

Preplanned Studies

Factors Associated with Influenza Vaccination Among Children Aged 6 Months to 12 Years — Three Provinces, China, 2024–2025 Influenza Season

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Summary

What is already known about this topic?

Influenza poses a substantial health risk to children. Despite being an effective preventive intervention, influenza vaccine coverage among children in China remains low.

What is added by this report?

This study identified factors associated with caregiver decisions on pediatric influenza vaccination. A child's prior influenza vaccination and caregivers' close contacts being vaccinated were positively associated with uptake. Concerns about vaccine efficacy were key barrier among caregivers who declined vaccination.

What are the implications for public health practice?

The findings inform interventions to improve childhood influenza vaccination and strengthen prevention and control efforts.

prior influenza vaccination in the 2023–2024 season [odds ratio (OR): 8.82, 95% confidence interval (CI): 6.83, 11.39] and with vaccination among caregiver's close social contacts (OR=3.67, 95% CI: 2.82, 4.78). The main reasons for vaccination were beliefs that the vaccine protects children's health (95.96%) and the health of others (59.83%). The primary reason for non-vaccination was concern about vaccine efficacy (39.79%).

Conclusion: Previous influenza vaccination and vaccination within caregivers' social networks were associated with increased acceptance of childhood influenza vaccination.

ABSTRACT

Introduction: Influenza vaccination coverage among children in China remains low. This study explored factors associated with childhood influenza vaccination.

Methods: A case-control study was conducted among children aged 6 months to 12 years in Zhejiang, Hubei, and Shaanxi provinces. Cases received influenza vaccine during the 2024–2025 season; age-matched controls from the same county had not been vaccinated against influenza. Standardized questionnaires were used to obtain caregivers' sociodemographic characteristics, influenza vaccine knowledge and attitudes, close contacts' influences, and reasons for vaccination or non-vaccination.

Results: The study included 2,141 children (1,088 cases; 1,053 controls). Vaccination was associated with

Influenza is an acute respiratory infectious disease caused by influenza virus that poses a substantial threat to child health. Vulnerable populations, including infants and young children, are susceptible to severe clinical outcomes following influenza infection (1). Influenza vaccination remains the most cost-effective public health strategy for children, providing direct protection and contributing to herd immunity.

In China, influenza vaccines are family-paid vaccines not included in the National Immunization Program prior to 2026. Childhood influenza vaccination coverage has been low. During the 2020–2021 influenza season, childhood coverage was 2.9% in China (2), contrasting with 50.7% in the USA (children 6 months–8 years) (3) and 46.1% in Australia (6–59 months) (4). Persistently low coverage underscores the need to understand determinants of caregivers' decision-making regarding childhood influenza vaccination in the Chinese context.

From December 2024 to January 2025, a matched case-control study was conducted in Zhejiang, Hubei, and Shaanxi provinces, representing eastern, central, and western China. None of these provinces provided

free influenza vaccination for children. Participants were parents or legal guardians (≥ 18 years) of children aged 6 months to 12 years old (born between December 2011 and May 2024) who lived in the study county/district for ≥ 3 months. Caregivers with impaired communication ability were excluded.

The target sample size was calculated using standard formulas for case-control studies with the following parameters: two-sided $\alpha = 0.05$, power $(1 - \beta) = 0.90$, baseline vaccination rate (P_0) = 10%, target odds ratio (OR) = 2.50, design effect = 5, and a 10% non-response-rate adjustment. With a 1:1 case-control ratio, 333 cases and 333 controls were required per province, 1,998 subjects in all.

Participants were identified using a multistage sampling strategy (Supplementary Figure S1, available at <https://weekly.chinacdc.cn/>): prefecture-level cities were stratified into high, medium, and low tiers based on influenza vaccine uptake since July 2024; one city was randomly selected from each tier. From each selected city, two counties or districts with higher uptake and two with lower uptake were selected, yielding 12 counties/districts per province, 36 counties/districts in all. In each county/district, a minimum of two vaccination clinics were selected, aiming for a balance between urban community health centers and rural township hospitals.

