# Analysis of 13-Valent Pneumococcal Conjugate Vaccine Coverage among Children Born in Jiangsu Province, 2017–2022: A Postprint

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## Abstract

Background: Childhood pneumonia poses a serious global disease burden. Pneumococcal conjugate vaccination is the most direct and effective preventive measure against pneumococcal diseases, yet current evidence on the coverage of the 13-valent pneumococcal conjugate vaccine (PCV 13) among children remains limited. Objective: To analyze PCV 13 vaccination coverage among children born in Jiangsu Province from 2017 to 2022, identify variations in coverage levels across different subgroups and explore underlying factors, and provide evidence to inform strategies to improve PCV 13 vaccination rates. Methods: Data on basic demographics and PCV 13 vaccination information (as of December 31, 2023) for children born in Jiangsu Province from 2017 to 2022 were extracted from the Jiangsu Provincial Comprehensive Immunization Service Management Information System, including date of birth, sex, household registration status, vaccination date, and dose number, and subjected to descriptive analysis. Results: The immunization information system of Jiangsu Province registered a total of 4,537,123 children born between 2017 and 2022, among whom 784,220 children received 2,406,974 doses of PCV 13, resulting in a vaccination coverage rate of 17.28%. A total of 697,698 children received the first dose in Jiangsu Province, with the age at first dose distribution as follows: <2 months for 82,503 (11.83%), 2–6 months for 511,273 (73.28%), 7–11 months for 26,106 (3.74%), 12–24 months for 38,530 (5.52%), and 2–5 years for 39,286 (5.63%). The vaccination rates for doses 1, 2, 3, and 4 among resident children (16.11%, 14.71%, 13.43%, 11.50%) were higher than those among migrant children (13.87%, 12.70%, 11.42%, 9.52%) (P<0.05). Geographically, vaccination rates for all doses exhibited a descending trend from southern to central to northern Jiangsu, with statistically significant differences (P<0.05). By sex, no statistically significant differences were found in the vaccination rates for dose 1 and dose 2 between boys and girls (P>0.05); however, the vaccination

rates for dose 3 and dose 4 were significantly lower among boys compared to girls (P<0.05). Among children born from 2017 to 2022, the vaccination rates for doses 1, 2, 3, and 4 increased annually by birth cohort (P<0.05). Across different household registration statuses, sexes, birth years, and regions, children receiving their first PCV 13 dose at 2–6 months of age accounted for the highest proportion, with statistically significant differences observed in the age distribution at first PCV 13 dose across these subgroups (P<0.05). Conclusion: The PCV 13 vaccination coverage rate among children in Jiangsu Province was 17.28%, representing a relatively low level. The proportion of children receiving their first dose at 2–6 months of age was the highest, and vaccination rates for all doses increased annually by birth cohort. To improve PCV 13 coverage levels in the target population, we recommend incorporating PCV 13 into the National Immunization Program.

## Full Text

# Analysis of 13-Valent Pneumococcal Conjugate Vaccine Coverage Among Children Born in Jiangsu Province, 2017–2022

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### Abstract

**Background:** Childhood pneumonia poses a substantial global disease burden, and pneumococcal conjugate vaccination represents the most direct and effective preventive measure against pneumococcal disease. However, data on 13-valent pneumococcal conjugate vaccine (PCV13) coverage among children remain limited.

**Objective:** To analyze PCV13 vaccination rates among children born between 2017 and 2022 in Jiangsu Province, identify disparities in coverage across different subgroups and their underlying causes, and provide evidence for improving future PCV13 uptake.

**Methods:** Using the Jiangsu Provincial Comprehensive Immunization Service Management Information System, we collected basic demographic and PCV13 vaccination data (as of December 31, 2023) for children born from 2017 to 2022, including date of birth, sex, household registration status, vaccination dates, and dose numbers. Descriptive analyses were performed on the extracted data.

**Results:** The provincial immunization information system registered 4,537,123

births between 2017 and 2022. Among these, 784,220 children received 2,406,974 doses of PCV13, yielding a vaccination rate of 17.28%. First-dose administration in Jiangsu occurred in 697,698 children, with 82,503 (11.83%) receiving their initial dose before 2 months of age, 511,273 (73.28%) at 2–6 months, 26,106 (3.74%) at 7–11 months, 38,530 (5.52%) at 12–24 months, and 39,286 (5.63%) at 2–5 years. Resident children exhibited significantly higher dose-specific vaccination rates for doses 1–4 (16.11%, 14.71%, 13.43%, and 11.50%, respectively) compared to migrant children (13.87%, 12.70%, 11.42%, and 9.52%; $P<0.05$). Geographically, dose-specific coverage decreased progressively from southern to central to northern Jiangsu, with statistically significant differences across regions ($P<0.05$). No significant gender difference was observed for the first two doses ($P>0.05$), but boys had lower coverage for the third and fourth doses than girls ($P<0.05$). Across the 2017–2022 birth cohorts, vaccination rates for doses 1–4 increased annually ($P<0.05$). For all subgroups analyzed by household registration, sex, birth year, and region, the 2–6 month age group accounted for the highest proportion of first-dose recipients, though the age distribution at first vaccination varied significantly across these strata ($P<0.05$).

