

THE EFFECT OF PCV-13 (Pneumococcus Conjugation Vaccine-13) IMMUNIZATION ON THE INCIDENCE OF ARI IN TODDLERS IN URBAN AND RURAL AREAS OF BANDUNG DISTRICT

Wini Anggraeni¹, Dyan Kunthi Nugrahaeni², Novie E Mauliku³

^{1,2,3} Master of Public Health, General Achmad Yani University, Cimahi

***Co-responding author:**

winianggraeni1979@gmail.com

Article Info

Submitted 22 04 2025

Revised 23 06 2025

Published 27 06 2025

Keywords:

Kejadian ISPA, Imunisasi PCV-13, Perkotaan pedesaan

P-ISSN: 2086-3292

E-ISSN: 2655-9900

National Accreditation:

Sinta 4

Abstract

Background: Acute Respiratory Tract Infection (ARI) is an acute infectious disease that affects one or more parts of the respiratory tract, from the nose to the alveoli, including the adnexal tissue such as the sinuses, middle ear cavity, and pleura. According to the WHO, pneumonia contributed to 14% of deaths in toddlers in the world in 2019. The WHO recommends that all countries use the Pneumococcal Conjugate Vaccine (PCV) in routine infant immunization. **Objective:** This study aims to analyze the effect of Pneumococcus Conjugation Vaccine-13 (PCV-13) Immunization on the incidence of ARI in toddlers in urban and rural areas of Bandung Regency. **Method:** The study employed a cohort study design. The sample in this study consisted of toddlers aged 1-3 years who were registered at the health center posyandu, with both urban and rural characteristics in Bandung Regency, totaling 240 samples. The dependent variable is the incidence of ARI in toddlers. In contrast, the independent variables are the administration of Pneumococcus Conjugation Vaccine-13 (PCV-13) immunization, gender, age of toddlers, nutritional status, immunization history, parental occupation, maternal knowledge, and maternal education. Univariate data analysis to determine the frequency distribution of variables, bivariate analysis using the Chi-Square test, and multivariate analysis using logistic regression. **Results of the study:** The results showed a significant relationship between the administration of Pneumococcus Conjugation Vaccine-13 (PCV-13) immunization and the incidence of ARI with a p-value of 0.0001 <0.05 and an RR value of 0.000 <1 in urban areas and a p-value in rural areas is 0.0001 <0.05 with an RR value of 0.167 <1 meaning that the administration of Pneumococcus Conjugation Vaccine-13 (PCV-13) immunization can reduce the incidence of ARI in toddlers in both urban and rural areas. **Conclusion:** Toddlers who receive complete doses of Pneumococcus Conjugation Vaccine-13 (PCV-13) immunization will be protected from ARI

INTRODUCTION

ISPA (acute respiratory tract infection) is classified as the primary trigger for death in children under five years of age (UNICEF, 2022), the World Health Organization (WHO) estimates that ISPA cases experienced by toddlers, especially in developing countries, show a high figure, namely 151.8 million cases per year. Indonesia is a country with quite significant ISPA cases, especially in toddlers (Prasiwi et al., 2021). Toddlers with immune systems that are still developing are susceptible to respiratory infections, especially babies who consume bottled milk rather than breast milk (Ridwan et al., 2021). WHO recommends that all countries use the Pneumococcus Conjugation Vaccine (PCV) in routine infant immunization, based on the current recommendations of the WHO Strategic Advisory Group of Experts (SAGE) for PCV-10 or PCV-13. Countries using PCV have reported significant reductions in pneumococcal disease and severe pneumonia (Centers for Disease Control, 2022). The implementation of PCV immunization in Indonesia began with the PCV Immunization Demonstration Program in the Provinces of West Nusa Tenggara and Bangka Belitung from 2017 to 2019, using PCV-13 Vallen. The vaccine was administered to children aged 2 months, 4 months, and 12 months, with a complete dose of three doses. The achievement of PCV immunization in the implementation of the demonstration program over the past three years has been quite good, with an average coverage of above 80% (Directorate of Immunization Management, Ministry of Health of the Republic of Indonesia, 2022).

There is a strong inverse relationship between PCV coverage and the incidence of severe invasive disease due to vaccine type and pneumonia hospitalization among undervaccinated children; that is, higher coverage is associated with greater reductions in disease due to indirect effects. For pneumonia, it was estimated that 50% and 90% coverage were sufficient to prevent one-third (33.3%, 95% CI 27.3 to 38.8) and about half (51.7%, 95% CI 43.7 to 58.6) of all-cause pneumonia hospitalizations among undervaccinated children. These trends were similar for children aged less than 4 months, as well as for urban, rural, and indigenous populations, although the effects were more minor for rural and indigenous populations. There was also a trend toward decreasing incidence of PCV13-type invasive pneumococcal disease (IPD) among undervaccinated children as PCV13 coverage increased (Chan et al., 2021). Despite the implementation of PCV-13 immunization programs, challenges persist in achieving optimal immunization coverage, particularly in rural and urban areas. Accessibility of health services, level of community knowledge, and environmental differences between rural and urban areas are factors that need to be considered in understanding the function of PCV-13 immunization on the incidence of ARI in toddlers. In the study, "Pneumococcal Nasopharyngeal Carriage in Indonesian Infants and Toddlers Post-PCV13 Vaccination in a 2+1 Schedule: A Prospective Cohort Study." (Prayitno et al., 2021) with a prospective cohort study design, the study subjects were toddlers who received the PCV13 vaccine according to the 2+1 schedule with independent variables of Nasopharyngeal Pneumonia Incidence in Toddlers in Indonesia and dependent variables Vaccination, Time or age at vaccination, Children's demographic data, such as age, gender, and social background, geographic location. The prevalence of colonization increased with age in both the control and vaccine groups. The prevalence of vaccine type (VT) serotypes in the control group ranged from 40.9% at 2 months to 54.3% at 18 months. In the vaccine group, the prevalence ranged from 25.9% at 2 months to 38.0% at 12 months and 22.6% at 18 months. The most common VT serotypes in both groups were 6A/6B, 19F, 23F, and 14. The prevalence of VT serotypes decreased significantly compared to non-vaccine type (NVT) serotypes after three doses of PCV13 vaccine. The prevalence of 6A/6B serotypes also decreased after PCV13 administration using the 2+1 schedule. Levels of pneumococcal conjugate vaccine coverage and indirect protection against invasive pneumococcal disease and pneumonia hospitalisations in Australia: An observational study (Chan et al., 2021) with Observational study, children and adults susceptible to invasive pneumococcal disease and pneumonia in Australia. There was a strong inverse association between PCV coverage and the incidence of PCV7-type IPD (adjusted incidence rate ratio [aIRR] 0.967, 95% confidence interval [CI]

