Jurnal Persatuan Perawat Nasional Indonesia
Journal of Indonesian National Nurses Association
P-ISSN: 2503-1376 E-ISSN: 2549-8576

Factors Associated with Acute Respiratory Tract Infections (ARIs) in Toddlers: A Cross-Sectional Study

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Received:
13 April 2026

Revised:
28 May 2026

Accepted:
5 July 2026

Keywords:
Acute respiratory infections, immunization, nutrition, smoking behavior, toddlers.

DOI:
http://dx.doi.org/10.32419/jppni.v11i2.856

ABSTRACT

Objective
This study aimed to analyze factors associated with the incidence of Acute Respiratory Infection ARIs among under-five children in the working area of the Gunung Jati Community Health Center, Cirebon District, Indonesia.

Methods
A quantitative analytical study with a cross-sectional design was conducted among 130 under-five children selected using simple random sampling. The independent variables were nutritional status, immunization status, and household cigarette smoke exposure, while ARIs incidence was the dependent variable. Data were collected using a structured questionnaire and analyzed using Chi-square tests and binary logistic regression.

Results
Multivariate analysis Nutritional status (AOR = 0.123; p = 0.001), immunization status (AOR = 0.058; p = 0.005), and household cigarette smoke exposure (AOR = 0.015; p < 0.001) were significantly associated with ARI. Household cigarette smoke exposure was the strongest factor associated with ARIs. incidence among under-five children.

Discussion
Nutritional status, immunization status, and household cigarette smoke exposure were significant factors associated with ARIs. Adequate nutrition and complete immunization reduced ARIs. risk, while cigarette smoke exposure increased it. Strengthening nutrition, immunization, and smoke-free home practices may help prevent ARIs in children.

Conclusion
Improving nutritional status, increasing immunization coverage, and promoting smoke-free home environments may contribute to reducing ARI incidence in this population.

Background

Acute Respiratory Infections (ARIs) remain one of the leading causes of morbidity and mortality among under-five children worldwide, particularly lower respiratory tract infections, which significantly contribute to mortality and Disability-Adjusted Life Years (DALYs) in children under five years of age in low- and middle-income countries (GBD 2021 Lower Respiratory Infections Collaborators, 2024). In Indonesia, ARIs remain a major public health problem among children under five years of age, with pneumonia and other respiratory infections continuing to contribute substantially to high morbidity rates (Ministry of Health of the Republic of Indonesia, 2024). At the regional level, ARI cases in Cirebon District also remain relatively high. According to the Cirebon District Health Office (2024), there were 93,098 ARIs cases in 2022 and 85,545 cases in 2023. Although the number of cases declined slightly, ARIs continue to represent a significant public health concern in the district. In addition to health impacts, ARIs impose a substantial economic burden on families and healthcare systems, including increased healthcare costs, loss of productivity, and household financial burden (Mosegui, Antoñanzas, & de Mello Vianna, 2023; Grace *et al.,* 2023).

The occurrence of ARIs in under-five children is influenced by multiple interrelated factors. Poor nutritional status can weaken immune function and increase susceptibility to infections (Bayu, Sari, & Rahmawati, 2024). In addition, immunization status plays an important role in providing protection against infectious diseases, where children with incomplete immunization have a higher risk of developing ARIs (Ibrahim, Nadimin, & Salsabilah, 2021). Environmental factors such as household exposure to cigarette smoke have also been shown to increase the risk of respiratory disorders in children due to impaired immune function and airway irritation (Eppang & Muldaniyah, 2025). Conceptually, these factors do not act independently but interact with one another in influencing the occurrence of ARIs in children (Wisudariani, Zusnita, & Butar Butar, 2022; Puspitaningrum, Aghniya, & Lestari, 2025). However, most previous studies have analyzed these risk factors separately or have not examined them simultaneously within a single integrated model in a specific primary healthcare context (Septiani *et al.,* 2024).

