

Preplanned Studies

Factors Associated with PCV13 Vaccine Hesitancy in Parents under an Innovative Immunization Strategy: a Cross-Sectional Study — Weifang City, Shandong Province, China, 2021

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Summary

What is already known on this topic?

Pneumococcal diseases (PDs) are serious threats to child health. Although vaccination is one of the most effective ways to prevent these diseases, the pneumococcal vaccination coverage rate is still relatively low in China.

What is added by this report?

This study investigated the factors associated with 13-valent pneumococcal conjugate vaccine (PCV13) vaccine hesitancy in parents under an innovative immunization strategy. This study found that 29.7% of the participants hesitated to vaccinate their children against PCV13 and the main reasons for vaccine hesitancy were individual and group influences.

What are the implications for public health practice?

This study can provide scientific evidence for further improving children's PCV13 vaccination rate and improving the prevention and control strategy for PDs.

Pneumococcal diseases (PDs) have become a serious public health problem worldwide. According to the latest research data released by the World Health Organization (WHO) in 2018, about 294,000 children under the age of 5 died from *Streptococcus pneumoniae* (Spn) infection globally (1). WHO asserts that pneumococcal vaccination is the most cost-effective way to prevent pneumococcal diseases. The infrequent occurrence of adverse vaccine side effects, lack of understanding, and distribution of misinformation, however, have led to a decline in the public's trust in vaccines in recent years, an increase in parents' vaccine hesitancy, and even more vaccine hesitancy in non-national immunization programs (2). In China, the 13-valent pneumococcal conjugate vaccine (PCV13) was officially launched in 2020. Until now, no study has focused on PCV13 vaccine

hesitancy in China. In 2021, the Government of Weifang City, Shandong Province, launched the first program in China to vaccinate registered children from 6 months to 2 years old with a free dose of domestic PCV13. Based on this innovative immunization strategy, we analyzed PCV13 vaccine hesitancy and influential factors for parents when making vaccine decisions for their children. The study found that 29.7% of participants were hesitant to vaccinate their children against PCV13. The most important reason for vaccine hesitancy is lack of knowledge about the vaccine.

Based on data from the children's vaccination information management system in Weifang City, Shandong Province, this study calculated the birth population and the children being vaccinated in each vaccination clinic in 2021. By systematic sampling method, this study selected a total of 57 vaccination clinics from 12 counties as survey sites. All participants were surveyed after their informed consent. The sample size required for this survey was estimated according to the cross-sectional survey formula with an absolute tolerance error of $d=3.0\%$. Considering that participants might reject the survey because their children were too young, the rejection rate was estimated to be 10.0%. Therefore, the final sample size was estimated to be 1,174. The specific calculation formula and the inclusion and exclusion criteria of participants are outlined in a previously published article (3).

After literature screening, research group discussions, and expert consultation, we designed the questionnaire. Pre-investigation was conducted prior to a formal investigation and all investigators were trained uniformly to the same standards. The investigators used the Pad that had been imported into the questionnaire to conduct the investigation. The questionnaire included six main aspects: sociodemographic characteristics of participants, participants' perceptions of vaccine knowledge,

knowledge of pneumonia and pneumococcal vaccine, willingness to receive pneumococcal vaccine, willingness to pay for pneumococcal vaccine, visiting behavior of children with pneumonia. It is important to note that if participants had multiple children, the study was aimed at the youngest child in the family.

SPSS (version 22.0; SPSS Inc., Chicago, IL, USA) was used to complete all data sorting, and classification variables were expressed in frequency (percentage). Chi-square test was used for comparison. Binary logistic regression model was used to analyze the related factors of pneumococcal vaccine hesitation. All statistical methods were adopted by the two-tailed test, and $P < 0.05$ was considered statistically significant. To analyze the reasons for vaccine hesitancy, the WHO vaccine hesitancy determinants matrix was used for judgment (4), which mainly included three categories: contextual, individual and group, and vaccine/vaccination-specific influences.