0.958 to 0.975, p-value < 0.001), and pneumonia hospitalisation (all-cause pneumonia: aIRR 0.991, 95% CI 0.990 to 0.994, p-value < 0.001) among undervaccinated children. Substantial indirect protection at lower levels of PCV coverage required high levels of PCV coverage (i.e., greater than 90%). The effectiveness of the 13-valent pneumococcal conjugate vaccine against hypoxic pneumonia in children in Lao People's Democratic Republic: An observational hospital-based test-negative study (Weaver et al., 2020) with An observational study of children and adults susceptible to invasive pneumococcal disease and pneumonia in Lao PDR that PCV13 reduced hypoxic pneumonia and pneumonia requiring supplemental oxygen by 37% (95% confidence interval: 6.57%; p = 0:02) in children with pneumonia

The purpose of this study was to analyze the effect of Pneumococcus Conjugation Vaccine-13 (PCV-13) immunization on the incidence of ARI in toddlers in urban and rural areas of Bandung Regency.

METHOD

Type and Design of Research

This study examines the impact of PCV-13 immunization on the incidence of Acute Respiratory Tract Infections (ARI) in toddlers residing in rural and urban areas of Bandung Regency. The dependent variable is the incidence of ARI in toddlers. In contrast, the independent variables include the administration of Pneumococcus Conjugation Vaccine-13 (PCV-13) immunization, gender, toddler age, nutritional status, immunization history, parental occupation, maternal knowledge, and maternal education. The research design used is a retrospective cohort design.

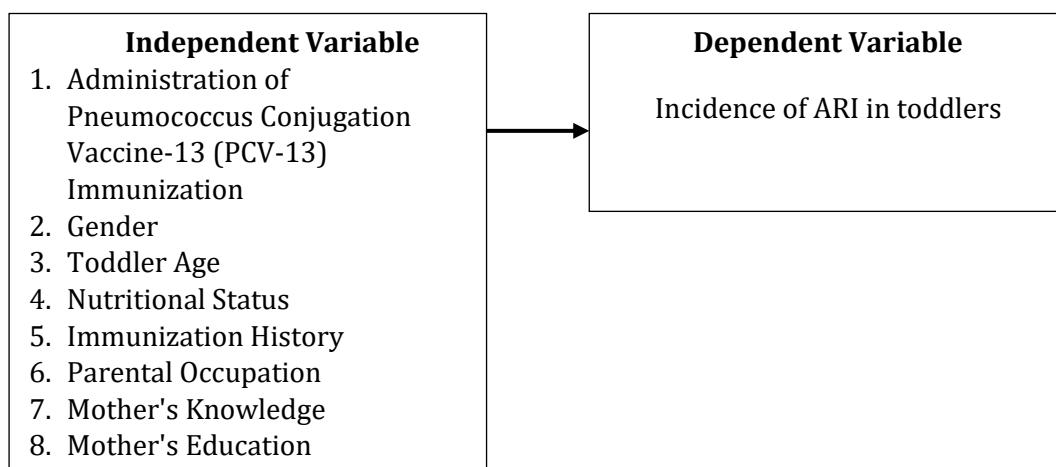


Figure 1. Research Concept Framework

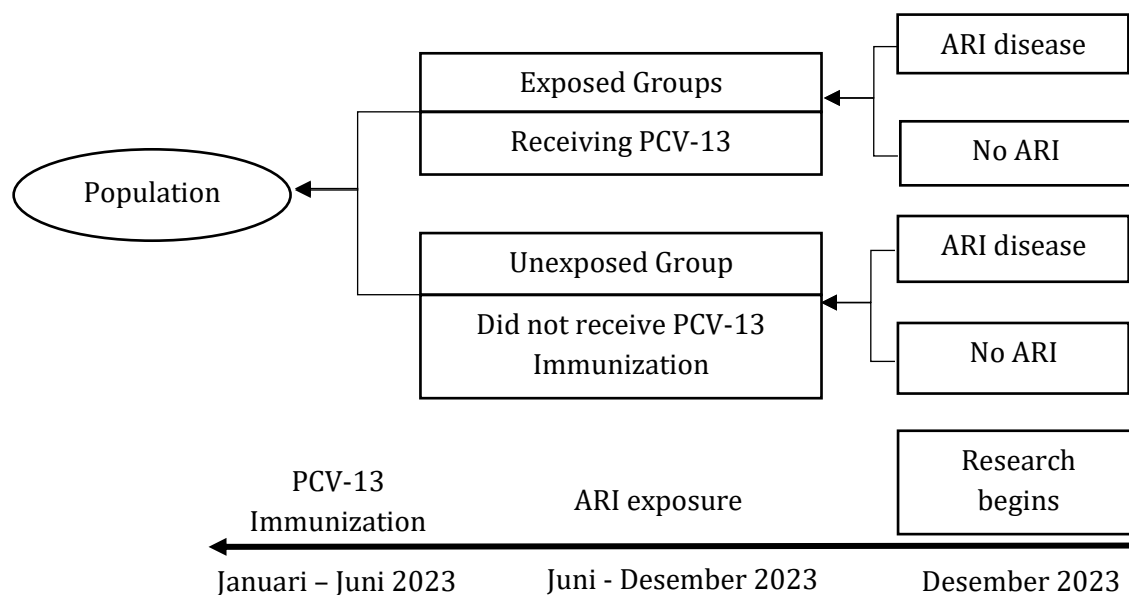


Figure 2. Cohort Study Scheme (Paulus et al., 2023)

The study design used was a retrospective cohort by analyzing existing data from the past to evaluate the effect of PCV-13 immunization exposure on the incidence of ARI in toddlers in urban and rural areas, retrospective cohort studies involved collecting data on PCV-13 immunization and the incidence of ARI from toddler health records in urban and rural areas. Samples were taken using random sampling with the best strata. This study compared the incidence of ARI between toddlers who received PCV-13 immunization and those who did not. Statistical analysis was conducted to determine whether there was a relationship between PCV-13 immunization and the incidence of ARI, and whether the relationship differed between toddlers in urban and rural areas.

