019>.
- United Nations Children's Fund (UNICEF). What is the UN convention on child rights? 2021 [accessed 2021 July 20]. <https://www.unicef.org.uk/what-we-do/un-convention-child-rights/>.
- Lane S, MacDonald NE, Marti M, Dumolard L. Vaccine hesitancy around the globe: analysis of three years of WHO/UNICEF Joint Reporting Form data-2015–2017. *Vaccine.* 2018;36:3861–67. doi:10.1016/j.vaccine.2018.03.063.
- Smith PJ, Kennedy AM, Wooten K, Gust DA, Pickering LK. A association between health care providers' influence on parents who have concerns about vaccine safety and vaccination coverage. *Pediatrics.* 2006;118:e1287–e92. doi:10.1542/peds.2006-0923.
- Yu W, Cao L, Liu Y, Li K, Rodewald L, Zhang G, Wang F, Cao L, Li Y, Cui J, et al. Two media-reported vaccine events in China from 2013 to 2016: impact on confidence and vaccine utilization. *Vaccine.* 2020;38(34):5541–47. doi:10.1016/j.vaccine.2020.05.014.
- Sun X, Huang Z, Wagner AL, Prosser LA, Xu E, Ren J, Wang B, Yan W, Zikmund-Fisher BJ. The role of severity perceptions and beliefs in natural infections in Shanghai parents' vaccine decision-making: a qualitative study. *BMC Public Health.* 2018;18(1):1–9. doi:10.1186/s12889-018-5734-9.
- BJNEWS.COM.CN. Two infants die from hepatitis B vaccine in Hunan; 2013 [accessed 2021 July 21]. <https://www.bjnews.com.cn/detail/155147214314907.html>.
- National Health Commission of the People's Republic of China, Disease Prevention and Control Bureau, The State Food and Drug Administration, the National Health and Family Planning Commission on issues related to hepatitis B vaccine media briefing transcript; 2013 [accessed 21 July 2021]. <http://www.nhc.gov.cn/jkj/s3582/201312/399f93b86a3041e2b4791231f61ab6b0.shtml>.
- 张世英. 乙肝疫苗事件影响公众预防接种信任度调查. *中国公共卫生管理.* 2015;31:76–77. doi:10.19568/j.cnki.23-1318.2015.01.032.
- Cao L, Zheng J, Cao L, Cui J, Xiao Q. Evaluation of the impact of Shandong illegal vaccine sales incident on immunizations in China. *Hum Vaccin Immunother.* 2018;14:1672–78. doi:10.1080/21645515.2018.1473697.
- 卞增惠, 张钟, 程云凤. 长春长生疫苗事件后公众预防接种意愿网络调查. *中国公共卫生.* 2020;36:1208–12. doi:10.11847/zgggws1123190.
- Han B, Wang S, Wan Y, Liu J, Zhao T, Cui J, Zhuang H, Cui F. Has the public lost confidence in vaccines because of a vaccine scandal in China. *Vaccine.* 2019;37:5270–75. doi:10.1016/j.vaccine.2019.07.052.
- Opel DJ, Mangione-Smith R, Taylor JA, Korfiatis C, Wiese C, Catz S, Martin DP. Development of a survey to identify vaccine-hesitant parents: the parent attitudes about childhood vaccines survey. *Hum Vaccin.* 2011;7(4):419–25. doi:10.4161/hv.7.4.14120.
- Opel DJ, Taylor JA, Mangione-Smith R, Solomon C, Zhao C, Catz S, Martin D. Validity and reliability of a survey to identify vaccine-hesitant parents. *Vaccine.* 2011;29(38):6598–605. doi:10.1016/j.vaccine.2011.06.115.
- Williams SE, Rothman RL, Offit PA, Schaffner W, Sullivan M, Edwards KM. A randomized trial to increase acceptance of childhood vaccines by vaccine-hesitant parents: a pilot study. *Acad Pediatr.* 2013;13:475–80. doi:10.1016/j.acap.2013.03.011.
- O'Leary ST, Brewer SE, Pyrzanoski J, Barnard J, Seveck C, Furniss A, Dempsey AF. Timing of information-seeking about infant vaccines. *J Pediatr.* 2018;203:125–30. e1. doi:10.1016/j.jpeds.2018.07.046.
- Henrikson NB, Opel DJ, Grothaus L, Nelson J, Scrol A, Dunn J, Faubion T, Roberts M, Marcuse EK, Grossman DC, et al. Physician communication training and parental vaccine hesitancy: a randomized trial. *Pediatrics.* 2015;136(1):70–79. doi:10.1542/peds.2014-3199.
- Napolitano F, D'Alessandro A, Angelillo IF. Investigating Italian parents' vaccine hesitancy: a cross-sectional survey. *Hum Vaccin Immunother.* 2018;14:1558–65. doi:10.1080/21645515.2018.1463943.
- Cunningham RM, Kerr GB, Orobio J, Munoz FM, Correa A, Villafranco N, Monterrey AC, Opel DJ, Boom JA. Development of a Spanish version of the parent attitudes about childhood vaccines survey. *Hum Vaccin Immunother.* 2019;15:1106–10. doi:10.1080/21645515.2019.1578599.