In the working area of the Gunung Jati Community Health Center, Cirebon District, ARI cases among under-five children showed an increasing trend from 1,553 cases in 2021 to 1,743 cases in 2022, and further increased to 1,950 cases in 2023 (Cirebon District Health Office, 2024). In addition, under-five children with poor nutritional status, incomplete immunization, and household exposure to cigarette smoke are still commonly found in this area. Based on these conditions, the novelty of this study lies in the simultaneous analysis of ARIs. Risk factors, including nutritional status, immunization status, and household cigarette smoke exposure, within a single analytical model among under-five children in the working area of the Gunung Jati Community Health Center, Cirebon District. This study is expected to provide more specific and contextual scientific evidence regarding factors associated with ARIs incidence among under-five children at the primary healthcare level. Theoretically, this study can be explained using the Neuman Systems Model (NSM) which views individuals as open systems affected by various

stressors (Neuman & Fawcett, 2011). In this context, nutritional status, immunization status, and cigarette smoke exposure act as stressors that can disrupt the stability of the child's system, thereby increasing the risk of ARIs. Therefore, this study aims to analyze the factors associated with the incidence of ARIs among under-five children in the working area of the Gunung Jati Community Health Center, Cirebon District.

Methods

This study employed a quantitative analytical approach with a cross-sectional design to examine factors associated with ARIs. among under-five children. The study was conducted in the working area of the Gunung Jati Community Health Center, Cirebon District, Indonesia. Data collection was carried out from January to February 2026. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (von Elm *et al*., 2007). The participant recruitment and selection process is presented in Figure 1 (STROBE Flow Diagram).

