

Preplanned Studies

Willingness of Caregivers to Have Their Children Vaccinated with Pneumococcal Vaccines in the Context of an Innovative Immunization Strategy — Weifang City, Shandong Province, 2021

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Summary

What is already known about this topic?

Pneumococcal diseases (PDs) pose a serious health threat to children. Vaccination is the most cost-effective intervention to prevent PDs, but pneumococcal vaccines coverage among children is low in China.

What is added by this report?

This study investigated the willingness of children's caregivers to have their children vaccinated with pneumococcal vaccines under an innovative policy to offer 1-dose of the 13-valent pneumococcal conjugate vaccines at no charge to families. The research found that 70.51% of caregivers were willing to have their infants receive pneumococcal vaccines and that reducing the cost of vaccines may increase caregivers' willingness.

What are the implications for public health practice?

This is the first evaluation in China of acceptance of pneumococcal vaccines among children under a 1-dose, cost-free policy. The results provide scientific evidence for updating local and national pneumococcal immunization strategies to promote the use of the pneumococcal vaccine.

Pneumococcal diseases (PDs) pose a serious health threat to children (1). Vaccination is the most cost-effective intervention to prevent PDs (2). However, vaccination coverage of pneumococcal vaccines, which has not been introduced into the National Immunization Program (NIP) in China, is rather low among Chinese children (3). The cost of vaccines and the opinions of caregivers toward non-NIP vaccines are important factors that influence vaccination coverage (4). Exploring efficient strategies for increasing coverage of non-NIP vaccines is a crucial initiative for

public health.

To improve pneumococcal vaccination coverage and reduce the burden of PDs, starting in June 2021, the government of Weifang City (directly under the jurisdiction of Shandong Province) implemented a policy of providing 1-dose of 13-valent pneumococcal conjugate vaccines (PCV13) at no charge to families for children aged 6 months to 2 years in registered households. Although the free dose does not necessarily have to be the first dose of PCV13, due to the limited financial capacity of the government, the cost of the remaining doses in the series must be borne by caregivers as voluntary vaccination. The Weifang program is the first in the mainland of China for PCV13. Our study investigated caregivers' willingness to vaccinate their children with pneumococcal vaccines under this one-free-dose policy and explored factors associated with acceptance.

There are 3 PCV13 manufacturers with market authorization in China, 2 of which are domestic. PCV13 is normally given in a multi-dose series in a schedule that varies by the child's age at the first dose. For example, 4 doses of PCV13 are recommended for full protection when starting at 3 months of age or younger, but only 1 dose is recommended when starting at 2 years of age or older. To avoid the influence of different immunization schedules for PCV13, we restricted the study population to children eligible for the full four-dose series of PCV13. Because our target population was infants younger than 3 months of age, we recruited caregivers as respondents, excluding those who were unable to determine the child's vaccinations.

The target sample size was determined by the formula, $N = \frac{Z_{1-\alpha/2}^2 P(1-p)}{d^2}$. A previous study showed that the caregivers' willingness to vaccinate children with pneumococcal vaccines was between 37.9% and 89.1% in China (5), which is a large range. We

conservatively assumed $P=50\%$, the allowable error at 3%, and $\alpha=0.05$. To allow for attrition, we increased the sample size by 10%, yielding a target sample size of 1,174.

The research team designed the questionnaires after discussing with project members and experts in related fields, and revised them after the pilot investigation. We obtained data on demographics, perceptions of the safety and effectiveness of vaccines, perceptions of the risk and seriousness of pneumonia, whether health workers (HWs) recommended pneumococcal vaccines, and whether caregivers trusted HWs. The questionnaires were administered by trained interviewers using portable Android devices to reduce input errors and missing values. We selected at random 30% of completed questionnaires for review each survey day.

Face-to-face and telephone interviews were conducted. During one working day in a clinic, caregivers who met the inclusion criteria were invited to participate in the interview. If the day's sample size target was not finished, we conducted a telephone survey of the children's parents with consent. Due to the impact of COVID-19, some vaccination clinics were unable to enroll the target sample size. To reach the overall target sample size, we increased survey sites based on the geographical location of each vaccination clinic and the number of children it served.

The study analyzed all data using SAS software (version 9.4, SAS Institute, Inc. Cary, NC, USA). Counts were expressed as n (%), and Chi-square tests and the Wilcoxon rank-sum test were used for comparisons. A multivariable logistic regression model was used to identify factors related to the caregivers' willingness. We chose independent variables using stepwise regression. Statistical tests were two-tailed; $P<0.05$ was considered significant.