In a frequency-matched case-control design, children aged 6 months to 12 years living in the county/district were identified using vaccination clinic information systems and stratified into three age groups: 6–23-month-olds, 3–6-year-olds, and 7–12-year-olds. Cases and controls were selected at random from the age strata based on their 2024–2025 influenza vaccination histories and were classified into the vaccinated group (cases) or the unvaccinated group (controls). A minimum of 50 caregivers of eligible children per county or district were targeted, with at least 25 cases and 25 controls proportionally allocated across age strata. Vaccination clinic staff invited caregivers to participate in the study.

A structured questionnaire developed by experts from China CDC was administered in-person by trained investigators after obtaining informed consent. The questionnaire included 1) demographic and socioeconomic characteristics of child and caregiver; 2) caregiver awareness and perceptions of influenza and influenza vaccine; 3) healthcare worker recommendations, family social contacts' influenza vaccination, and the child's prior influenza vaccination

history; and 4) reasons for vaccination of cases and non-vaccination of controls.

Data were collated using Excel 2019 and analyzed using SAS (version 9.4; SAS Institute Inc., Cary, NC, USA). Descriptive statistics are presented as means (standard deviations, SD) for continuous variables (compared using t-tests) and proportions for categorical variables (compared using chi-square tests). Variables significant in univariate analyses were entered into multilevel conditional logistic regression (matched design) to estimate intraclass correlation coefficient (ICC) and evaluate potential clustering. Given small ICC, conditional logistic regression was used to assess associations between independent variables and caregivers' vaccination decisions. Sociodemographic characteristics not significant in univariate analysis were excluded. Province, county/district, and child age group were stratification variables in the conditional logistic regression model. R software (version 4.5.2; R Foundation, Vienna, Austria) was used to generate a forest plot. Tests were two-tailed, with significance at $\alpha < 0.05$.

A total of 2,181 caregivers were surveyed; 2,141 met eligibility criteria and were included in the analyses: 1,088 vaccinated cases and 1,053 unvaccinated controls. Table 1 shows sociodemographic characteristics of the children and their caregivers by study group; no significant differences were observed between cases and controls, demonstrating similar demographic characteristics with respect to survey province and urban/rural setting.

Table 2 shows caregiver awareness, perceptions, and other factors related to influenza vaccination by study group. Several factors were significantly different between vaccinated and unvaccinated groups: caregiver awareness of influenza and influenza vaccine, confidence in vaccine efficacy and safety, concern about the child's susceptibility to and severity of influenza, and belief in the importance of vaccination. Other factors examined included the child's influenza vaccination history; influenza illness and vaccination histories of caregiver's close contacts (family, relatives, friends); and doctor/nurse recommendations for vaccination.

A multilevel matched logistic regression model was constructed with provincial-level variables as stratification units, yielding an ICC of < 0.001 . When stratified by county or district-level variables, the ICC was 0.013, indicating that 1.30% of the variance was attributable to county or district differences. The small

TABLE 1. Characteristics of caregivers and their children in the influenza-vaccinated and unvaccinated groups.

Variable	Vaccinated cases		Unvaccinated controls		χ^2 / t	P
	n	Percentage (%)	n	Percentage (%)		
Province					0.116	0.944
Zhejiang	345	31.71	330	31.34		
Hubei	394	36.21	378	35.90		
Shaanxi	349	32.08	345	32.76		
Region					2.348	0.125
Urban	848	77.94	849	80.63		
Rural	240	22.06	204	19.37		
Children age					1.191	0.551
6 months to 2 years	169	15.53	172	16.34		
3–6 years	354	32.54	359	34.09		
7–12 years	565	51.93	522	49.57		
Gender					0.163	0.687
Female	534	49.08	526	49.95		
Male	554	50.92	527	50.05		
Education status					1.438	0.487
Home-based	188	17.28	200	18.99		
Childcare center/kindergarten	293	26.93	266	25.26		
Primary/junior high school	607	55.79	587	55.75		
Registered residence					0.868	0.351
Local province	1031	94.76	988	93.83		
A different province	57	5.24	65	6.17		
Caregivers						
Age, years (mean±SD)	37.49±7.80		36.93±7.01		-1.750	0.081
Parenthood					3.109	0.211
Mother	784	72.06	763	72.46		
Father	210	19.30	219	20.80		
Others	94	8.64	71	6.74		
Gender					0.042	0.838
Female	842	77.39	811	77.02		
Male	246	22.61	242	22.98		
Education					2.530	0.282
Junior middle school or below	145	13.33	131	12.44		
Senior high school	238	21.87	206	19.56		
Bachelor's degree or above	705	64.80	716	68.00		
Household income per capita					4.186	0.242
≤2,999 CNY per month	194	17.83	207	19.66		
3,000–4,999 CNY per month	432	39.71	444	42.17		
5,000–9,999 CNY per month	345	31.71	301	28.58		
≥10,000 CNY per month	117	10.75	101	9.59		

