Analysis of the Phenomenon of Acute Respiratory Infection (ARI) in Children Under Five at the Boyolali Regency Regional Health Center

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Abstract

Boyolali is located at the foot of Mount Merapi, and characterized by a cold, humid climate with an average temperature of 20°C. Acute Respiratory Infections (ARI) affect the upper and lower respiratory tracts for less than 14 days and are caused by viruses, bacteria, or fungi. ARI remains among the top three causes of illness in Central Java. This study aims to analyze individual and environmental factors contributing of ARI incidence in children under five years of age. An observational cross-sectional design was employed, with data collected through questionnaires. The number of children under 5 years old recorded was 109,968, resulting in a minimum sample size of 383. Questionnaires were distributed across 6 service areas of the Boyolali Public Health Center. Data analysis used binary logistic regression techniques. Results: ARI in infants (sig < 0.05). The odds ratio is 4.307. This means that infants with good individual factors will increase the number of non-ARI infants by 4.307 times. Environmental factors in infants (sig < 0.05). The odds ratio is 152.660. This means that infants with favorable environmental factors will increase of non-ARI infants by 152.660 times. Based on the results of the Spearman correlation test. Individual factors are important in environmental factors. Conclusion: In this study, both individual factors and environmental conditions significantly influence the incidence of ARI in infants in the Puskesmas in Boyolali .

***Keywords*: Acute Respiratory Infections, Analysis, Children, Risk Factors.**

INTRODUCTION

Acute Respiratory Infections (ARI) are infectious conditions originating in the upper or lower respiratory tract, capable of causing a wide range of illness severity, from mild discomfort to life-threatening complications. Disease outcomes are influenced by the type of pathogen and environmental circumstances. ARI remains a prevalent health issue in developing countries (Islam et al., 2022). Among children under 5 in low-income nations, ARI contributes to approximately one-third of all deaths annually, with 95% attributed to lower respiratory tract infections (Alexis & Tazinya, 2018). The global burden of ARI is still substantial, particularly in infants and toddlers, with approximately 3.9 million deaths occurring each year. ARI is an acute infection affecting various components of the respiratory system, starting from the nose to the lungs (alveoli) including its adnexic tissues such as the sinuses/cavities around the nose, pleural middle ear cavity. The etiology involves more than 300 species of bacteria, viruses, and rickettsiae. ARI typically lasts less than 14 days and predominantly impacts the lower respiratory tract in fatal pediatric cases (Eric et al., 2016;

Asa, 2023).

Acute Respiratory Tract Infections (ARI) continues to be one of the leading causes of morbidity and mortality worldwide due to infectious diseases. Nearly 4 million deaths are attributed to ARI annually, with 98% resulting from lower respiratory tract infections. According to WHO estimates, approximately 1.9 million children under five die each year due to ARI, with 70% of these deaths occurring in developing countries In Indonesia, ARI ranks first among the ten most frequently diagnosed conditions in health care facilities. Ministry of Health data from 2022 indicated over 5 million reported ARI cases nationwide, illustrating the significant strain this condition places on the healthcare system.

Central Java Province ranks among the top three regions for ARI incidence, alongside West Java and East Java, with 132,565 cases or 13.03% of the national total. The prevalence of ARI in toddlers reached 93.620 cases, of which 10,551 (11.27%) occurred in Central Java. According to the 2023 Indonesian Health Survey (SKI), the national prevalence of ARI among children under five was 4.8% (Kemenkes RI, 2023).

Boyolali Regency, situated at the foot of Mount Merapi, experiences cold and humid conditions. Climatic differences between the highlands and lowlands can influence ARI incidence among toddlers (Lestari et al., 2018). The cold climate accelerates disease transmission, with humidity, rainfall, and temperature serving as key meteorological factors (Anwar et al., 2020)

In general, toddlers affected by ARI are influenced by three primary risk categories: behavioral, individual, and environmental (Menanti et al., 2022). These include: 1) Behavioral factors: such as the family's use of mosquito repellent and smoking practices, both internal and external exposures; 2) Individual factors, including child's age, birth weight, nutritional status, vitamin A intake, and immunization history; and 3) Environmental factors, such as non-concrete housing floors, high humidity, poor ventilation, proximity to neighboring homes, occupancy density, air pollution, cigarette smoke, waste combustion, vechicle emissions, and industrial pollutants (Rafaditya et al., 2022). Common symptoms include earache, fever, headache, otorrhea, redness, swelling and ear (Zubaidah et al., 2025).