Place and Time of Research

This study was conducted in Bandung Regency, covering two environmental contexts: villages, representing rural areas, and cities, representing urban areas. This is based on the characteristics of areas categorized as urban and rural, as outlined in Regulation No. 120 of 2020 from the Head of BPS. The study was conducted in two regions: rural in Kopo Village, Kutawaringin District, and urban in Bojong Village, Majalaya District. Based on the characteristics of the area, the research area was selected based on the highest PCV immunization coverage data from each regional characteristic, as determined by the Village Classification data in Bandung Regency. The research time began in January 2024. With a research duration of 3 weeks, this study covers a period that reflects the incidence of ARI in toddlers. This study examines the environmental, demographic, and epidemiological factors that may influence the study's results.

Data Collection and Analysis Techniques

The study population consisted of toddlers, specifically infants aged 1 to 3 years in Bandung Regency in 2023, totaling 63,940 toddlers. The target population was grouped using the stratified random sampling method by dividing the population into groups based on urban and rural characteristics. The urban area is Bojong Village, Majalaya District, with the number of toddlers who have received the 3rd dose of immunization from January to June 2023 being 133 people. The rural area is Kutawaringin Village, where the number of toddlers who have received the 3rd dose of immunization from January to June 2023 is 62. From this population, the sample size was determined using the sample size calculation formula in cohort research with an OR of 2.62, so that a minimum sample size of 120 toddlers was

obtained. The following sampling technique used proportional random sampling, with subpopulations defined by the characteristics of urban and rural areas. A simple random sampling technique was then carried out, selecting participants randomly from the toddler population in both urban and rural areas. Based on table 1 below, the results of the sample calculation obtained a minimum sample size in urban areas of 82 toddlers, then the ratio of 1: 1 is 82 toddlers in the PCV-13 exposed group and 82 toddlers as a group not exposed to PCV-13 so that the total number of samples in urban areas is 164 toddlers. For samples in rural areas, 38 toddlers were exposed to PCV-13, and 38 toddlers were not exposed to PCV-13; therefore, the total number of samples in rural areas is 76 toddlers. It can be concluded that the total sample size to be taken is 240 toddlers, with 120 toddlers in the PCV-13 exposed group and 120 toddlers in the PCV-13 unexposed group.

Table 1. Number of Samples in each Subpopulation

No	Place Name	Number of toddlers immunize d with PCV-13	Sample		
			Exposed Groups	Unexpose d Group	Total Amount (1:1)
1	Urban	133	82	82	164
2	Rural	62	38	38	76
Amount		195	120	120	240

The data collection techniques in this study consisted of both primary and secondary data. The primary data collected were in the form of visit/measurement dates, toddler identity, toddler weight measurement to assess nutritional status, parent identity, parent occupation, mother's education, and mother's knowledge of PCV-13 immunization. Secondary data collected from the Health Office were in the form of toddler target data and PCV-13 immunization achievements from January to June 2023, data from the Kopo Health Center for urban areas and the Majalaya Health Center for rural areas to obtain the names of toddlers who received 3 doses of PCV-13 according to the inclusion criteria and the names of toddlers who did not receive 3 doses of PCV-13. Data analysis used univariate analysis to determine the frequency distribution of the effect of PCV-13 immunization on the incidence of ARI in toddlers in urban and rural areas of Bandung Regency. Bivariate analysis was conducted to examine the relationship between the independent variable (PCV-13 immunization) and the dependent variable (ARI incidence in toddlers). The bivariate analysis employed the chi-square test to assess the relationship between the PCV-13 immunization variable and the incidence of ARI in both urban and rural areas. Multivariate analysis was conducted to examine other variables that served as controls and confounding variables (child age, gender, immunization history, regional characteristics, parental occupation, maternal knowledge, and maternal education), which, in theory, could affect the dependent variable (ARI incidence in toddlers). In this study, multivariate analysis using logistic regression was employed. In conducting research on the effect of PCV-13 (Pneumococcus Conjugation Vaccine-13) immunization on the incidence of ARI in toddlers in urban and rural areas of Bandung Regency in 2023, it was by the research code of ethics through ethical approval number 01/KEPK/FitKes-UNJANI/I/2024 dated January 3, 2024 issued by the Health Research Ethics Commission of the Faculty of Health Sciences and Technology, Jenderal Achmad Yani University, Cimahi.

RESULTS AND DISCUSSION

1. Description of the provision of Pneumococcus Conjugation Vaccine-13 (PCV-13) immunization, gender, age of toddlers, immunization history, nutritional status, mother's occupation, mother's

knowledge, and mother's education, with the incidence of ARI in toddlers in the characteristics of urban and rural areas of Bandung Regency.