**Conclusion:** PCV13 coverage among children in Jiangsu Province remains low at 17.28%, with the majority of first doses administered at 2–6 months of age. While vaccination rates have increased annually, coverage falls substantially short of the 90% target required for routine immunization programs. To improve PCV13 coverage in the target population, we recommend incorporating PCV13 into the National Immunization Program.

**Keywords:** Pneumococcal vaccines; 13-valent pneumococcal conjugate vaccine; Vaccination; Vaccination coverage; Child; Jiangsu Province

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## Introduction

*Streptococcus pneumoniae* (pneumococcus) is a leading cause of bacterial pneumonia and meningitis in children and adults, particularly affecting children under five years of age, older adults, and immunocompromised individuals. Recent 2018 estimates indicate that approximately 294,000 children under five died globally from pneumococcal disease (PD), which WHO has classified as a "very high priority" disease for vaccine prevention. In China, two pneumococcal vaccines are currently available: the 13-valent pneumococcal conjugate vaccine (PCV13) and the 23-valent pneumococcal polysaccharide vaccine (PPV23). PCV13, indicated for infants and children from 6 weeks to 5 years of age, has proven

effective in reducing pneumonia and invasive pneumococcal disease and is primarily used for PD prevention in children under five. However, PCV13 remains a non-National Immunization Program vaccine in China, resulting in suboptimal coverage with substantial regional variation. This study leverages Jiangsu' s provincial immunization information system to analyze PCV13 uptake among children born from 2017 to 2022, providing evidence to inform strategies for improving vaccination coverage.

## Methods

**1.1 Study Population** We included all children born between 2017 and 2022 who were registered in the Jiangsu Provincial Comprehensive Immunization Service Management Information System. Data were extracted as of December 31, 2023.

**1.2 Vaccination Data** For children receiving PCV13 between 2017 and 2022, we collected individual-level data including date of birth, sex, household registration status, vaccination dates, and dose numbers through December 31, 2023. Dose-specific vaccination rates were calculated as: (number of children receiving PCV13 dose ÷ total number of children born 2017–2022) × 100.

**1.3 PCV13 Vaccination Schedule** Jiangsu' s 13 prefecture-level cities were categorized geographically into southern, central, and northern regions. Southern Jiangsu includes Nanjing, Wuxi, Changzhou, Suzhou, and Zhenjiang; central Jiangsu comprises Nantong, Yangzhou, and Taizhou; and northern Jiangsu includes Xuzhou, Lianyungang, Huai' an, Yancheng, and Suqian. The recommended immunization schedule follows product labeling: infants aged 2–6 months receive a 3-dose primary series with one booster (4 doses total); infants aged 7–11 months receive a 2-dose primary series with one booster (3 doses total); children aged 12–23 months receive 2 doses; and children aged 2–5 years receive a single dose.

**1.4 Statistical Analysis** Data were compiled in Excel 2010 and analyzed using SPSS 24.0. Descriptive epidemiological methods were employed for analysis. Categorical data are presented as percentages, with comparisons performed using chi-square tests or chi-square tests for trend. Statistical significance was defined as two-sided $P<0.05$.

## Results

**2.1 Overview of Births and Vaccination** The provincial immunization information system registered 4,537,123 births from 2017 to 2022, including 2,363,006 boys (52.08%) and 2,174,117 girls (47.92%), with 3,052,029 resident children (67.27%) and 1,485,094 migrant children (32.73%). Overall, 784,220 children received PCV13, yielding a vaccination rate of 17.28%. This included 407,983 boys (17.27%) and 376,237 girls (17.31%), and 540,931 resident children

(17.72%) versus 243,289 migrant children (16.38%). These 784,220 children received 2,406,974 total doses, with 634,839 children (13.99%) completing $ $3 doses. Among vaccinated children, 697,698 received their first dose in Jiangsu, with 593,776 (85.11%) receiving it by 6 months of age, 26,106 (3.74%) at 7–11 months, 38,530 (5.52%) at 12–24 months, and 39,286 (5.63%) at 2–5 years.