Children with ARI may present with symptoms classified into three categories: Mild symptoms, cough, hoarseness, nasal discharge, and fever above 37^{o}C (Asa, 2023). Moderate symptoms, rapid breathing dependent on age (≥60 breaths/min in infants under two months and fever above 39°C in children aged 2–. Other signs include red throat, brownish skin rashes resembling measles, itching, and purulent ear infections (Zebua et al., 2023). The clinical manifestations of ARI include redness of the throat and the appearance of reddish-brown

spots on the skin resembling measles, accompanied by itching. Additional symptoms may involve otalgia and purulent discharge from the ear canal, with respiratory sounds often described as snoring. Severe symptoms of ARI include cyanosis of the lips or skin, decreased consciousness or unresponsiveness, snoring-like breathing accompanied by agitation, intercostal retractions during inspiration, a rapid pulse exceeding 160 beats per minute or one that is non-palpable, and erythematous throat(Hartono et al., 2021).

Factors associated with ARI in toddlers in the Boyolali community include both individual and environmental determinants. Individual factors contributing to ARI incidence include Low Birth Weight (BBLR) defined as < 2,500 grams (Lestari & Adisasmita, 2021). Exclusive breastfeeding offers numerous benefits for infants, as breast milk plays a crucial role in enhancing immune function and providing protection against various diseases. The duration and quality of breastfeeding significantly influence a child's immune system development (Bakar et al., 2019). Immunization is a key preventive strategy against ARI, particularly those caused by bacterial and viral agents. Vaccines, such as DPT-HB, Measles, PCV, and BCG have been shown to boost immunity prevent severe infections, and reduce morbidity and mortality (Krauer et al., 2024). Toddlers with incomplete immunization schedules are more likely to experience ARI. Additionally, poor nutritional status serves as a critical determinant of ARI susceptibility.. Behavioral factors such as smoking and the presence of humid, inadequately ventilated housing contribute to an unhealthy living environment, thereby increasing ARI risk among toddlers (Wimalisca et al., 2023). Access to healthcare services is essential for early detection, timely treatment, and effective health education. Health centers play a vital role as frontline service providers in addressing ARI. Based on the factors described above, this study analyzes the interplay between individual and environmental variables in the incidence of ARI among toddlers in Boyolali Regency.

METHODS

This study employed an observational analytical design using a cross-sectional approach to examine the association between individual and environmental factors and the incidence of Acute Respiratory Infections (ARI) among children under five years of age. The research was conducted in Boyolali Regency, located in Central Java Province, Indonesia, a highland region situated at the foot of Mount Merapi, characterized by a cool and humid climate with average temperatures ranging from 18°C to 23°C. Data collection was carried out between January and March 2024 across six community health center (*Puskesmas*) service areas.

The target population included children aged 0–59 months residing in the six-community health center (*Puskesmas*) service areas in Boyolali. According to regional health records, the total population of children under five years old in 2024 was 109,968. The minimum sample size was calculated using the WHO formula for prevalence studies, assuming a 95% confidence level and a 5% margin of error, resulting in a sample size of at least 383 respondents. To minimize non-response bias, 400 respondents were recruited, and 386 completed the survey and met eligibility criteria.

Cluster random sampling was implemented, using the six Puskesmas service areas as clusters. Households with eligible children were randomly selected within each cluster. Inclusion criteria were: children aged 0–59 months; permanent residence in the study area with average temperatures between 18°C–23°C; mother or primary caregivers willing and able to provide informed consent; and children not currently receiving treatment for chronic illnesses. Exclusion criteria included caregivers unable to complete the interview or provide valid information; and children diagnosed with chronic systemic diseases such as HIV, malignancy, or chronic renal failure.

Primary data were collected using a structured, pre-tested questionnaire administered through face-to-face interviews conducted by trained enumerators. The questionnaire included sections on: Individual factors: child's age, gender, birth weight, breastfeeding duration, immunization history, nutritional status, and access to health services; Environmental factors: housing ventilation, indoor air quality, proximity to roads or factories, housing density, and exposure to cigarette smoke.