A total of 1,195 questionnaires were collected in this survey, of which 1,110 were valid, with an effective questionnaire rate of 93.0%. Among the 1,110 participants, more than half were 31 to 40 years old (52.1%), 35.4% were fathers, 61.0% were mothers, and 3.5% were grandparents. Among the participants, 780 (70.2%) were willing to vaccinate their children against PCV13, 121 (10.8%) participants were not willing to vaccinate their children against PCV13, and 209 (18.8%) participants were not sure whether to vaccinate children against PCV13. Therefore, 70.2% of participants were identified as PCV13 vaccine

recipients and 29.7% were identified as vaccine hesitators.

A total of 308 parents were unwilling to vaccinate their children against PCV13 due to individual and group influences, which accounted for the largest portion (Figure 1). As presented in Table 1, among the vaccine hesitators, 249 people did not know about the vaccine (A1), 92 people were uncertain about the vaccine's effects (C2) and 84 people were uncertain about the safety of the vaccine (C3).

As presented in Table 2, PCV13 vaccine hesitancy among participants who thought vaccination was important was significantly lower than among those who thought vaccination was not important (28.5% vs. 64.1%, $P < 0.001$). PCV13 vaccine hesitancy among participants who were willing to pay for the PCV13 vaccine also was significantly lower than among those who were not willing to pay (19.6% vs. 55.6%, $P < 0.001$). Participants who could clearly distinguish between the PCV13 vaccine and the COVID-19 vaccine were less hesitant toward the PCV13 vaccine (25.2% vs. 39.9%, $P < 0.001$).

The statistically significant variables in Table 2 were incorporated into the logistic multi-factor regression model for further analysis. As presented in Table 3, the participants who were not willing to pay for the PCV13 vaccine for their children [$OR = 3.85$, 95% confidence interval (CI): 2.81–5.25], who thought vaccination was not important ($OR = 3.54$, 95% CI: 1.66–7.56), and who were not willing to pay for all self-funded vaccines ($OR = 1.98$, 95% CI: 1.35–2.93)

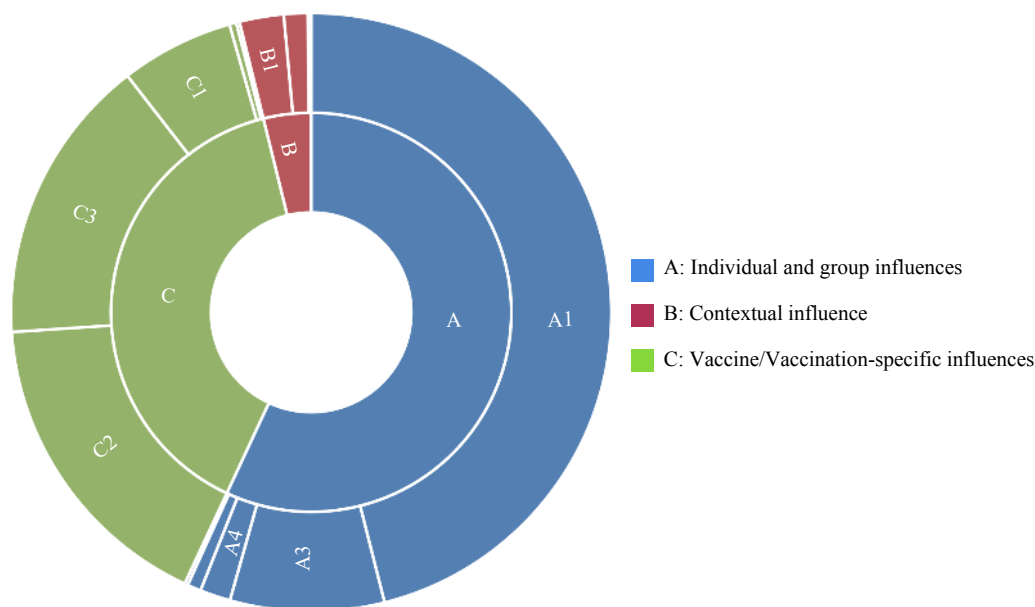


FIGURE 1. Reasons of hesitancy in 13-valent pneumococcal conjugate vaccines in Weifang, Shandong Province, China.

TABLE 1. Distribution of reasons for 13-valent pneumococcal conjugate vaccine hesitancy among study participants in Weifang City, Shandong Province, China.