Table 2. Frequency Distribution of Independent Variables

Variabel	ARI incident				Total	
	No		Yes			
	n	%	n	%	N	%
PCV-13 Immunization						
Received 3 Doses	117	48,8	3	1,3	120	50,0
Did Not Receive 3 Doses	62	25,8	58	24,2	120	50,0
Gender						
Male	94	39,2	34	14,2	128	53,3
Female	85	35,4	27	11,3	112	46,7
Toddler Age						
1-2 Year	137	57,1	44	18,3	181	75,4
2-3 Year	42	17,5	17	7,1	59	24,6
Characteristics of						
Urban Areas	124	51,7	40	16,7	164	68,3
Rural Areas	55	22,9	21	8,8	76	31,7
Immunization History						
Yes Complete	96	40,0	2	0,8	98	40,8
Incomplete	83	34,6	59	24,6	142	59,2
Nutritional Status						
Severely underweight	3	1,3	0	0,0	3	1,3
Underweight	8	3,3	0	0,0	8	3,3
Normal weight	138	57,5	55	22,9	193	80,4
Risk of overweight	30	12,5	6	2,5	36	15,0
Mother's Occupation						
Working	7	2,9	0	0,0	7	2,9
Not working	172	71,7	61	25,4	233	97,1
Mother's Knowledge						
Low	37	15,4	14	5,8	51	21,3
Enough	86	35,8	35	14,6	121	50,4
Good	56	23,3	12	5,0	68	28,3
Mother's Education						
Primary	108	45,0	21	8,8	129	53,8
Secondary	62	25,8	39	16,3	101	42,1
High	9	3,8	1	0,4	10	4,2
Total	179	74,6	61	25,4	240	100,0

The results of the analysis showed that among toddler respondents in urban areas who received PCV-13 immunization and experienced ARI, there were zero toddlers (0%). In contrast, among toddler respondents who did not receive PCV-13 immunization and experienced ARI, there were 40 toddlers (24.2%). Meanwhile, among toddler respondents in rural areas, those who received PCV-13 immunization and experienced ARI were 3 toddlers (3.9%), while those who did not receive PCV-13 immunization and experienced ARI were 18 toddlers (23.7%). According to Jie Tian's 2023 research results, PCV13 vaccination can significantly reduce the incidence of clinical pneumonia among children under 5 years of age, both in outpatient and inpatient settings (Tian et al., 2023). The results of a study conducted in 3 districts (Central Lombok Regency, West Lombok Regency and East Lombok Regency) in NTB Province in 2019 showed that the PCV immunization program using the 13-valent PCV vaccine, with a schedule of administration to infants aged 2 months, 3 months and 12 months has proven effective in reducing the proportion of pneumococcal serotypes that can cause

severe pneumonia, with the prevalence of colonization increasing with age in both the control and vaccine groups. The prevalence of vaccine type (VT) serotypes in the control group ranged from 40.9% at 2 months to 54.3% at 18 months, while in the vaccine group it ranged from 25.9% at 2 months to 38.0% at 12 months and 22.6% at 18 months of age (Prayitno et al., 2021). The analysis results showed that among toddler respondents with urban area characteristics and a complete immunization history, zero toddlers (0%) experienced ARI, while among those with an incomplete immunization history, 40 toddlers (24.4%) experienced ARI. In rural areas, there were characteristics with a complete immunization history, whereas many as two toddlers (2.6%) experienced ARI. In toddler respondents with an incomplete immunization history, as many as 19 toddlers (25.0%) experienced ARI. The immunization history in question is having received four doses of DPT-Hb-Hib immunization and two doses of MR Immunization. According to the results of Bawankule's 2017 study, children who were vaccinated against measles were less likely to suffer from ARI than children who were not vaccinated in India and Pakistan. Measles vaccination was associated with a 15–30 percent reduction in ARI cases in India and Pakistan, and a 12–22 percent reduction in diarrhea cases in the Democratic Republic of the Congo, India, Nigeria, and Pakistan (Bawankule et al., 2017). It is interesting to note that basic immunization was correlated with protection against pneumonia, even though the pneumococcal conjugate vaccine had not been included in the vaccine regimen (Sultana et al., 2019).

2. Relationship between dependent variables and independent variables

Table 3. Relationship between Dependent Variables and Independent Variables

Table 5: Relationship between Dependent Variables and Independent Variables								
Independent Variable	Dependent Variable				Total	RR 95% CI	P-Value	
	ARI incident							
	No		Yes					
	n	%	n	%				
PCV-13 Immunization Administration	Characteristics of Urban Areas							
	Received 3 Doses	82	50,0	0	0,0	82	1,952	0,00
	Did Not Receive 3 Doses	42	25,6	40	24,4	82	(1,581-2,412)	0
	Amount	124	75,6	40	24,4	164		
	Characteristics of Rural Areas							
	Received 3 Doses	35	46,1	3	3,9	38	1,750	0,00
	Did Not Receive 3 Doses	20	26,3	18	23,7	38	(1,276-2,400)	0
	Amount	55	72,4	21	27,6	76		
Gender	Characteristics of Urban Areas							
	Male	67	40,9	22	13,4	89	0,991	0,91
	Female	57	34,8	18	11,0	75	(0,832-1,179)	5
	Amount	124	75,6	40	24,4	164		
	Characteristics of Rural Areas							
	Male	27	35,5	12	15,8	39	0,915	0,53
	Female	28	36,8	9	11,8	37	(0,693-1,208)	0
	Amount	55	72,4	21	27,6	76		
Toddler Age	Characteristics of Urban Areas							
	1-2 Years	97	59,1	33	20,1	130	0,940	0,56
	2-3 Years	27	16,5	7	4,3	34	(0,771-1,146)	2
	Amount	124	75,6	40	24,4	164		
	Characteristics of Rural Areas							
	1-2 Years	40	52,6	11	14,5	51	1,307	0,09
	2-3 Years	15	19,7	10	13,2	25	(0,920-1,857)	1