Between July 17 and August 3, 2021, we conducted a survey in 57 vaccination clinics across 12 counties/districts. During this time, 1,195 caregivers were surveyed; 90.79% (1,085/1,195) of the questionnaires were completed and considered valid. Among the valid questionnaires, 72.35% (785/1,085) were face-to-face and the rest were via telephone. We conducted Chi-square analyses comparing caregivers' willingness and demographics by whether the survey was face-to-face or over telephone, and found no statistically significant differences (Supplementary Materials, available in <https://weekly.chinacdc.cn/>).

Mothers, fathers, and grandparents were 62.58% (679/1,085), 36.31% (394/1,085), and 1.11%

(12/1,085) of the participants. The average age of the parents was 31.26 ± 4.88 years old. Among all participants, 70.51% (765/1,085) were willing to have their infants receive pneumococcal vaccines. Factors associated with greater willingness included perception of the importance of vaccination, having an HWs recommendation for vaccination, trust in the vaccine information provided by HWs, awareness of the PCV13 policy in Weifang, and other significant factors (Table 1).

According to Table 2, caregivers who believed that vaccination was important (OR=3.96, 95% CI: 1.92–8.20), who received vaccination recommendations from HWs (OR=2.09, 95% CI: 1.11–3.93), and who trusted vaccine information provided by HWs (OR=1.92, 95% CI: 1.08–3.41) were more likely to have their infants vaccinated.

Table 3 shows factors related to hesitancy or refusal to accept pneumococcal vaccines. The top three factors were being unfamiliar with pneumococcal vaccines, lacking confidence in the effectiveness of pneumococcal vaccines, and worrying about adverse reactions.

DISCUSSION

This study found that 70.51% of caregivers were willing for their children to get pneumococcal vaccines under the one-free-dose policy in Weifang. The acceptance rate for pneumococcal vaccines in our study was lower than that found in an online survey conducted in 2020 and was higher than that found in field surveys in Shanghai and Guangzhou (5).

We speculated that the relatively higher willingness in Weifang may be related to the fact that caregivers have gained much in-depth health knowledge through various media during the COVID-19 pandemic. Additionally, immunization strategies may change vaccination willingness. Vaccine support from Gavi and other nonprofit organizations has significantly increased the coverage of pneumococcal vaccines in recipient countries (6). We also found that the willingness to accept pneumococcal vaccines was associated with the awareness of the one-free-dose policy in Weifang. The pneumococcal vaccination willingness among caregivers who knew about the one-free-dose immunization policy was 1.70 times higher than those who did not know.

Caregivers' perceptions of the risk of pneumonia and the safety and effectiveness of vaccines are important factors related to pneumococcal vaccination willingness

TABLE 1. Characteristics and pneumococcal vaccination willingness among caregivers in Weifang, Shandong Province, China (n=1,085).