Note: χ^2 test for categorical variables; independent-samples t test for continuous variables. All tests were two-tailed.

Abbreviation: CNY=Chinese Yuan; SD=standard deviation.

TABLE 2. Comparison of caregivers' awareness, perceptions, and related factors of pediatric influenza vaccination by children's seasonal influenza vaccination status.

Variable	Vaccinated cases		Unvaccinated controls		χ^2 / t	P
	n	Percentage (%)	n	Percentage (%)		
Awareness						
1. Influenza is a respiratory infectious disease transmitted through coughing or sneezing (Yes)	1,062	97.61	998	94.78	11.802	0.001
2. Influenza can lead to severe complications such as viral pneumonia (Yes)	982	90.26	873	82.91	24.986	<0.001
3. Influenza is typically seasonal, while the common cold can occur year-round (Yes)	1,025	94.21	950	90.22	11.918	0.001
4. Vaccination is unnecessary if one has previously contracted influenza (No)	720	66.18	597	56.70	20.319	<0.001
5. The optimal time for influenza vaccination is before the local seasonal epidemic begins (Yes)	988	90.81	866	82.24	33.838	<0.001
6. The minimum age for a child to receive their first influenza vaccine is 6 months (Yes)	648	59.56	465	44.16	50.838	<0.001
Awareness score of influenza and its vaccine (mean±SD)	4.99±1.16		4.51±1.46		-8.360	<0.001
Perceptions						
Confidence in influenza vaccine effectiveness					303.323	<0.001
Agree	930	85.48	531	50.43		
Disagree	158	14.52	522	49.57		
Confidence in influenza vaccine safety					255.876	<0.001
Agree	971	89.25	622	59.07		
Disagree	117	10.75	431	40.93		
Confidence in influenza vaccine importance for child's health					308.483	<0.001
Agree	996	91.54	620	58.88		
Disagree	92	8.46	433	41.12		
Susceptibility of child contracting influenza					145.782	<0.001
High	785	72.15	490	46.53		
Low	303	27.85	563	53.47		
Severity of influenza for child					163.478	<0.001
High	854	78.49	550	52.23		
Low	234	21.51	503	47.77		
Related factors						
Child experienced ILI during the 2024–2025 season					1.454	0.228
Yes	546	50.18	501	47.58		
No	542	49.82	552	52.42		
Child's influenza vaccination in 2023–2024 season					619.197	<0.001
Yes	780	71.69	191	18.14		
No	308	28.31	862	81.86		
Impact of a company's voluntary suspension of influenza vaccine supply in August 2024					89.667	<0.001
Negative impact	92	8.46	208	19.75		
Never heard	341	31.34	401	38.08		
No negative impact	655	60.20	444	42.17		
Influence of influenza vaccine price reductions					76.490	<0.001
Negative influence	21	1.93	70	6.65		
Never heard	175	16.08	286	27.16		
No negative influence	892	81.99	697	66.19		

Continued

Variable	Vaccinated cases		Unvaccinated controls		χ^2 / t	P
	n	Percentage (%)	n	Percentage (%)		
Healthcare worker recommendation for influenza vaccination						
Yes	928	85.29	732	69.52	76.480	<0.001
No	160	14.71	321	30.48		
Caregivers' close contacts with ILI during the 2024–2025 season					25.824	<0.001
Yes	519	47.70	388	36.85	383.746	<0.001
No	569	52.30	665	63.15		
Caregivers' close contacts received influenza vaccine during the 2024–2025 season						
Yes	860	79.04	393	37.32		
No	228	20.96	660	62.68		
Distance to nearest influenza vaccination clinic					0.103	0.748
<5 km	792	72.79	760	72.17		
≥5 km	296	27.21	293	27.83		

Note: χ^2 test for categorical variables; independent-samples t test for continuous variables. All tests were two-tailed.
Abbreviation: ILI=influenza-like illness.

proportion of variance attributable to inter-county or district differences supports using conditional logistic regression.