Independent Variable	Dependent Variable				Total	RR 95% CI	P-Value		
	ARI incident								
	No		Yes						
	n	%	n	%					
	Amount	55	72,4	21	27,6	76			
Immunization History	Characteristics of Urban Areas								
	Yes Complete	79	48,2	0	0,0	79	1,889 (1,546-2,308)	0,00 01	
	Not Complete	45	27,4	40	24,4	85			
	Amount	124	75,6	40	24,4	164			
	Characteristics of Rural Areas								
	Yes Complete	17	22,4	2	2,6	19	1,342 (1,056-1,706)	0,05 4	
	Not Complete	38	50,0	19	25,0	57			
		Amount	55	72,4	21	27,6	76		
Nutritional status	Characteristics of Urban Areas								
	Very underweight	3	1,8	0	0,0	3	-	0,11 0	
	Underweight	4	2,4	0	0,0	4			
	Normal weight	89	54,3	36	22,0	125			
	Risk of being overweight	28	17,1	4	2,4	32			
	Amount	124	75,6	40	24,4	164			
	Characteristics of Rural Areas								
	Very underweight	4	5,3	0	0,0	4	-	0,28 2	
	Underweight	0	0,0	0	0,0	0			
	Normal weight	49	64,5	19	25,0	68			
	Risk of being overweight	2	2,6	2	2,6	4			
	Amount	55	72,4	21	27,6	76			
	Mother's Job	Characteristics of Urban Areas							
		Working	5	3,0	0	0,0	5	1,336 (1,221-1,462)	0,19 7
Not working		119	72,6	40	24,4	159			
Amount		124	75,6	40	24,4	164			
Characteristics of Rural Areas									
Working		2	2,6	0	0,0	2	1,336 (1,221-1,462)	0,37 6	
Not working		53	69,7	21	27,6	74			
		Amount	55	72,4	21	27,6	76		
Mother's Knowledge	Characteristics of Urban Areas								
	Low	32	19,5	9	5,5	41	-	0,363	
	Quite	66	40,2	26	15,9	92			
	Good	26	15,9	5	3,0	31			
	Amount	124	75,6	40	24,4	164			
	Characteristics of Rural Areas								
	Low	5	6,6	5	6,6	10	-	0,130	
	Quite	20	26,3	9	11,8	29			
	Good	30	39,5	7	9,2	37			
	Amount	55	72,4	21	27,6	76			
Mother's Education	Characteristics of Urban Areas								
	Basic	68	41,5	13	7,9	81	-	0,015	
	Intermediate	52	31,7	27	16,5	79			
	Enough	4	2,4	0	0,0	4			
	Amount	124	75,6	40	24,4	164			
	Characteristics of Rural Areas								

Independent Variable	Dependent Variable				Total	RR 95% CI	P-Value
	ARI incident						
	No		Yes				
	n	%	n	%			
Basic	40	52,6	8	10,5	48	-	0,004
Intermediate	10	13,2	12	15,8	22		
Enough	5	6,6	1	1,3	6		
Amount	55	72,4	21	27,6	76		

- a. The relationship between PCV-13 immunization and the incidence of ARI in urban and rural areas of Bandung Regency. The results of the analysis showed that there was a significant relationship between the administration of PCV-13 immunization and the incidence of ARI with a P-value of 0.000 <P-value 0.05 in urban areas as well as in rural areas P-value 0.000 <P-value 0.05, meaning that there was a significant relationship between the administration of PCV-13 immunization and the incidence of ARI in toddlers. With a Relative Risk (RR) value in urban area characteristics of 0.000<1, it means that the administration of PCV-13 immunization reduces the incidence of ARI where the administration of PCV-13 immunization is a protective factor, as well as in rural area characteristics with an RR of 0.167<1 that the administration of PCV-13 immunization can reduce the incidence of ARI in toddlers. Then, from the OR value in the characteristics of urban areas, we obtained 1.952 (95% CI 1.581-2.412), meaning that not receiving PCV-13 immunization has a risk of ARI in toddlers 1.9 times that of receiving PCV-13 immunization. The characteristics of rural areas obtained an OR of 10.500 (95% CI 2.749-40.102), meaning that not receiving PCV-13 immunization has a risk of ARI in toddlers 10.5 times higher compared to receiving PCV-13 immunization. The above shows that the administration of PCV-13 immunization in urban and rural areas affects the incidence of ARI in toddlers with varying relative risks, where the RR in rural areas is higher than in urban areas, and the OR value is also higher in rural areas than in urban areas. This finding aligns with the research of Jie Tian et al. (2023), which indicates that the group receiving PCV-13 had a significantly lower risk of pneumonia, including outpatient and inpatient pneumonia, compared to those with no PCV-13 exposure. The estimated effectiveness of the vaccine was 19% (95% CI: 3 to 32) for all causes of pneumonia, 20% (95% CI: 5 to 33) for outpatient visits, and 29% (95% CI: 3 to 48) for hospitalization, in children vaccinated with PCV-13 with at least one dose of PCV13. The protective efficacy of PCV13 was found to be higher in inpatient pneumonia (30%, 95% CI: 5% to 49%) compared to outpatient pneumonia (19%, 95% CI: 4% to 32%) (Tian et al., 2023).
- b. Relationship between immunization history and the incidence of ARI in urban and rural areas of Bandung Regency. The results of the analysis show that in the characteristics of urban areas, there is a significant relationship between immunization history and the incidence of ARI in toddlers with a P-value of 0.000 <P-value 0.05. Likewise, the characteristics of rural areas with a P-value of 0.054 (p < 0.05) indicate a significant relationship between immunization history and the incidence of ARI in toddlers. From the RR value of urban area characteristics of 0.000 < 1, it means that a history of immunization can reduce the incidence of ARI, similar to the findings in rural characteristics with an RR value of 0.316 < 1, indicating that a history of immunization can also reduce the incidence of ARI in toddlers. Based on the conclusion above, immunization history has a significant relationship with the incidence of ARI in both urban and rural areas. The RR value in urban areas is smaller than in rural areas. Likewise, the OR value in urban areas is smaller than in rural areas. The results of the study are in line with the research of Putri E G Damanik, et al in 2018 that the results of statistical analysis with the Chi Square test obtained a value of $\rho = 0.037$ ($\rho < 0.05$) which indicates that there is a significant relationship between the completeness of basic immunization status in children aged 12-24 months with the incidence of ARI. In addition, through the OR calculation, OR = 3.763 was

obtained which indicates that children aged 12-24 months who suffer from ARI are 3.8 times more likely not to have complete basic immunization compared to toddlers who do not suffer from ARI at a 95% confidence level, the OR value is believed to be in the interval 1.038-13.646 (Damanik et al., 2018). Likewise, according to Shabir A. Madhi in 2008 and research by Sutriana et al. in 2020, it was concluded that immunization also plays a crucial role in preventing pneumonia by maximizing the benefits of routine diphtheria, pertussis, and tetanus immunizations, as well as measles vaccines and measles boosters, for children. This has an impact on rapidly reducing child mortality rates in low-income countries, especially in Africa. It is interesting to note that basic immunization correlates with protection against pneumonia even though the pneumococcal conjugate vaccine has not been included in this vaccine regimen (Sutriana et al., 2021).