Reason	No. of participants	Proportion (%)
A: Individual and group influences		
A1: I don't know much about 13-valent pneumococcal conjugate vaccine	249	75.5
A2: I don't know where to get 13-valent pneumococcal conjugate vaccine	1	0.3
A3: The children are healthy and do not need the 13-valent pneumococcal conjugate vaccine	45	13.6
A4: Children with allergies or contraindications cannot receive the 13-valent pneumococcal conjugate vaccine	9	2.7
A5: Children were considered too young to receive the 13-valent pneumococcal conjugate vaccine	4	1.2
B: Contextual influences		
B1: Participants' work schedule or traveling distance from home to vaccination clinic prevent them from having their children receive the 13-valent pneumococcal conjugate vaccine	13	3.9
B2: Whether children should receive the 13-valent pneumococcal conjugate vaccine should be discussed with family members	7	2.1
B3: Participants are not willing to pay the vaccination fee on their own	1	0.3
C: Vaccine/vaccination-specific influences		
C1: The 13-valent pneumococcal conjugate vaccine is expensive	33	10.0
C2: The efficacy of 13-valent pneumococcal conjugate vaccine is uncertain	92	27.9
C3: The safety of 13-valent pneumococcal conjugate vaccine is uncertain	84	25.5
C4: The 13-valent pneumococcal conjugate vaccine is not included in the immunization program	2	0.6
C5: The 13-valent pneumococcal conjugate vaccine is not mandatory	1	0.3

Note: The study used multiple-choice questions to analyze the reasons for vaccine hesitancy, so the sum of these three categories was not 100%.

TABLE 2. Characteristics of 1,110 participants in the 13-valent pneumococcal conjugate vaccine hesitancy study in Weifang City, Shandong Province, China.

Characteristic	N (%)	PCV13 vaccine hesitancy				χ^2	P
		Yes		No			
		N	%	N	%		
Relationship between participant and child							
Mother	677 (60.9)	198	29.2	479	70.8	1.499	0.473
Father	394 (35.4)	117	29.7	277	70.3		
Grandparent	39 (3.5)	15	38.5	24	61.5		
Participants' medical education background							
Yes	142 (12.7)	38	26.8	104	73.2	0.687	0.407
No	968 (87.2)	292	30.2	676	69.8		
Participants' age (years)							
≤30	454 (40.9)	115	25.3	339	74.7	7.655	0.022
31–40	579 (52.1)	187	32.3	392	67.7		
≥41	77 (6.9)	28	36.4	49	63.6		
Participants' education level							
Elementary school and below	23 (2.0)	12	52.2	11	47.8	18.619	0.001
Junior high school	256 (23.0)	92	35.9	164	64.1		
High school/technical school/technical secondary school	271 (24.4)	88	32.5	183	67.5		
Junior college/bachelor's degree	529 (47.6)	132	25.0	397	75.0		
Graduate degree	31 (2.7)	6	19.4	25	80.6		

TABLE 2. (Continued)

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Characteristic	N (%)	PCV13 vaccine hesitancy				χ^2	P
		Yes		No			
		N	%	N	%		
Children's gender							
Male	585 (52.7)	176	30.1	409	69.9	0.075	0.793
Female	525 (47.2)	154	29.3	371	70.7		
Type of family							
Single child family	472 (42.5)	121	25.6	351	74.4	6.589	0.012
Non-single child family	638 (57.4)	209	32.8	429	67.2		
Average annual family income (CNY)							
<50,000	207 (18.6)	81	39.1	126	60.9	14.431	0.001
50,000–150,000 (not contained)	669 (60.2)	196	29.3	473	70.7		
≥150,000	234 (21.0)	53	22.6	181	77.4		
Number of family members							
≤3	232 (20.9)	56	24.1	176	75.9	4.390	0.036
≥4	878 (79.0)	274	31.2	604	68.8		
Religious belief							
Conflict	6 (0.5)	1	16.7	5	83.3	0.493	0.676
No conflict	1,104 (99.4)	329	29.8	775	70.2		
High importance of vaccination							
Yes	1,071 (96.4)	305	28.5	766	71.5	22.859	<0.001
No	39 (3.5)	25	64.1	14	35.9		
High safety of domestic vaccines							
Yes	1,010 (90.9)	298	29.5	712	70.5	0.271	0.647
No	100 (9.0)	32	32.0	68	68.0		
High safety of imported vaccines							
Yes	559 (50.3)	138	24.7	421	75.3	13.708	<0.001
No	551 (49.6)	192	34.8	359	65.2		
High efficacy of domestic vaccines							
Yes	1,005 (90.5)	289	28.8	716	71.2	4.820	0.028
No	105 (9.4)	41	39.0	64	61.0		
High efficacy of imported vaccines							
Yes	660 (59.4)	163	24.7	497	75.3	19.738	<0.001
No	450 (40.5)	167	37.1	283	62.9		
Trust in vaccine-related information provided by doctors or nurses							
Yes	1,048 (94.4)	301	28.7	747	71.3	9.132	0.003
No	62 (5.5)	29	46.8	33	53.2		
Willingness to take children for self-funded vaccinations							
Yes	940 (84.6)	234	24.9	706	75.1	68.712	<0.001
No	170 (15.3)	96	56.5	74	43.5		
Attitudes to the degree of harm to children's health caused by pneumonia							
Serious	1,054 (94.9)	300	28.5	754	71.5	19.041	<0.001
General	44 (3.9)	26	59.1	18	40.9		
Light	12 (1.0)	4	33.3	8	66.7		