Figure 1 shows a forest plot from the multivariable logistic regression. Caregivers were more inclined to vaccinate their children during the 2024–2025 season if their child received influenza vaccine in the 2023–2024 season; if caregivers' close contacts were vaccinated during the current season; if caregivers believed that influenza vaccine was crucial for children's health; if caregivers perceived a high risk of their children contracting influenza; if a healthcare worker recommended influenza vaccination; if caregivers perceived influenza vaccine as effective; or if caregivers were unaware of, or considered irrelevant, voluntary suspension of influenza vaccine supply by a company in August 2024.

Figure 2 shows reasons associated with caregiver decisions regarding influenza vaccination for their children. Among caregivers of vaccinated children, predominant motivations were protection of their child's health (95.96%, 1,044/1,088), protection of the health of others (59.83%, 651/1,088), and reduction of caregivers' worry about influenza (47.43%, 516/1,088). Among caregivers of unvaccinated children, leading reasons for non-vaccination were concerns about vaccine effectiveness (39.79%, 419/1,053), adverse events (39.32%, 414/1,053), and belief that the child's good health rendered vaccination unnecessary (36.28%, 382/1,053).

DISCUSSION

The matched case-control study of childhood influenza vaccination in three Chinese provinces found that a child's previous receipt of influenza vaccine and concurrent-season vaccination among caregivers' social contacts (family, relatives, friends) were positively associated with caregivers' decisions to vaccinate their children, providing a reference for future interventions.

Strong association ($OR=8.82$) between previous and current childhood influenza vaccinations indicates that previous vaccination experience is a good predictor of vaccine acceptance. However, vaccination history is not a simple modifiable predictor, as it involves caregiver attitudes, habitual vaccination behaviors, and accessible service channels. A positive vaccination experience helps establish acceptance and participation in immunization services.

Receipt of influenza vaccine by social contacts was the second most influential factor in caregivers' decision-making, aligning with existing evidence that social influences encourage caregivers to opt for vaccination (5). Knowing that close social contacts have been vaccinated provides caregivers with firsthand information, positively shapes attitudes, and encourages adherence to group norms – factors for consideration in promotion efforts to strengthen influenza vaccination of children.

Recommendations from healthcare professionals strongly influence caregiver decisions and pediatric vaccination rates. However, influenza vaccine uptake