Instrument validity was conducted using Pearson's correlation, with all items yielding statistically significant results ($p < 0.05$). Reliability analysis using Cronbach's alpha produced coefficients of 0.703 for individual factors and 0.734 for environmental factors, indicating acceptable internal consistency. All data were coded and analyzed using IBM SPSS Statistics version 26. Descriptive statistics were used to summarize respondent characteristics and frequency distributions. Bivariate analysis using Spearman's rank correlation assessed the association between independent variables and ARI incidence. Variables with p-values < 0.05 were then included in a binary logistic regression model to identify significant predictors of ARI. Results were reported as odds ratios (OR) with 95% confidence intervals (CI), and statistical significance was defined as $p < 0.05$.

RESULTS

The results of the Spearman correlation test indicate that economic status is significantly associated with food security. Economic status plays a crucial role in determining family food security and was evaluated based on variables such as father's education, mother's education, father's occupation, maternal employment status, monthly family income, and number of family members. These components collectively contribute to the household's food security status. The data from the results of research that have been carried out are summarized and shown in Table 2.

Table 2 presents a summary of the questionnaire data. The findings show that ARI incidence amoing toddlers was higher among those aged >/= 2 years (83,6%), those who received breastfeeding for less than 6 months (62,2%), and those with incomplete DPT-HB immunization at 2, 3, and 4 months (37,6%). Limited access to healthcare services, measured by long travel distances and times, was reported in 85,1% of ARI cases. Among households, 48,6% had a monthly income between 1.5 million – 3 million IDR. Additionally, 74% of ARI cases occurred in families with a history of ARI, and 78,4% of cases were linked to homes located near roads, indicating elevated exposure to air pollution. Poor ventilation was observed in 91,9% of homes where ARI was present, while 77% of affected toddlers lived in homes with a population density of four individuals.

Spearman's correlation test results further revealed significant associations between individual status and environmental conditions with the incidence of ARI among children under five. Individual status was significantly correlated with ARI status (r=0,543; p = 0,000), environmental conditions were significantly correlated with ARI status (r = 0,701; p = 0,000), and individual status also showed a significant relationship with environmental conditions (r = 0, 637; p = 0,000).

These statistically significant variables were included in a binary logistic regression analysis to assess their influence on ARI outcomes in toddlers. The regression results are presented in Table 4.

Table 1. Results of the Validity and Reliability Test of the Questionnaire

	R	sig	Reliability
Individual:			0,703
Toddler Age	0,787	0,000	
Long time getting breast milk	0,741	0,000	
Gender	0,787	0,000	
Nutritional Factors	0,525	0,003	
Immunization	0,871	0,000	
Access to health services	0,395	0,031	

Environmental Conditions:			0,734
Condition of the house	0,698	0,000	
Air pollution/cigarette smoke	0,900	0,000	
Occupancy density	0,917	0,000	

Based on the results of the test of the questions in the questionnaire were valid (the value of the correction test was significant and reliable or valid (the alpha Cronbach test was > 0.7) After obtaining the validity and reliability test of the questionnaire which was distributed to 400 respondents. Of the questionnaires that have been distributed, a total of 400 were filled out completely, 386.

Table 2. The Results of The Respondents Questionnaire, Regarding Individual Factors and Environmental Factors

Category	ARI		Not ARI	
	n	%	n	%
Toddler Age:				
< 3 years	12	16,2%	57	18,2%
>/= 3 years	61	83,6%	253	81,8%
How Long to Get Breast Milk :				
< 6 Months	47	62,2%	16	15%
6 Months	26	37,9%	267	85%
> 6 Months	0	0%	0	0%
Immunization Factors				
Hepatitis	4	5,4%	0	0%
BCG	25	33,8%	19	6,1%
Polio 4 x months 1,2,3,4	9	12,2%	85	27,4%
DPT-HB 3 x 2,3,4 months	27	37,7%	49	15,8%
PCV 2x 2 months 2.3	4	5,4%	77	24,8%
Rotavirus 3x months 2,3,4	4	5,4%	63	20,3%
Measles	0	0%	7	2,4%
DPT-Hb	0	0%	5	1,6%
MR (Measles Rubela)	0	0%	5	1,6%
Access to health services:	0	0%	18	5,8%
Distance and travel time	62	85,1%	87	28,1%
Availability of health facilities	11	14,9%	223	71,9%
Family Income/month:				
< 1.5 million	34	47,3%	9	2,9%
1.5 million – 3 million	36	48,6%	80	25,8%
3 million – 5 million	3	4,1%	181	58,4%
5 million – 7 million	0	0%	30	9,7%
> 7 million	0	0%	10	3,2%
Family Member Factors:				
No ARI	19	26%	71	22,9%
ARI	54	74%	239	77,1%
Air Pollution:				
Roadside house	57	78,4%	11	3,5%
Cigarette Smoke	16	21,6%	218	69,7%