Characteristics	Category	Total (%)	Willing (%)	Unwilling (%)	P
Child gender	Male	569 (52.44)	400 (70.30)	169 (29.70)	0.88
	Female	516 (47.56)	365 (70.74)	151 (29.26)	
Family type	Single child family	455 (41.94)	341 (74.95)	114 (25.05)	<0.01
	Multiple child family	630 (58.06)	424 (67.30)	206 (32.70)	
Average annual household income (CNY)	<50,000	194 (17.88)	121 (62.37)	73 (37.63)	<0.01
	50,000–150,000	660 (60.83)	466 (70.61)	194 (29.39)	
	≥150,000	231 (21.29)	178 (77.06)	53 (22.94)	
Relationship between participant and child	Mother	679 (62.58)	480 (70.69)	199 (29.31)	0.95
	Father	394 (36.31)	277 (70.30)	117 (29.70)	
	Grandparent	12 (1.11)	8 (66.67)	4 (33.33)	
Education level	Elementary school or below	15 (1.38)	8 (53.33)	7 (46.67)	<0.01
	Junior high school	242 (22.30)	155 (64.05)	87 (35.95)	
	High school/technical school/vocational school	269 (24.79)	181 (67.29)	88 (32.71)	
	Junior college/bachelor degree	528 (48.66)	396 (75.00)	132 (25.00)	
	Graduate degree	31 (2.87)	25 (80.65)	6 (19.35)	
Participants' medical education background*	Yes	139 (12.81)	103 (74.10)	36 (25.90)	0.32
	No	946 (87.19)	662 (69.98)	284 (30.02)	
Whether the pneumococcal vaccine is the COVID-19 vaccine	Yes or unknown	333 (30.69)	202 (60.66)	131 (39.34)	<0.01
	No	752 (69.31)	563 (74.87)	189 (25.13)	
Perceived importance of vaccination	Yes	1046 (96.41)	751 (71.80)	295 (28.20)	<0.01
	No	39 (3.59)	14 (35.90)	25 (64.10)	
Perceived safety of vaccination	Yes	990 (91.24)	700 (70.71)	290 (29.29)	0.64
	No	95 (8.76)	65 (68.42)	30 (31.58)	
Perceived effectiveness of vaccination	Yes	984 (90.69)	703 (71.44)	281 (28.56)	<0.05
	No	101 (9.31)	62 (61.39)	39 (38.61)	
Perception that pneumonia is serious in children	Serious	1032 (95.12)	740 (71.71)	292 (28.29)	<0.01
	General	42 (3.87)	17 (40.48)	25 (59.52)	
	Light	11 (1.01)	8 (72.73)	3 (27.27)	
Perception that children can suffer from pneumonia	High	597 (55.02)	459 (76.88)	138 (23.12)	<0.01
	General	330 (30.41)	215 (65.15)	115 (34.85)	
	Low	158 (14.57)	91 (57.59)	67 (42.41)	
Awareness of Weifang's one-free-dose policy for PCV13	Yes	203 (18.71)	174 (85.71)	29 (14.29)	<0.01
	No	882 (81.29)	591 (67.01)	291 (32.99)	
HWs recommended pneumococcal vaccines for children	Yes	153 (14.10)	136 (88.89)	17 (11.11)	<0.01
	No	932 (85.90)	629 (67.49)	303 (32.51)	
Trust in the vaccine information provided by HWs	Yes	1024 (94.38)	733 (71.58)	291 (28.42)	<0.01
	No	61 (5.62)	32 (52.46)	29 (47.54)	
Child's siblings received pneumococcal vaccine	Yes	128 (20.32)	121 (94.53)	7 (5.47)	<0.01
	No	502 (79.68)	303 (60.36)	199 (39.64)	

* Medical education background refers to people with medicine-related training, such as medical workers, medical students, and teachers in medical schools.

Abbreviations: PCV13=13-valent pneumococcal conjugate vaccine; HWs=Health workers.

TABLE 2. Logistic regression analyses of caregivers' willingness to accept pneumococcal vaccines for their children, Weifang, Shandong Province, China.

Independent variables	Category	P	OR (95% CI)
Perceived importance of vaccination	No	–	Ref
	Yes	<0.01	3.96 (1.92–8.20)
HWs recommended pneumococcal vaccines for children	No	–	Ref
	Yes	<0.05	2.09 (1.11–3.93)
Trust in the vaccine information provided by HWs	No	–	Ref
	Yes	<0.05	1.92 (1.08–3.41)
Awareness of Weifang's one-free-dose policy for PCV13	No	–	Ref
	Yes	<0.05	1.70 (1.01–2.87)
Whether the pneumococcal vaccine is the COVID-19 vaccine	Yes or unknown	–	Ref
	No	<0.01	1.67 (1.23–2.25)
Average annual household income (CNY)	<50,000	–	Ref
	50,000–150,000	0.14	1.31 (0.92–1.87)
	≥150,000	<0.01	1.85 (1.18–2.90)
Perception that children can suffer from pneumonia	High	–	Ref
	General	<0.01	0.60 (0.44–0.83)
	Low	<0.01	0.43 (0.29–0.63)
Perception that pneumonia is serious in children	Serious	–	Ref
	General	<0.01	0.38 (0.19–0.77)
	Light	0.96	1.04 (0.25–4.27)

Note: Thirteen variables were included in the logistic model: type of family, average household income per year, education level of participants, participants' medical education background, whether the pneumococcal vaccine is the COVID-19 vaccine, perceived importance of vaccination, perception that pneumonia is serious in children, perception that children can suffer from pneumonia, awareness of Weifang's one-free-dose policy for PCV13, HWs recommended pneumococcal vaccines for children, trust in the vaccine information provided by HWs, perceived safety of vaccination, and perceived effectiveness of vaccination. Eight variables were statistically significant. Abbreviations: PCV13=13-valent pneumococcal conjugate vaccine; HWs=Health workers.