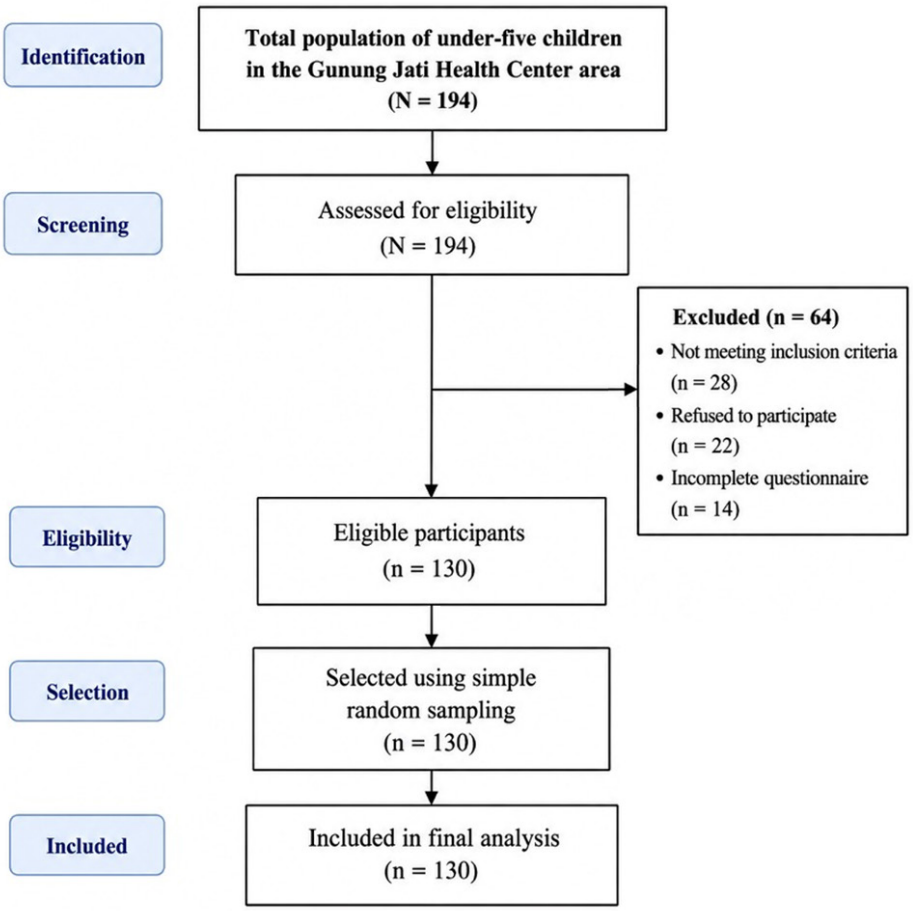

Figure 1. Flow Diagram of the Sample Selection Process

The study population consisted of all children aged 1–5 years residing in the catchment area of the Gunung Jati Community Health Center (Puskesmas) or visiting the health center for health services, Cirebon Regency, Indonesia (n=194). The sample size was determined using the Slovin formula with a 5% margin of error, resulting in 130 respondents. Simple random sampling was used to select participants who met the inclusion criteria. The processes of identification, screening, eligibility assessment, exclusion, inclusion, and final analysis are described in this study.

The inclusion criteria were: (1) parents or primary caregivers of children aged 1–5 years who were registered at or visited the Gunung Jati Community Health Center, Cirebon Regency, Indonesia, for health services (2) parents or legal guardians were willing to participate, and provided written informed consent; and (3) parents or legal guardians who were able to communicate effectively. The exclusion criteria were: (1) children who were seriously ill or hospitalized at the time of data collection and therefore unable to participate in the study; (2) parents or legal guardians who had communication difficulties or were unable to provide complete and accurate information.

The independent variables in this study were nutritional status, immunization status, and household cigarette smoke exposure. The dependent variable was the incidence of ARIs in under-five children. Operational definitions were as follows: Nutritional status was categorized as good or poor based on the World Health Organization Child Growth Standards using the Weight-for-Age (WAZ) index (World Health Organization, 2006). Immunization status was classified as complete or incomplete according to the Indonesian national immunization program established (Ministry of Health of the Republic of Indonesia, 2021). Household cigarette smoke exposure was categorized as exposed or not exposed based on whether household members smoked inside the house. ARIs incidence was defined as the presence of ARIs symptoms experienced by under-five children during the two weeks preceding the survey, based on caregiver recall obtained through the study questionnaire.

Data were collected using a structured questionnaire adapted from previous studies that assessed determinants of acute respiratory infections (ARIs) in children under five years of age (Fathmawati, Rauf, & Indraswari, 2021; Wijiastutik & Nikmah, 2023). The questionnaire consisted of 15 closed-ended items divided into four domains: nutritional status (items 1–4), immunization status (items 5–8), household cigarette smoke exposure (items 9–12), and ARIs incidence (items 13–15). Each item used categorical response options (yes/no or predefined categories based on variable classification). For scoring procedures, each correct or favorable response was assigned a value of 1, while unfavorable responses were assigned a value of 0. The total score for each variable was summed and subsequently categorized into two groups based on predetermined cut-off points derived from the distribution of scores and/or standard classification criteria: Nutritional status: good (adequate score) and poor (inadequate score based on WHO Weight-for-Age classification) Immunization status: complete (all recommended immunizations received) and incomplete (missing one or more required immunizations). Household cigarette smoke exposure: exposed (presence of household members who smoke inside the house) and not exposed (no smoking inside the house).

Prior to data collection, the study questionnaire underwent validity and reliability testing involving 30 parents or legal guardians of children aged 1–5 years with characteristics similar to those of the study population but who were not included in the final study sample. Because the questionnaire consisted of dichotomous (correct/incorrect) items, item validity was assessed using the point-biserial item–total correlation coefficient. The item–total correlation coefficients ranged from 0.421 to 0.812, all exceeding the critical value of 0.361 ($n = 30$, $\alpha = 0.05$), indicating that all questionnaire items were valid. Internal consistency reliability was assessed using Cronbach's alpha, yielding a coefficient of 0.696, which indicates acceptable reliability for exploratory research.