- c. The relationship between maternal education and the incidence of ARI in urban and rural areas of Bandung Regency. The results of the analysis show that in the characteristics of metropolitan areas, there is a significant relationship between maternal education and the incidence of ISPA in toddlers, with a P-value of 0.015 <P-value of 0.05. Similarly, in the characteristics of rural areas, there is a significant relationship between maternal education and the incidence of ISPA in toddlers, with a P-value of 0.004 <P-value of 0.05. The results of the study are in line with Cinta's 2018 study, which stated that there was a relationship between maternal education level and the incidence of ARI in toddlers aged 1-4 years, with a P-value of 0.001 < α value = 0.05. Where as many as 94 respondents with maternal education level, there were more education levels, namely low education (elementary and junior high school) which were 45 respondents (47.9%), then 42 respondents (44.7%) had secondary education (high school / vocational school), and 7 respondents (7.4%) had higher education (DIII, S1, S2, S2, S3). As many as 94 respondents with ARI incidents were identified, with 66 respondents (70.2%) having toddlers with ARI, and 28 respondents (29.8%) having toddlers without ARI (Cinta, 2018).
- d. Relationship between gender, toddler age, nutritional status, maternal occupation, and the incidence of ARI in urban and rural areas of Bandung Regency. The analysis results showed no significant relationship.

The results of the analysis showed that there was a significant relationship between the administration of PCV-13 Immunization and the incidence of ARI with a P-value of 0.000 <P-value 0.05 characterized by urban areas as well as rural areas P-value 0.000 <P-value 0.05 meaning that there was a significant relationship between the administration of PCV-13 immunization and the incidence of ARI in toddlers. With a Relative Risk (RR) value in urban area characteristics of 0.000 <1, it means that the administration of PCV-13 immunization reduces the incidence of ARI where the administration of PCV-13 immunization is a protective factor as well as in rural area characteristics with RR 0.167 <1 that the administration of PCV-13 immunization can reduce the incidence of ARI in toddlers. Likewise, for the variables of immunization history and maternal education, there was a significant relationship to the incidence of ARI. The variables of gender, age of toddlers, nutritional status, maternal occupation, and maternal knowledge did not have a significant relationship to the incidence of ARI in urban and rural areas of Bandung Regency. Each independent variable is subjected to bivariate analysis with the dependent variable. This analysis determines which variables are eligible to be included in the multivariate analysis, namely those with a p-value <0.25. For independent variables whose bivariate results yield a p-value > 0.25 but are substantially important, these variables can be included in the multivariate model.

Table 4. Bivariate Selection in Urban and Rural Areas

Variabel	P-Value
PCV-13 Immunization Administration	0,000
Immunization History	0,000
Mother's Job	0,041
Mother's Knowledge	0,181
Mother's Education	0,009

The results of the bivariate analysis yielded various P-values, so in the chi-square analysis, variables with a p-value < 0.25 will be continued for multivariate analysis. The variables that will be analyzed multivariately in terms of the characteristics of urban and rural areas include the provision of PCV-13 immunization, immunization history, maternal occupation, maternal knowledge, and maternal education.

Table 5. Multivariate Modeling in Urban and Rural Areas

Variabel	B	P-Value	OR (95% CI)
PCV-13 Immunization Administration	2,968	0,000	19,454 (4,520-83,735)
Immunization History	2,093	0,015	8,107 (1,510-43,531)
Mother's Job	-8,870	0,999	-
Mother's Education	1,599	0,000	4,946 (2,410-10,152)

Based on the results of multivariate modeling in urban and rural areas after removing variables with a p-value > 0.05, a change in OR value > 10% was obtained, so that all variables were re-entered into the modeling. Except for the mother's knowledge variable, it was removed from the modeling because the change in OR value was <10 10%. From the multivariate analysis, the variables significantly related to the occurrence of ARI in both urban and rural areas were PCV-13 immunization, immunization history, and the mother's education level. While the mother's occupation was a confounding variable.

CONCLUSION AND RECOMMENDATION

Based on the results of research and discussion regarding the effect of PCV-13 immunization on the incidence of ARI in toddlers in urban and rural areas of Bandung Regency in 2023, which involved 240 respondents and was conducted using univariate, bivariate, and multivariate analyses. There is a significant relationship between the administration of PCV-13 immunization, immunization history, and maternal education, and the incidence of ARI in toddlers, both in urban and rural areas. The results of the multivariate analysis showed that the variables significantly related to the incidence of ARI in both urban and rural areas were PCV-13 immunization, immunization history, and maternal education. While the mother's occupation is a confounding variable.