TABLE 3. Reasons for hesitation or refusal to accept pneumococcal vaccines (n=320).

Reasons	Total	Proportion (%)
Unfamiliar with pneumococcal vaccines	244	76.25
Lack of confidence in the effectiveness of the PCV13	91	28.44
Worried about adverse reactions from vaccines	85	26.56
My child is healthy, and he/she does not need the vaccines	44	13.75
Pneumococcal vaccines are expensive	32	10.00
Too busy to go to the clinic or live too far from the clinic	13	4.06
Children have allergies or contraindications to vaccines	7	2.19
Do not know where to get the PCV13	1	0.31
Other reasons (participants may give detailed reasons)	12	3.75

Note: Reasons are not mutually exclusive. Each participant can select up to three answers. Abbreviations: PCV13=13-valent pneumococcal conjugate vaccine; HWs=Health workers.

(7). Hon et al. surveyed 3,485 parents in Hong Kong, China and found that pneumococcal vaccination of children was related to the awareness of parents regarding the seriousness of PDs and the belief that PCV can effectively prevent PDs (8). In our study, 95.12% of the participants perceived pneumonia as a

serious threat to children's health, and most of the participants trusted in the safety and effectiveness of vaccines. Notably, many participants lacked knowledge about pneumococcal vaccines. For example, 30.69% of the participants misidentified the pneumococcal vaccine as the COVID-19 vaccine. In addition, the

primary reason for hesitancy or refusal to vaccinate against PDs was being unfamiliar with pneumococcal vaccines. Health education for caregivers is extremely important for the public health sector.

Vaccine recommendations from HWs significantly increase acceptance of vaccines and improve vaccination willingness among the public (9). The opinions and attitudes of HWs toward vaccines are likely to influence their vaccine recommendation behavior (10). In our survey, 94.38% of the participants reported that they trusted the vaccine information provided by HWs, and the willingness of these participants was significantly higher than those who did not trust the vaccine information provided by HWs. Unfortunately, a minority of the participants had received a pneumococcal recommendation from HWs to vaccinate against PDs. To minimize the incidence of PDs in high-risk groups (such as infants and the elderly), HWs should be encouraged to take positive action to improve pneumococcal vaccination coverage.

In summary, reducing the burden of out-of-pocket costs for PCV may increase the willingness of caregivers to have their children vaccinated. Education of caregivers about vaccination should be reinforced, and the importance of HWs promotion of vaccination should be emphasized.

To our knowledge, this is the first study in China to investigate caregivers' willingness to vaccinate their children in the context of an immunization policy that provides one-free-dose of PCV13 per child. The results provide scientific evidence for updating local and national pneumococcal immunization strategies. Our study has limitations. We did not ask participants whether they were willing to have their infants complete the vaccination series if they must bear the cost of the remaining doses, and we did not explore measures to promote completion of the full-course, four-dose PCV13 series. These limitations will be addressed in future research.

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SUPPLEMENTARY MATERIAL

Sampling Method

Weifang City, located on the east coast of China, has a total of 12 counties with 195 vaccination clinics. We ranked the vaccination clinics in each county according to the number of births in the clinic service area in 2020. Through systematic sampling, each county selected three vaccination clinics. The sample size of each vaccination clinic is distributed proportionally, according to the number of births (Supplementary Table S1).

SUPPLEMENTARY TABLE S1. The estimation of sample size in vaccination clinics.

County	Vaccination clinics	The number of births in 2020	Proportion (%)	Sample size
Fangzi	Clinic 1	1,140	71.65	37
	Clinic 2	265	16.66	9
	Clinic 3	186	11.69	6
	Subtotal	1,591		52
Gaomi	Clinic 1	512	55.05	69
	Clinic 2	278	29.89	37
	Clinic 3	140	15.06	19
	Subtotal	930		125
Hanting	Clinic 1	452	61.92	41
	Clinic 2	168	23.01	15
	Clinic 3	110	15.07	10
	Subtotal	730		66
Kuiwen	Clinic 1	1,425	43.67	70
	Clinic 2	1,088	33.34	54
	Clinic 3	750	22.99	37
	Subtotal	3,263		161
Linqu	Clinic 1	471	47.62	47
	Clinic 2	307	31.04	30
	Clinic 3	211	21.34	21
	Subtotal	989		98
Qingzhou	Clinic 1	346	49.08	52
	Clinic 2	216	30.64	32
	Clinic 3	143	20.28	21
	Subtotal	705		105
Shouguang	Clinic 1	1,299	67.41	107
	Clinic 2	391	20.29	32
	Clinic 3	237	12.30	19
	Subtotal	1,927		158
Weicheng	Clinic 1	607	60.58	57
	Clinic 2	339	33.83	32
	Clinic 3	56	5.59	5
	Subtotal	1,002		94