Data collection was conducted after obtaining ethical approval. Eligible respondents were informed about the study objectives, procedures, risks, and benefits, and written informed consent was obtained prior to participation. Data were collected through interviewer-administered questionnaires. All completed questionnaires were reviewed immediately for completeness and consistency to minimize missing data prior to analysis. Several strategies were implemented to minimize potential bias. Recall bias was minimized by using a structured questionnaire that asked parents or legal guardians to report ARIs symptoms experienced by their children during the two weeks preceding the survey. Selection bias was minimized through simple random sampling

and clearly defined inclusion and exclusion criteria. Information bias was minimized by using a standardized questionnaire and trained interviewers to ensure consistency in data collection procedures.

Data analysis was performed using statistical software. Univariate analysis was used to describe the frequency distribution and percentage of each variable. For descriptive purposes, children's age was categorized into **5–11 months** and **1–4 years** to distinguish infants from older children under five years of age based on developmental stages (World Health Organization, 2023b). Continuous variables, including children's body weight and parents' or legal guardians' age, were summarized as mean ± standard deviation (SD) since it was normally distributed. Bivariate analysis was conducted using the Chi-square test to examine the associations between the independent variables (nutritional status, immunization status, and household cigarette smoke exposure) and ARIs incidence. A p-value of <0.05 was considered statistically significant. Multivariate analysis was performed using binary logistic regression to identify the most dominant factors associated with ARIs incidence while controlling for potential confounding variables. The results were presented as odds ratios (ORs) with 95% confidence intervals (CIs). This study was approved by the Research Ethics Committee (Approval No. 12/ETIK/UBHI/2026). Confidentiality and anonymity of respondents were strictly maintained. All data were used solely for researchpurposes, and participation was voluntary.

Results

Table. 1 Distribution of Respondent Characteristics (n=130)

Variable	Frequency (n)	Percentage (%)
Toddler's Gender		
Male	61	46.90
Female	69	53.10
Toddler's Age		
5–11 months	28	21.50
1–4 years	102	78.50
Education Level		
Primary school	20	15.38
Junior high school	32	24.62
Senior high school	58	44.62
University/College	20	15.38
Occupation		
Housewife (not employed)	55	42.31
Laborer	28	21.54
Self-employed	30	23.08
Civil servant/Employee	17	13.08
Smoking Status		
Smoker	47	36.15
Non-smoker	83	63.85
Total	130	100

Table 1 shows that 69 respondents (53.10%) were female. The majority of toddlers were aged 1–4 years, comprising 102 children (78.50%). Regarding educational attainment, 58 respondents (44.62%) had completed senior high school education. Regarding occupation, 55 respondents (42.31%) were housewives (not employed). In terms of smoking status, 83 respondents (63.85%) were non-smokers. In addition, the mean weight of toddlers was 10.60 ± 3.80 kg, while the mean age of parents or guardians was 33.10 ± 7.80 years (data not presented in Table 1). Table 2 shows that 81 respondents (62.3%) had good nutritional status. Regarding immunization status, 93 respondents (71.5%) had incomplete immunization status. In terms of household cigarette smoke exposure, 83 respondents (63.8%) were not exposed to cigarette smoke at home. Table 3 shows the associations between nutritional status, immunization status, household smoking exposure, and the incidence of ARIs among under-five children. The results indicated that all independent variables were significantly associated with ARIs incidence ($p < 0.001$).