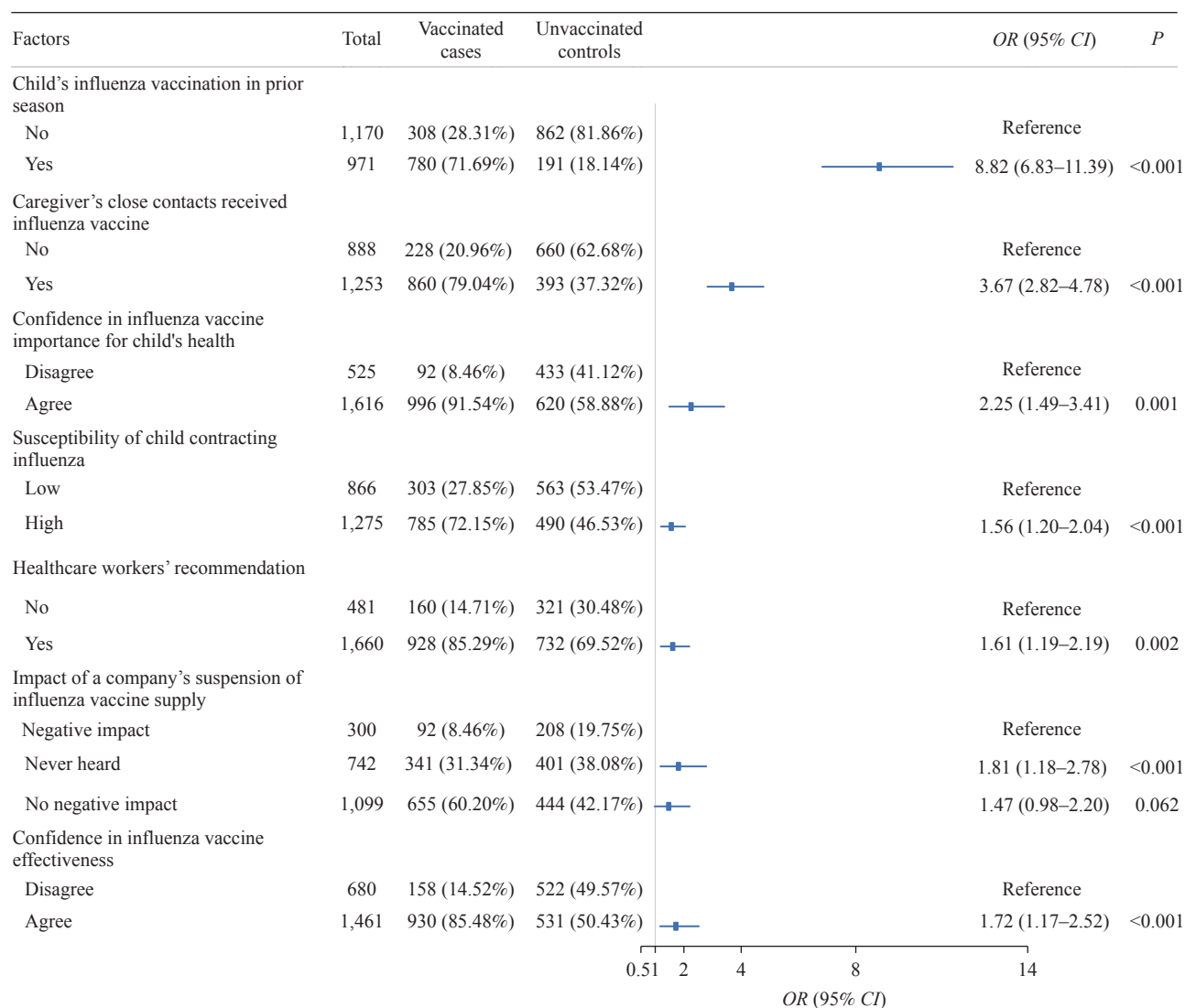


FIGURE 1. Forest plot of influencing factors for influenza vaccination among children aged 6 months to 12 years.

Note: Error bars represent 95% CI.

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

among healthcare professionals in China is lower than in many other countries (6), due in part to vaccine effectiveness or safety concerns (5). Unvaccinated healthcare workers may be less willing to recommend vaccination to patients. An integrated clinical/public-health framework with professional training, patient education, vaccine prescriptions from clinicians, and vaccination services in healthcare settings will improve accessibility and convenience. Such integrated efforts may increase healthcare worker engagement with influenza vaccination and contribute to higher acceptance.

The results showed that caregivers' perceptions of vaccine effectiveness and importance and concerns about adverse reactions influenced vaccination

decisions — consistent with studies finding similar challenges for sustaining confidence (7), underscoring the importance of interventions that reinforce population-specific determinants of vaccine confidence (8).

A study limitation is the demand-side focus on vaccination services without supply-side analyses. The setting had no regions offering free influenza childhood vaccination; therefore, findings cannot be generalized to settings offering free influenza vaccination for children, which is known to enhance vaccination rates (9). Further investigation into free vaccination policies is warranted. The study did not collect data on whether caregivers themselves were vaccinated, potentially interfering with estimation of social network effects.