- Charan J, Biswas T. How to calculate sample size for different study designs in medical research? *Indian J Psychol Med.* 2013;35:121–26. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3775042/>.
- People's Government of Guangdong Province. Guangdong immunization program has achieved remarkable results, the vaccination rate reached more than 95%; 2007 [accessed 2021 July 22]. http://www.gd.gov.cn/gdgk/gdyw/200704/t20070425_15518.htm.
- 王晨. 全国人民代表大会常务委员会执法检查组关于检查《中华人民共和国传染病防治法》实施情况的报告——2018年8月28日在第十三届全国人民代表大会常务委员会第五次会议上. *中华人民共和国全国人民代表大会常务委员会公报.* 2018:665–73. doi:CNKI:SUN:ZGRE.0.2018-17-005.
- Dubé E, Gagnon D, Nickels E, Jeram S, Schuster M. Mapping vaccine hesitancy—Country-specific characteristics of a global phenomenon. *Vaccine.* 2014;32:6649–54. doi:10.1016/j.vaccine.2014.09.039.
- National Health Commission of the People's Republic of China, Propaganda Department. Achievements in immunization planning-No. 5 of the materials distributed by the regular press conference of the National Health Commission on 25 April, 2019; 2019 [accessed 2021 Feb 5]. <http://www.nhc.gov.cn/xcs/s7847/201904/c3e7050d4e5c4021ac1cb1681c702a67.shtml>.

28. Alsubaie SS, Gosadi IM, Alsaadi BM, Albacker NB, Bawazir MA, Bin-Daud N, Almanie WB, Alsaadi MM, Alzamil FA. Vaccine hesitancy among Saudi parents and its determinants. *Saudi Med J*. 2019;40(12):1242–50. doi:10.15537/smj.2019.12.24653.
29. Larson H, de Figueiredo A, Karafllakis E, Rawal M. State of vaccine confidence in the European Union in 2018. *Eur J Public Health*. 2019;29:ckz185.374. doi:10.1093/eurpub/ckz185.374.
30. Yufika A, Wagner AL, Nawawi Y, Wahyuniati N, Anwar S, Yusri F, Haryanti N, Wijayanti NP, Rizal R, Fitriani D, et al. Parents' hesitancy towards vaccination in Indonesia: a cross-sectional study in Indonesia. *Vaccine*. 2020;38(11):2592–99. doi:10.1016/j.vaccine.2020.01.072.
31. Abdullahi MF, Stewart Williams J, Sahlèn K-G, Bile K, Kinsman J. Factors contributing to the uptake of childhood vaccination in Galkayo District, Puntland, Somalia. *Glob Health Action*. 2020;13:1803543. doi:10.1080/16549716.2020.1803543.
32. 孙焯祥, 徐来荣, 李珊燕, 马寅, 林鸿波, 俞琳, et al. 疫苗冷链温度实时监管系统应用效果评价. *中国疫苗和免疫*. 2015. doi:CNKI:SUN:ZGJM.0.2015-06-018.
33. 刘晓欣, 林瑞超, 杨春宁, 余世琪, 张博. 中国疫苗安全监管现状, 问题及对策. *中国公共卫生管理*. 2017;33:192–95. doi:CNKI:SUN:GGWS.0.2017-02-014.
34. 孙丽, 丛艳丽, 王亚菲, 张振国, 张富斌, 崔世恒, et al. 河北省预防接种异常反应商业保险补偿模式的公众态度分析. *中国疫苗和免疫*. 2017;23:278–81. doi:CNKI:SUN:ZGJM.0.2017-03-009.
35. National Health Commission of the People's Republic of China, Disease Prevention and Control Bureau. Notice on the issuance of inspection methods for children's nursery and school vaccination certificates; 2021 [accessed 2021 Mar 1]. <http://www.nhc.gov.cn/jkj/s7924/202102/761a22a8b4294329863a213aff4bd43.shtml>.
36. Trushitkumar BP, Pathak R, Singh R, Alves V, Mahesh N, Chaluvaraj T, Chandramouli R, Varghese B. Assessment of parents' knowledge, attitude and practice about child vaccination in rural areas. *J Pharm Res*. 2017;16:229–36. doi:10.18579/JPCRKC%2F2017%2F16%2F3%2F118764.
37. Zimmerman RK, Wolfe RM, Fox DE, Fox JR, Nowalk MP, Troy JA, Sharp LK. Vaccine criticism on the world wide web. *J Med Internet Res*. 2005;7(2):e17. doi:10.2196/jmir.7.2.e17.
38. Napolitano F, Napolitano P, Angelillo IF. Seasonal influenza vaccination in pregnant women: knowledge, attitudes, and behaviors in Italy. *BMC Infect Dis*. 2017;17:1–7. doi:10.1186/s12879-016-2138-2.
39. Arriola CS, Vasconez N, Bresee J, Roper AM. Knowledge, attitudes and practices about influenza vaccination among pregnant women and healthcare providers serving pregnant women in Managua, Nicaragua. *Vaccine*. 2018;36:3686–93. doi:10.1016/j.vaccine.2018.05.013.
40. Chung Y, Schamel J, Fisher A, Frew PM. Influences on immunization decision-making among US parents of young children. *Matern Child Health J*. 2017;21:2178–87. doi:10.1007/s10995-017-2336-6.