Table 2. Distribution of Respondents by Nutritional Status, Immunization Status, and Household Smoking Exposure (n=130)

Variables	Frequency (n)	Percentage (%)
Nutritional Status		
Good	81	62.30
Poor	49	37.70
Immunization Status		
Fully Vaccinated	37	28.50
Partially Vaccinated	93	71.50
Household Smoking Exposure		
Good	83	63.80
Poor	47	36.20
Total	130	100%

Table 3. Bivariate Analysis of Factors Associated with ARIs Incidence in Toddlers (n = 130)

Variable	Incident ISPA		Total	p-Value
	ARIs n(%)	No ARIs n(%)		
Nutritional Status				
Good (Z-score -2 SD to 2 SD)	19 (38.80)	30 (61.20)	49 (100%)	<0.001
Poor (Z-score -3 SD to <-2 SD)	80 (98.80)	1 (1.20)	81 (100%)	
Immunization Status				
Complete	9 (24.30)	28 (75.70)	37 (100%)	<0.001
Incomplete	90 (96.80)	3 (3.20)	93 (100%)	
Household Smoking Exposure				
Smoking present	81 (97.60)	2 (2.40)	83 (100%)	<0.001
No smoking exposure	18 (38.30)	29 (61.70)	47 (100%)	

Multivariate analysis using binary logistic regression was conducted to identify factors independently associated with ARIs among under-five children (Table 4). The results showed that nutritional status, immunization status, and household cigarette smoke exposure remained significantly associated with ARIs incidence after controlling for other variables. Nutritional status was significantly associated with ARIs incidence ($p = 0.001$). Children with good nutritional status had lower odds of developing ARIs compared to those with poor nutritional status (AOR = 0.123; 95% CI: 0.035–0.433). Immunization status was also significantly associated with ARIs incidence ($p = 0.005$). Children who received complete immunization had lower odds of developing ARIs compared to those with incomplete immunization (AOR = 0.058; 95% CI: 0.008–0.446). Household cigarette smoke exposure was identified as the most dominant factor associated with ARIs incidence (Wald = 26.890; $p < 0.001$). Children who were not exposed to cigarette smoke at home had substantially lower odds of developing ARIs compared to those who were exposed (AOR = 0.015; 95% CI: 0.003–0.070). Overall, household cigarette smoke exposure was the most dominant factor associated with ARIs among under-five children, followed by immunization status and nutritional status.

Discussion

The present study demonstrated that nutritional status, immunization status, and household smoking exposure were significantly associated with the incidence of ARIs among toddlers. Children with poor nutritional status, incomplete immunization, and household exposure to tobacco smoke were more likely to experience ARIs. These findings are consistent with previous evidence indicating that biological, immunological, and environmental factors are major determinants of childhood respiratory infections (Wang *et al.,* 2020; Sarfo *et al.,* 2023). From the perspective of the NSM, these factors represent interacting intrapersonal and extrapersonal stressors that weaken the child's normal line of defense, compromise system stability, and increase susceptibility to respiratory infections. Neuman (1996**)** emphasized that the NSM provides a comprehensive framework for nursing research and practice by identifying stressors that threaten system stability and guiding interventions at the primary, secondary, and tertiary prevention levels. Furthermore, Montano (2021) highlighted that the NSM has been widely applied in nursing practice, education, research, and community health to strengthen clients' lines of defense against various stressors. More recently, a scoping review by Oliveira *et al.* (2024) showed that the NSM has mainly been applied in gerontological, hospital, outpatient, home, and community nursing settings, with limited use in identifying community-based risk factors for ARIs among toddlers. This study extends the model by integrating biological (nutritional and immunization status), behavioral (exclusive breastfeeding), and environmental (cigarette smoke exposure) stressors. It provides empirical evidence on modifiable risk factors for ARIs in children under five, strengthening the model's application in primary prevention and community nursing practice.