Continued

County	Vaccination clinics	The number of births in 2020	Proportion (%)	Sample size
Zhucheng	Clinic 1	1,067	81.64	89
	Clinic 2	178	13.62	15
	Clinic 3	62	4.74	5
	Subtotal	1,307		109
Anqiu	Clinic 1	1,957	87.60	84
	Clinic 2	191	8.55	8
	Clinic 3	86	3.85	4
	Subtotal	2,234		96
Changle	Clinic 1	257	58.01	38
	Clinic 2	124	27.99	18
	Clinic 3	62	14.00	9
	Subtotal	443		65
Changyi	Clinic 1	972	76.12	34
	Clinic 2	201	15.74	7
	Clinic 3	104	8.14	4
	Subtotal	1,277		45
Total		16,398		1,174

Survey Method

Face-to-face and telephone interviews were conducted. Face-to-face interviews used two recruitment methods. First, we have surveyed caregivers who brought infants younger than three months of age to the clinics for vaccination. Caregivers could participate in the survey whether they came to the vaccination clinic to receive PCV or another vaccine. These caregivers did not know our survey before they came to the vaccination clinics. The duration of this method in each vaccination clinic was one working day. We define this as the first means in the face-to-face survey (Means 1).

When the first means was unable to reach the target sample size, we called caregivers who belonged to the vaccination clinic service area and had not accepted the survey. We invited them to come to the vaccination clinic to join in our survey. This is the second means used in the face-to-face survey (Means 2).

If the called party refused our invitation, investigators would ask them whether they were willing to accept the telephone survey (Means 3).

To explore whether data from the different survey means could be mixed, we selected two counties with more than 100 questionnaires; the number of different means questionnaires was relatively evenly distributed for analysis (Supplementary Table S2). We chose two districts, namely Shouguang and Linqu (Supplementary Table S3). We conducted a Chi-square analysis on the vaccination willingness and the participants' demographic characteristics (Supplementary Table S4).

SUPPLEMENTARY TABLE S2. Sample size of different survey means in each county of Weifang (n=1,085).

County	Face-to-face		Telephone	Total
	Means 1	Means 2	Means 3	
Fangzi	6	39	4	49
Gaomi	31	46	17	94
Hanting	18	45	2	65
Kuiwen	68	31	85	184
Linqu	46	37	43	126
Qingzhou	6	69	26	101
Shouguang	70	90	65	225
Weicheng	6	7	10	23
Zhucheng	32	20	32	84
Anqiu	47	8	4	59
Changle	15	20	12	47
Changyi	1	27	0	28
Total	346	439	300	1,085

SUPPLEMENTARY TABLE S3. Pneumococcal vaccination willingness among caregivers with different survey means in Shouguang and Linqu (n=351).

Survey methods		Total (%)	Willing (%)	Unwilling (%)	P
Face-to-face	Means 1	116 (33.05)	69 (59.48)	47 (40.52)	0.493
	Means 2	127 (36.18)	84 (66.14)	43 (33.86)	
Telephone	Means 3	108 (30.77)	71 (65.74)	37 (34.26)	

SUPPLEMENTARY TABLE S4. Characteristics of participants in different survey means (n=351).

Characteristic	Face-to-face		Telephone	P
	Means 1	Means 2	Means 3	
Child gender				
Male	58	70	56	0.720
Female	58	57	52	
Family type				
Single child family	41	51	57	0.025
Multiple child family	75	76	51	
Education level				
Elementary school or below	0	3	0	0.143
Junior high school	31	24	22	
High school/technical school/vocational school	32	33	23	
Junior college/bachelor degree	52	66	59	
Graduate degree	1	1	4	
Average annual household income (CNY)				
<50,000	22	27	19	0.667
50,000–150,000	68	77	67	
≥150,000	26	23	22	