TABLE 2. (Continued)

Characteristic	N (%)	PCV13 vaccine hesitancy				χ^2	P
		Yes		No			
		N	%	N	%		
Risk of pneumonia in children							
Serious	601 (54.1)	138	23.0	463	77.0	33.350	<0.001
General	343 (30.8)	119	34.7	224	65.3		
Light	166(14.9)	73	44.0	93	56.0		
Whether the pneumococcal vaccine is COVID-19 vaccine							
Yes or unknown	343 (30.9)	137	39.9	206	60.1	24.779	<0.001
No	767 (69.0)	193	25.2	574	74.8		
Willingness to vaccinate your child with PCV13 if you pay your own expenses							
Yes	799 (71.9)	157	19.6	642	80.4	138.702	<0.001
No	311 (28.0)	173	55.6	138	44.4		
Whether your children had pneumonia before							
Yes	26 (2.3)	6	23.1	20	76.9	0.560	0.454
No	1,084 (97.6)	324	29.9	760	70.1		

Note: As defined by the World Health Organization, a question will be used in the study to assess participants' hesitation about pneumococcal vaccine: "Would you be willing to vaccinate pneumococcal vaccine for your child?" The options are Yes, No, and Not Sure. If participants chose either of the latter two options, they were considered to have vaccine hesitancy.

Abbreviation: PCV13=13-valent pneumococcal conjugate vaccine; CNY=Chinese Yuan.

TABLE 3. Logistic regression analysis of children pneumococcal vaccine hesitancy in Weifang City, Shandong Province, China.

Independent variables	Category	β	S_x	Wald χ^2	P	OR (95% CI)
High importance of vaccination	Yes	–				
	No	1.265	0.387	10.692	0.001	3.542 (1.660–7.558)
High efficacy of imported vaccines	Yes	–				
	No	0.346	0.149	5.403	0.020	1.413 (1.056–1.892)
Willingness to take children for self-funded vaccinations	Yes	–				
	No	0.685	0.198	11.934	0.001	1.984 (1.345–2.927)
Risk of pneumonia in children	Serious	–				
	General	–0.218	0.216	1.025	0.311	0.804 (0.527–1.227)
	Light	–0.679	0.205	10.917	0.001	0.507 (0.339–0.759)
Whether the pneumococcal vaccine is COVID-19 vaccine	Yes or Unknown	–				
	No	–0.809	0.154	27.732	<0.001	0.445 (0.329–0.602)
Willingness to vaccinate your child with PCV13 if you pay your own expenses	Yes	–				
	No	1.346	0.159	71.795	<0.001	3.842 (2.814–5.245)

“–” means reference category.

Abbreviation: OR=odds ratio; CI=confidence interval.

were more likely to be vaccine hesitant.

DISCUSSION

This study found that 29.7% of participants hesitated to vaccinate their children against PCV13,

which was lower than the vaccine hesitancy rates found in previous studies investigating varicella vaccine (51.2%), enterovirus 71 inactivated vaccine (33.8%), and HPV vaccine (37.2%) (5–7). This finding may be related to effective advertising of the innovative vaccination strategy of Weifang City, Shandong Province. The results showed that the main channels

for participants to acquire information about PCV13 were community or hospital advocacy (45.2%), followed by the internet (36.8%), suggesting that participants may have a relatively high understanding of the vaccine due to these advertisements, thus leading to a relatively low degree of vaccine hesitation.