Table 4. Multivariate Logistic Regression Analysis of Factors Associated with ARIs among Under-Five Children

Variable	B	S.E.	Wald	p-value	Adjusted OR (Exp(B))	95% CI
Nutritional Status	-2.095	0.640	10.722	0.001	0.123	0.035–0.433
Immunization Status	-2.847	1.020	7.790	0.005	0.058	0.008–0.446
Household Smoking Exposure	-4.200	0.810	26.890	<0.001	0.015	0.003–0.070

The significant association between nutritional status and ARIs has important theoretical and practical implications. From the NSM perspective, poor nutritional status acts as a significant intrapersonal stressor that compromises system stability and weakens physiological defense mechanisms. Malnutrition impairs both innate and adaptive immune responses, thereby increasing susceptibility to respiratory infections (Calder *et al.,* 2020). The significant association observed in this study supports the NSM proposition that weakened internal defenses increase vulnerability to illness. In low-resource settings, recurrent exposure to infectious agents may further increase the risk of respiratory infections among young children, contributing to repeated illness episodes and adverse health outcomes (Wang *et al.,* 2020). These findings suggest that nutritional assessment, growth monitoring, and caregiver education should be strengthened as primary prevention strategies to reduce ARIs among children under five years of age.

In this study, 37.70% of the children were reported to have poor nutritional status. This relatively high proportion may be associated with inadequate dietary intake, inappropriate complementary feeding practices, recurrent infectious diseases, limited parental knowledge regarding child nutrition, and socioeconomic constraints that affect access to nutritious foods. Similar findings were reported by Andriani et al., (2023), who identified household, maternal, and community factors as important determinants of child malnutrition in Indonesia, and by Nurhidayah et al., (2023), who demonstrated that parents' knowledge and feeding skills significantly influence the nutritional status of toddlers. However, these findings should be interpreted with caution because children's nutritional status in the present study was obtained through interviewer-administered questionnaires based on caregivers' reports rather than direct anthropometric measurements of body weight and height. This approach may have introduced recall bias, reporting bias, and misclassification of nutritional status, thereby affecting the accuracy of the estimated prevalence. Future studies should incorporate standardized anthropometric measurements to improve the validity and reliability of nutritional status assessment.

Similarly, the significant association between immunization status and ARIs suggests that incomplete vaccination increases children's susceptibility to respiratory infections. Within the NSM framework, immunization serves as a protective mechanism that strengthens the client system against potential stressors before disease occurs. This interpretation is consistent with evidence showing that inadequate vaccine coverage remains a major public health challenge in low- and middle-income countries (Causey *et al.,* 2021). Since vaccination protects against major respiratory pathogens, including pneumococcus and influenza viruses (World Health Organization, 2023a; Bianchini *et al.,* 2019), improving immunization coverage should remain a priority strategy for reducing respiratory morbidity in early childhood (Carolina, Renaldo, & Astuti, 2025). The findings of this study further support the NSM assumption that preventive interventions can enhance system stability and reduce vulnerability to illness.

In this study, 71.50% of the children had received partial vaccination. This high proportion may be associated with several factors, including limited parental knowledge of the childhood immunization schedule, concerns about vaccine safety or adverse events, missed vaccination appointments, difficulties in accessing immunization services, and socioeconomic barriers that reduce the completion of recommended vaccines (Gebeyehu et al., 2023). In addition, inadequate family support and insufficient health education from healthcare providers may further contribute to incomplete immunization coverage (Bangura et al., 2020).

Household smoking exposure was also significantly associated with ARIs in this study. According to the NSM, exposure to tobacco smoke can be classified as an extrapersonal stressor originating from the child's external environment. Continuous exposure to secondhand smoke may impair airway defense mechanisms, increase inflammation, and reduce immune responsiveness, thereby weakening the child's normal line of defense (Xiang *et al.,* 2023; Kawachi *et al.,* 2023). The

significant relationship identified in this study supports the NSM proposition that environmental stressors can disrupt system stability when protective mechanisms are insufficient. Therefore, family-based interventions aimed at creating smoke-free home environments are essential to minimize environmental risks and strengthen child health protection.