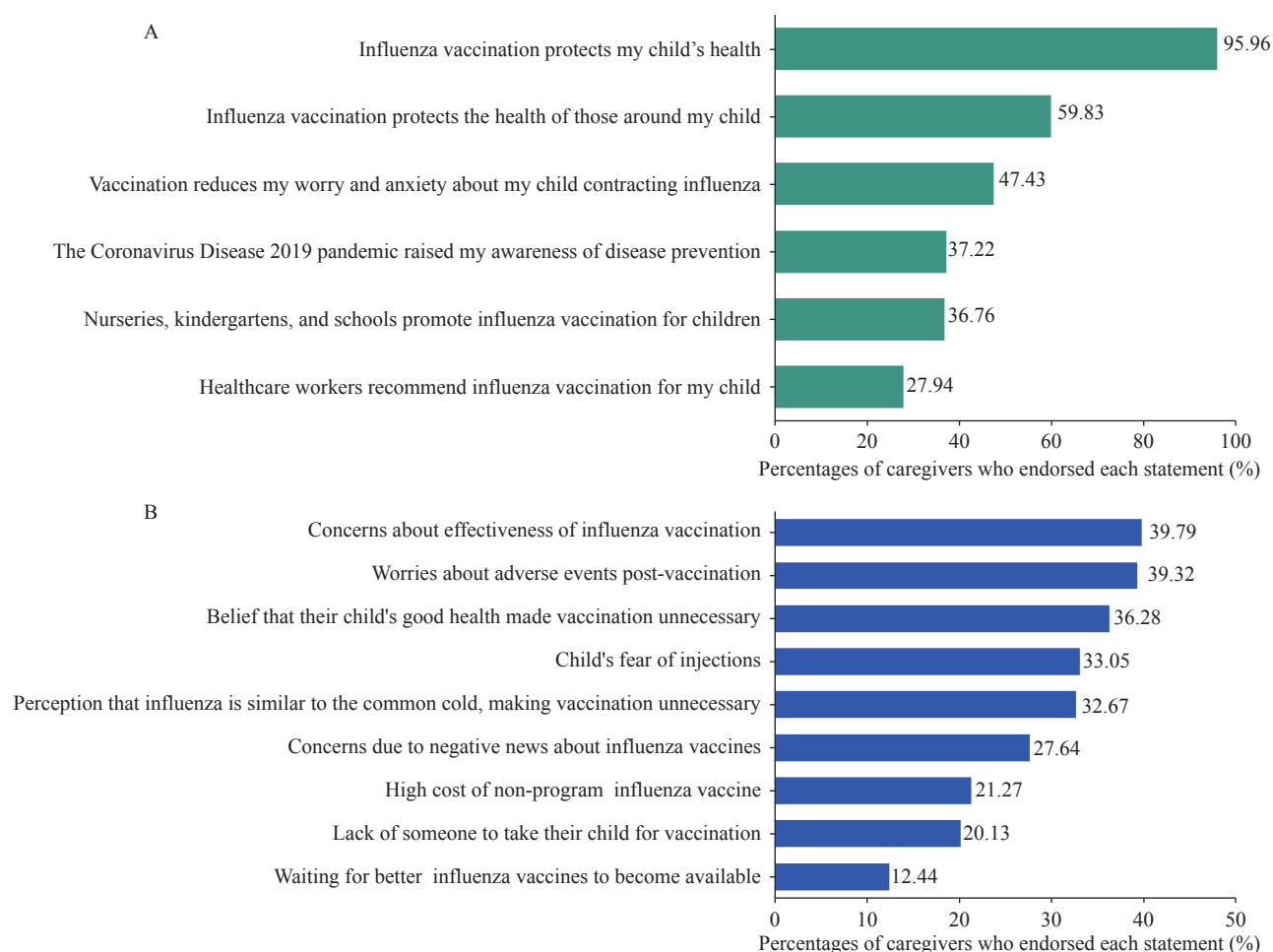


FIGURE 2. Reasons reported by caregivers for vaccinating or not vaccinating their child against seasonal influenza. (A) Reasons for caregivers to vaccinate their child against influenza ($n=1,088$); (B) Reasons for caregivers not to vaccinate their child against influenza ($n=1,053$).

In conclusion, child's prior influenza vaccination, vaccine uptake within caregivers' social network, and healthcare worker recommendation were associated with childhood influenza vaccination, providing evidence for targeted interventions to increase influenza vaccination of children, and strategies for influenza prevention and control.