REFERENCE

- Abha, P., & Deepti, P. (2018). Risk factors of acute lower respiratory tract infection: a study in hospitalized central Indian children under 5 years of age. *MOJ Current Research & Reviews*, 1(3), 129–133. <https://doi.org/10.15406/mojcrr.2018.01.00020>
- Ahmed, K. Y., Page, A., Arora, A., Ogbo, F. A., Agho, K. E., Diallo, T., Ezech, O. E., Uchechukwu, O. L., Ghimire, P. R., Akombi, B. J., Ogeleka, P., Abir, T., Issaka, A. I., Rwabilimbo, A. G., Subramanee, D., Nagdev, N., & Dhami, M. (2020). Associations between infant and young child feeding practices and acute respiratory infection and diarrhoea in Ethiopia: A propensity score matching approach. *PLoS ONE*, 15(4), 1–20. <https://doi.org/10.1371/journal.pone.0230978>

- Alemayehu, S., Kidanu, K., Kahsay, T., & Kassa, M. (2019). Risk factors of acute respiratory infections among under five children attending public hospitals in southern Tigray, Ethiopia, 2016/2017. *BMC Pediatrics*, 19(1), 1–8. <https://doi.org/10.1186/s12887-019-1767-1>
- Anteneh, Z. A., & Hassen, H. Y. (2020). Determinants of acute respiratory infection among children in Ethiopia: A multilevel analysis from Ethiopian demographic and health survey. *International Journal of General Medicine*, 13, 17–26. <https://doi.org/10.2147/IJGM.S233782>
- Cacho, N. T., & Lawrence, R. M. (2017). Innate immunity and breast milk. *Frontiers in Immunology*, 8(MAY). <https://doi.org/10.3389/fimmu.2017.00584>
- Centers for Disease Control. (2022). *Penyakit Pneumokokus Penyakit dan Vaksinasi Pneumokokus Global Penyakit pneumokokus global*. <https://www.cdc.gov/pneumococcal/global.html>
- Chan, J., Gidding, H. F., Blyth, C. C., Fathima, P., Jayasinghe, S., McIntyre, P. B., Moore, H. C., Mulholland, K., Nguyen, C. D., Andrews, R., & Russell, F. M. (2021). Levels of pneumococcal conjugate vaccine coverage and indirect protection against invasive pneumococcal disease and pneumonia hospitalisations in Australia: An observational study. *PLoS Medicine*, 18(8), 1–21. <https://doi.org/10.1371/journal.pmed.1003733>
- Cinta, A. (2018). Hubungan Tingkat Pendidikan Ibu Dengan Kejadian Infeksi Saluran Pernapasan Atas Pada Balita. *Citra Delima: Jurnal Ilmiah STIKES Citra Delima Bangka Belitung*, 2(1), 17–22. <https://doi.org/10.33862/citradelima.v2i1.7>
- Control, C. for D. (2006). Pneumococcal conjugate vaccine. What you need to know. *South Dakota Medicine: The Journal of the South Dakota State Medical Association*, 59(12), 528–529.
- Cox, M., Rose, L., Kalua, K., de Wildt, G., Bailey, R., & Hart, J. (2017). The prevalence and risk factors for acute respiratory infections in children aged 0–59 months in rural Malawi: A cross-sectional study. *Influenza and Other Respiratory Viruses*, 11(6), 489–496. <https://doi.org/10.1111/irv.12481>
- Dagne, H., Andualem, Z., Dagnew, B., & Taddese, A. A. (2020). Acute respiratory infection and its associated factors among children under-five years attending pediatrics ward at University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia: Institution-based cross-sectional study. *BMC Pediatrics*, 20(1), 1–7. <https://doi.org/10.1186/s12887-020-1997-2>
- Damanik, P., Siregar, M. A., & Aritonang, E. Y. (2018). Correlation between Nutritional Status, Exclusive Breastfeeding, Basic Immunization Status, and the Incidence of Acute Respiratory Infection (ARI) in Children Aged 12–24 Months in the Work Area of the Glugur Darat Health Center, Medan City. *Nutrition, Reproductive Health and Epidemiology*, 1(4), 1–7.
- DINKES Kabupaten Bandung. (2022). *Profile Kesehatan Kabupaten Bandung Tahun 2022*.
- Direktorat Pengelolaan Imunisasi Kementerian Kesehatan RI. (2022). *Petunjuk Teknis Pelaksanaan Penumokokus Konyugasi (PCV)*.
- Dirjen P2PM Kemenkes RI. (2022). *Laporan Kinerja Laporan Kinerja Laporan Kinerja*.
- Fathmawati, F., Rauf, S., & Indraswari, B. W. (2021). Factors related with the incidence of acute respiratory infections in toddlers in Sleman, Yogyakarta, Indonesia: Evidence from the Sleman Health and Demographic Surveillance System. *PLoS ONE*, 16(9 September), 1–13. <https://doi.org/10.1371/journal.pone.0257881>
- Fitranti, D. Y., Wijayanti, H. S., Tsani, A. F. A., & Panunggal, B. (2023). Panduan Praktikum Penilaian Status Gizi. In *UIN Walisongo Semarang*.
- Hemilä, H. (2017). Vitamin C and infections. *Nutrients*, 9(4). <https://doi.org/10.3390/nu9040339>
- J.W. Senterfitt, A. Long, M. Shih, S. M. T. (2013). How Social and Economic Factors Affect Health. Social Determinants of Health. *Los Angels County Department of Public Health*, 1(January), 1–24.
- Kemenkes RI. (2017a). *Panduan Tatalaksana Pneumonia Balita*.
- Kemenkes RI. (2017b). Pedoman dan Standar Etik Penelitian dan Pengembangan Kesehatan Nasional. *Kementerian Kesehatan RI*, 1–158. <http://www.depkes.go.id/article/view/17070700004/program-indonesia-sehat-dengan->