**2.2 Vaccination Rates by Characteristics** **2.2.1 Household Registration Status:** Resident children had significantly higher dose-specific vaccination rates than migrant children for all four doses (16.11% vs 13.87%, 14.71% vs 12.70%, 13.43% vs 11.42%, and 11.50% vs 9.52%, respectively; P<0.001) .

**2.2.2 Gender:** Among 2,363,006 boys, dose-specific coverage was 15.37%, 14.02%, 12.70%, and 10.73% for doses 1–4, respectively. Among 2,174,117 girls, corresponding rates were 15.39%, 14.08%, 12.85%, and 10.98%. No significant gender difference was observed for the first two doses (P>0.05), but boys had lower coverage for doses 3 and 4 (P<0.001) .

**2.2.3 Geographic Region:** Southern Jiangsu children had the highest dose-specific coverage (20.04%, 18.72%, 17.41%, and 14.97%), followed by central Jiangsu (15.45%, 14.12%, 12.63%, and 10.90%), with northern Jiangsu showing the lowest rates (8.48%, 7.14%, 6.00%, and 4.77%). All regional differences were statistically significant (P<0.001) .

**2.2.4 Birth Year:** Vaccination rates increased annually across the 2017–2022 cohorts, rising from 1.99%, 1.37%, 1.22%, and 0.99% in 2017 to 34.11%, 32.85%, 30.69%, and 24.06% in 2022 for doses 1–4, respectively (P<0.001) .

**2.3 Age Distribution at First Dose by Characteristics** Overall, 73.28% of first doses were administered at 2–6 months of age, with 11.83% given before 2 months. This pattern held across all subgroups: household registration status, sex, birth year, and region all showed the highest proportion of first doses at 2–6 months. However, the age distribution varied significantly within each stratum (P<0.05) . Notably, while children born in 2019–2022 had the second-highest proportion of first doses before 2 months, those born in 2017–2018 had their second-highest proportion at 2–5 years, reflecting expanded eligibility following domestic PCV13 availability in 2019.

## Discussion

Pneumococcal infection represents a major global public health threat, with vaccination being the optimal prevention strategy. By 2021, 151 countries or territories had introduced PCV13, with 95% implementing at least three doses. Our analysis of Jiangsu' s provincial data reveals that while PCV13 coverage among 2017–2022 births increased annually, the overall $ $1-dose and $ $3-dose rates of 17.28% and 13.99% remain low—similar to Ningbo' s experience but far below developed country levels. As a non-National Immunization Program vaccine with high cost, price represents the primary barrier to uptake, consistent

with findings from Ningbo, Shanghai, and Beijing' s Haidian District showing urban-rural disparities linked to economic factors.

Our study demonstrates significant coverage gaps by household registration, with resident children achieving higher rates than migrant children. Migrant families face challenges including frequent relocation, reduced access to immunization information, and less proactive engagement with local clinics, complicating vaccination delivery. Geographic disparities mirror economic gradients, with southern Jiangsu (most economically developed) showing highest coverage, followed by central then northern regions—patterns consistent with other non-program vaccines. These findings suggest vaccine cost and household economics are critical determinants of PCV13 uptake.

The observed annual increase in coverage likely reflects three factors: growing parental awareness as the vaccine became more established, expanded eligibility following domestic PCV13 approval in 2019, and increased supply from additional manufacturers alleviating earlier shortages. Regarding age at first dose, the predominance of 2–6 month initiation across all subgroups aligns with recommendations, though the notable proportion of first doses before 2 months in recent cohorts and the catch-up vaccination at 2–5 years in earlier cohorts highlight both improved early uptake and expanded access.

**Limitations:** First, vaccinations administered outside Jiangsu were not captured, potentially underestimating true coverage. Second, the complexity of real-world implementation limited our analysis to dose-specific rather than full-series completion rates, providing an incomplete picture of coverage.

## Summary and Outlook

This population-based analysis of Jiangsu' s immunization information system demonstrates that PCV13 coverage among children born 2017–2022 remains below 20%—far from the 90% target for routine immunizations and insufficient for establishing population immunity. WHO recommends all countries incorporate PCV into their national immunization programs. As more pneumococcal vaccines become available, adding PCV13 to the National Immunization Program would eliminate access disparities and improve coverage. In the interim, intensified public education to increase awareness and parental acceptance is essential to reduce the burden of pneumococcal disease.

## Author Contributions

Liu Li drafted the manuscript and performed statistical analysis. Hu Ran and Kang Guodong collected, organized, and analyzed the data. Zhang Lei created figures and tables and revised the manuscript. Wang Zhiguo designed the study, revised the manuscript, and supervised the project.

## Conflict of Interest

The authors declare no conflicts of interest.

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