Furthermore, the high incidence of ARIs observed in this study may reflect the cumulative influence of multiple interacting stressors. The NSM posits that illness occurs when stressors penetrate the flexible and normal lines of defense and exceed the capacity of the lines of resistance. The present study found a significant association between nutritional status and ARIs, with children who had better nutritional status being less likely to experience respiratory infections. This finding may be explained by the fact that malnutrition impairs immune function, reduces host defense mechanisms, and increases susceptibility and severity of infectious diseases (Merera, 2021). Conversely, adequate nutrition enhances immune competence and strengthens resistance to infection (Amirjani et al., 2023; Noor et al., 2023). From the perspective of the NSM nutritional status represents an intrapersonal stressor that influences the stability of the child's system, where better nutritional status strengthens the normal line of defense and increases resistance to environmental stressors. Therefore, improving nutritional status is essential as part of primary prevention strategies to reduce ARIs incidence in children.

A significant association was also observed between immunization status and ARIs, indicating that children with complete immunization were less likely to suffer from respiratory infections compared to those with partial immunization. This protective effect can be explained by the role of vaccines in reducing susceptibility to major respiratory pathogens and enhancing immune protection against infectious diseases **(Bianchini** *et al.,* **2019; Carolina,** Renaldo, & Astuti, 2025). Within the NSM framework, immunization functions as a primary prevention intervention that strengthens the flexible line of defense before exposure to stressors occurs, thereby maintaining system stability and reducing vulnerability to ARIs.

Household smoking exposure was significantly associated with ARIs, with children exposed to cigarette smoke having a higher risk of respiratory infections than those living in smoke-free environments. This is consistent with evidence showing that tobacco smoke impairs respiratory function, weakens immune responses, and increases susceptibility to respiratory infections in children (Puspitasari & Rahardja, 2021; Putri, Maharani, & Romdhoni, 2022; Abubakar et al., 2025). From the NSM perspective, household smoking exposure represents a persistent extrapersonal stressor that continuously disrupts the child's defense system and compromises physiological stability. These findings emphasize the importance of smoke-free home interventions as part of comprehensive primary prevention strategies to reduce ARIs among children.

These results have important implications for nursing practice and public health programs. Nurses and healthcare workers should strengthen health education for parents regarding balanced nutrition, the importance of complete immunization, and the dangers of smoking exposure in the household. At the community level, public health programs should focus on improving immunization coverage and promoting smoke-free home policies. For future research, further studies are recommended to use longitudinal designs to better assess causal relationships and to explore additional environmental and behavioral risk factors associated with ARIs in toddlers.

This study has several limitations. The cross-sectional design limits the ability to establish causal relationships between variables. In addition, nutritional status and immunization history were assessed based on caregiver-completed questionnaires without verification from anthropometric measurements or medical records, which may introduce recall bias and misclassification. Other potential confounding factors, such as household environmental conditions, hygiene practices, and access to health services, were not fully analyzed. Finally, the study was conducted in a single primary health care center, which may limit the generalizability of the findings.

Conclusion

Based on the findings of this study, nutritional status, immunization status, and household smoking exposure were significantly associated with the incidence of ARIs among toddlers in the working area of the Gunung Jati Community Health Center. Better nutritional status and complete immunization were associated with a lower occurrence of ARIs, whereas household smoking exposure was associated with a higher occurrence of ARIs among toddlers. These findings underscore the importance of considering nutritional, immunization, and household environmental factors in child health programs. To address these issues, several specific efforts should be strengthened. Nutritional status can be improved through regular growth monitoring at community health posts (Integrated Health Post), provision of supplementary feeding programs for undernourished children, and nutrition education for parents focusing on balanced diets and appropriate complementary feeding.

Immunization coverage can be enhanced by strengthening outreach services, implementing reminder recall systems for incomplete immunization schedules, and increasing community education regarding the importance of completing basic childhood vaccinations. In addition, smoke-free home environments can be promoted through health counseling for parents, particularly fathers who smoke, the establishment of smoke-free household agreements, and community-based smoking cessation support programs. These integrated interventions are expected to reduce ARIs incidence among children under five years of age.

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