pendekatan-keluarga.html

- Kemendes RI. (2018). Hasil Riset Kesehatan Dasar Tahun 2018. *Kemendiknas Kesehatan RI*, 53(9), 1689–1699.
- Kemendes RI. (2020). Permenkes RI No 2 Tahun 2020. *Kemendiknas Kesehatan RI*, 167(1), 1–5. <https://www.e-ir.info/2018/01/14/securitisation-theory-an-introduction/>
- Kemendiknas Kesehatan. (2019). Pedoman Pencegahan Pengendalian ISPA. 2019.
- Nurwahidah, N., & Haris, A. (2019). Pengetahuan Orangtua Berhubungan Dengan Kejadian ISPA Pada Balita Di Puskesmas Kumbe Kota Bima. *Jurnal Keperawatan Terpadu (Integrated Nursing Journal)*, 1(2), 9. <https://doi.org/10.32807/jkt.v1i2.32>
- Paulus, A. Y., Sulaeman, Mayasari, A. C., Ayu, J. D., Musniati, N., Sari, M. P., Hamdan, D. F., Farid, A., Selly, J. B., Amalia, N., Aulia, U., & Adnyana, I. M. D. M. (2023). *Biostatistika Epidemiologi* (Issue 1).
- Prasiwi, N. W., Ristanti, I. K., FD, T. Y., & Salamah, K. (2021). Hubungan Antara Status Gizi dengan Kejadian ISPA pada Balita. *Cerdika: Jurnal Ilmiah Indonesia*, 1(5), 560–566.
- Prayitno, A., Supriyatno, B., Munasir, Z., Karuniawati, A., Hadinegoro, S. R. S., Prihartono, J., Safari, D., Sundoro, J., & Khoeri, M. M. (2021). Pneumococcal nasopharyngeal carriage in Indonesia infants and toddlers post-PCV13 vaccination in a 2+1 schedule: A prospective cohort study. *PLoS ONE*, 16(1 January), 1–14. <https://doi.org/10.1371/journal.pone.0245789>
- Purnama, S. G. (2016). Buku Ajar Penyakit Berbasis Lingkungan. *Ministry of Health of the Republic of Indonesia*, 112.
- Ridwan, S. F., Rohima, W., Sudarsono, W., Septina, S. A., & Putri, S. R. (2021). Faktor Risiko Fisiologis Penyebab Kejadian Infeksi Saluran Pernafasan Akut (ISPA) pada Balita: Literatur Riview. *JUMANTIK (Jurnal Ilmiah Penelitian Kesehatan)*, 6(1), 85–95.
- Riyanto, A. (2022). *Pengolahan dan analisis data Data Kesehatan*. Nuha Medika.
- Saputri, E., Endarti, D., & Andayani, T. M. (2020). Tingkat Pengetahuan Orang Tua terhadap Penyakit Pneumonia dan Imunisasi Pneumococcal Conjugate Vaccine (PCV) di Indonesia. *JURNAL MANAJEMEN DAN PELAYANAN FARMASI (Journal of Management and Pharmacy Practice)*, 10(2), 156. <https://doi.org/10.22146/jmpf.54423>
- Sultana, M., Sarker, A. R., Sheikh, N., Akram, R., Ali, N., Mahumud, R. A., & Alam, N. H. (2019). Prevalence, determinants and health care-seeking behavior of childhood acute respiratory tract infections in Bangladesh. *PLoS ONE*, 14(1), 1–18. <https://doi.org/10.1371/journal.pone.0210433>
- Sutriana, V. N., Sitaresmi, M. N., & Wahab, A. (2021). Risk factors for childhood pneumonia: a case-control study in a high prevalence area in Indonesia. *Clinical and Experimental Pediatrics*, 64(11), 588–595. <https://doi.org/10.3345/CEP.2020.00339>
- Taksande, A. M., & Yeole, M. (2016). Risk factors of Acute Respiratory Infection (ARI) in under-fives in a rural hospital of Central India. *Journal of Pediatric and Neonatal Individualized Medicine*, 5(1). <https://doi.org/10.7363/050105>
- Tian, J., Zheng, B., Yang, L., Guan, Y., Xu, C., & Wang, W. (2023). Effectiveness of 13-valent pneumococcal conjugate vaccine on all-cause pneumonia in children under 5 years in Shanghai, China: An observational study. *Vaccine*, 41(41), 5979–5986. <https://doi.org/10.1016/j.vaccine.2023.08.041>
- Troeger, C., Blacker, B., Khalil, I. A., Rao, P. C., Cao, J., Zimsen, S. R. M., Albertson, S. B., Deshpande, A., Farag, T., Abebe, Z., Adetifa, I. M. O., Adhikari, T. B., Akibu, M., Al Lami, F. H., Al-Eyadhy, A., Alvis-Guzman, N., Amare, A. T., Amoako, Y. A., Antonio, C. A. T., ... Reiner, R. C. (2018). Estimates of the global, regional, and national morbidity, mortality, and aetiologies of lower respiratory infections in 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet Infectious Diseases*, 18(11), 1191–1210. [https://doi.org/10.1016/S1473-3099\(18\)30310-4](https://doi.org/10.1016/S1473-3099(18)30310-4)
- Tromp, I., Jong, J. K. De, Raat, H., Jaddoe, V., Franco, O., Hofman, A., De Jongste, J., & Moll, H. (2017). Breastfeeding and the risk of respiratory tract infections after infancy: The Generation R Study.

- PLoS ONE*, 12(2), 1–12. <https://doi.org/10.1371/journal.pone.0172763>
- UNICEF. (2022). *Responding to COVID-19*. <https://doi.org/10.4018/978-1-6684-3504-5.ch011>
- Weaver, R., Nguyen, C. D., Chan, J., Vilivong, K., Lai, J. Y. R., Lim, R., Satzke, C., Vongsakid, M., Newton, P. N., Mulholland, K., Gray, A., Dubot-Pérès, A., Dance, D. A. B., & Russell, F. M. (2020). The effectiveness of the 13-valent pneumococcal conjugate vaccine against hypoxic pneumonia in children in Lao People's Democratic Republic: An observational hospital-based test-negative study. *The Lancet Regional Health - Western Pacific*, 2, 100014. <https://doi.org/10.1016/j.lanwpc.2020.100014>
- WHO & UNICEF. (2006). *Pneumonia: the forgotten killer of children*.
- WHO & UNICEF. (2015). Ending preventable child deaths from pneumonia and diarrhoea by 2025. Development of the integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea. *Archives of Disease in Childhood*, 100, S23–S28. <https://doi.org/10.1136/archdischild-2013-305429>
- World Health Organization. (2014). Revised WHO Classification and Treatment of Childhood Pneumonia at Health Facilities: Evidence Summaries. In *Who*.