Conflicts of interest: No conflicts of interest.

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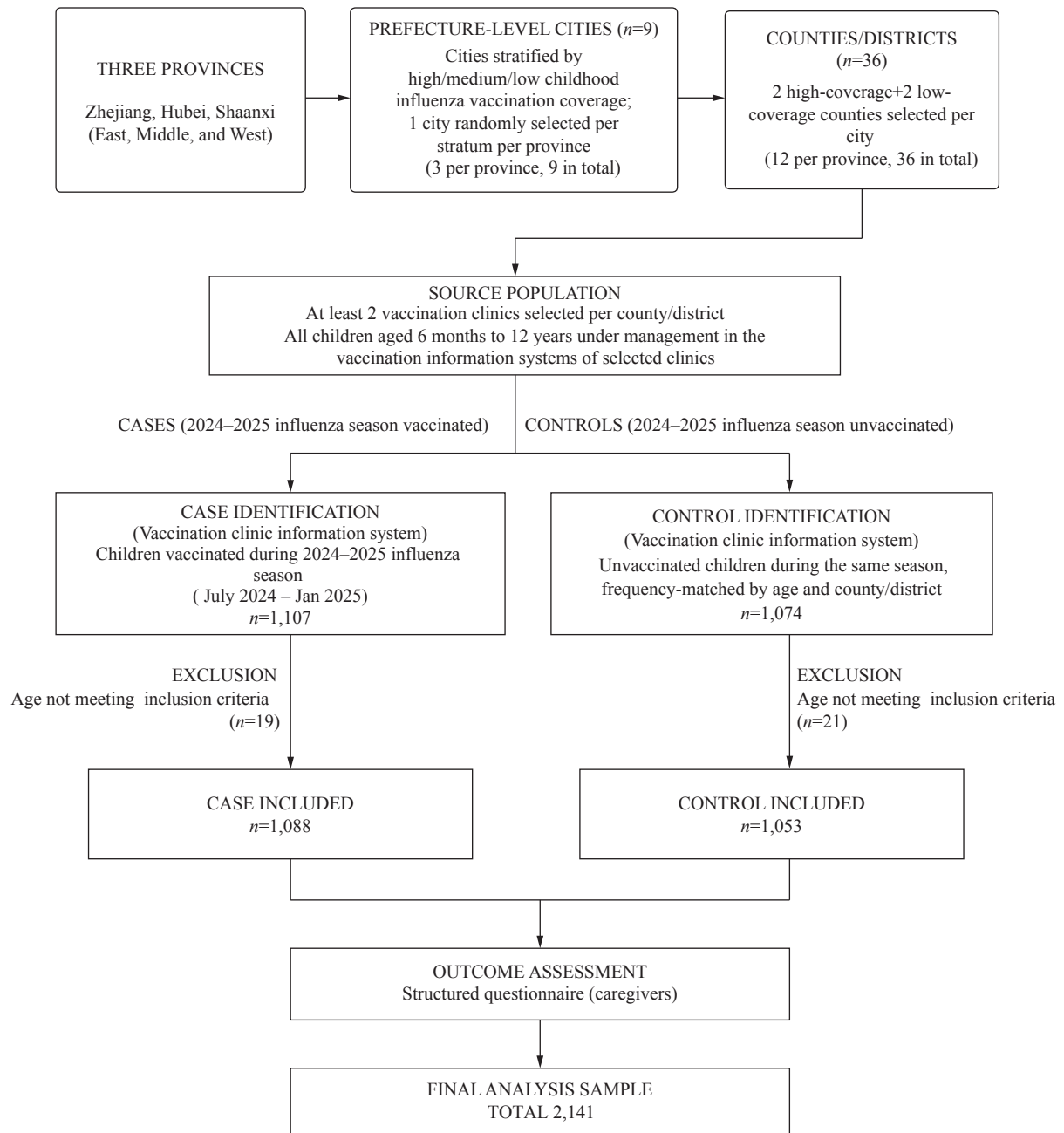
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SUPPLEMENTARY MATERIAL



SUPPLEMENTARY FIGURE S1. Sampling flow diagram.