This study shows that the older the participants are, the more likely they are to be hesitant about vaccines, which is contrary to the results of a Swiss study (8). This may be related to China's national conditions. The results also showed that participants with a lower cultural degree are more prone to be vaccine hesitant, which was consistent with the research results of Rosso (9) but was contrary to the research results of Van (10). This may be explained by China's overall level of education. Participants with lower levels of education have fewer opportunities to learn about pneumococcal vaccines and related topics, which makes them more likely to become vaccine hesitant.

The survey also showed that participants were relatively hesitant to pay for the full pneumococcal vaccine fee by themselves. This can be explained by the fact that PCV13 is still a non-immunization program vaccine in China. Previous studies have also shown that non-programmed vaccines experience higher rates of hesitancy than programmed vaccines (11). Logistic regression showed that total self-expenditure was the risk factor for participants' PCV13 vaccine hesitation, reflecting the importance of vaccine price in their decisions to vaccinate.

Globally, 2 to 3 million deaths from infectious diseases can be prevented by vaccination every year. Vaccination is the most cost-effective method for prevention and treatment of infectious diseases. In order to further reduce the burden of pneumococcal diseases in China and similar countries, it is suggested to take the following measures to improve the PCV13 vaccination rate in children:

Carry out multi-channel publicity and vaccine promotion campaigns to improve parental awareness and communicate the importance of PCV13 for children. This study showed that the most important reason for participants' vaccine hesitancy was lack of knowledge about PCV13. Gilkey stated that medical workers can directly influence the vaccination information of children and parents, which can promote vaccination to some extent (12). Therefore, publicity channels can focus on medical workers, emphasize the standard training of medical workers, and provide information about the safety and effectiveness of PCV13 to vaccination groups.

Secondly, internet platforms can be used to promote PCV13 and PCV13-related knowledge. Fundamental working units can also organize health education activities to make parents aware of the importance of vaccination, so as to further improve parents' awareness of PCV13 and reduce vaccine hesitancy.

Standardize and optimize vaccine management regulations to enhance public confidence regarding the quality and safety of PCV13. In recent years, there have been many incidents of vaccine hesitancy. For example, parents' trust in vaccines declined significantly after the illegal management of vaccines in Jinan in 2016 (13). Relevant departments should strictly obey the regulations of the Vaccine Administration Law of the People's Republic of China, strictly supervise the production of vaccines in enterprises, and strengthen the management of all circulation links. It is suggested that government organizations will play an important role in PCV13 vaccination mobilization.

Build the appropriate financial support mechanisms in China to incentivize PCV13 vaccinations effectively and at scale. At present, the price of PCV13 in the Chinese vaccine market is relatively high, which leads to higher vaccine hesitancy (14). Therefore, local governments should provide appropriate financial support to reduce the burden of PCV13 vaccination costs for parents. Secondly, it is possible to include PCV13 vaccination costs in the resident medical insurance system and explore different payment modes to promote non-immunization program vaccines. The government can also get the best price for its citizens through centralized bidding processes. PDs have brought a heavy burden of disease to China. In order to solve this problem to the greatest extent, it is suggested to include PCV13 into the national immunization program as soon as possible.

Earlier in 2022, *China CDC Weekly* published an article which analyzed the factors associated with PCV13 vaccine willingness in parents (3). Although vaccine willingness and vaccine hesitancy are opposite concepts, they display similar factors. This study further discussed the reasons for participants' concerns about vaccine safety suggested similar interventions to the previously published study. This study also discussed the appropriate financial support mechanisms for society. These two articles are synergistic and complementary.

This study is subject to some limitations. Firstly, this study is based on a cross-sectional survey, so it may not be representative of all of China. Secondly, this study

only selected participants from Weifang City, so it needs to be cautious when extrapolating its conclusions to broader contexts. Given that PCV13 is a newly marketed vaccine in China, more epidemiological studies investigating the surveillance of pneumococcal disease risks among pediatric, adult, and elderly populations are required to evaluate the immunization efficacy of PCV13. In addition, safety monitoring of this vaccine is recommended.

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