Houses Near Factory	0	0%	84	26,8%
Ventilation:				
Bad	67	91,9%	17	5,5%
Good	6	8,1%	293	94,5%
Occupancy density:				
4 people	71	77%	19	6,1%
> 4 people	2	3%	225	72,6%
< 4 people	0	0%	66	21,3%

Source: Primary Data, 2024

Table 3. The Results of Sperman Correlation Test

	Environmental Factors	ARI Factors for Toddlers
Factor Individual	r = 0. 637 *p-value* =0.000	r = 0.543 *p-value* = 0.000
Environmental Factors		r = 0.701 *p-value* = 0.000

Source: Primary Data, 2024

The results of the Spearman correlation test showed that individual factors and environmental factors had a relationship with ARI factors in toddlers (sig <0.05). Individual factors also have a relationship with environmental factors (sig<0.05). Because individual factors and environmental factors have a significant relationship between ARI in toddlers, the two variables can be included in a binary logistics regression test to determine their effect on ARI in toddlers. The results of the binary logistics regression test are presented in table 4.

Table 4. The Results of Binary Logistics Regression Test

Variable	B	*p-value*	OR	95% CI	
				Lower	Upper
Factor Individual	1,460	0,006	4,307	1,517	12,227
Environmental Factors	5,028	0,000	152,660	42,476	548,668
Constant	-8,608	0,000	0,000		

Source: Primary Data, 2024

The logistic regression analysis showed that both individual and environmental factors significantly influenced the incidence of ARI in children under five. Children with poor individual conditions were 4.3 times more likely to develop ARI, while those exposed to unfavorable environmental conditions had a 152.7-fold increased risk. These findings highlight the critical role of both personal health practices and environmental quality in preventing ARI among young children.

DISCUSSION

The analysis revealed that individual factors are significantly associated with environmental conditions, indicating that both domains play a critical role in the incidence of ARI among children under five. This study assessed individual factors such as toddler age,

duration of breastfeeding, immunization completeness, access to healthcare services, and family income, all of which were considered determinants of environmental quality. Binary logistics regression analysis demonstrated that both individual and environmental factors were significantly correlated with ARI incidence (sig < 0.05). The odds ratio for individual factors was 4.307, suggesting that poor individual conditions increase the likelihood of ARI by over fourfold. Conversely, favorable individual attributes can reduce ARI risk. The odds ratio for environmental factors was 152,660, indicating that unfavorable environmental conditions dramatically elevate the likelihood of ARI. This finding underscores the protective role of a healthy environment in reducing the prevalence of respiratory infections.

In this study, 60.8% of toddlers with ARI had poor individual health indicators, while 39.2% had favorable ones. Among the individual factors, incomplete immunization—specifically DPT-HB administered at 2, 3, and 4 months—accounted for 37.7% of ARI cases. Children under five are particularly susceptible to ARI due to their developing immune systems(Septiani et al., 2025). Exclusive breastfeeding during the first six months is critical, offering comprehensive nutritional and immunological benefits. Breast milk provides essential antibodies and promotes optimal growth and immunity(Rita et al., 2025). Parental lack of awareness regarding child health and the absence of regular vitamin A supplementation can increase the risk of ARI. Vitamin A plays an essential role in boosting the immune system and can be obtained from chicken liver, beef liver, carrots, sweet potatoes, broccoli, spinach, and mango (Abainpah et al., 2025). Incomplete immunization and low birth weight are also established risk factors for ARI incidence among toddlers(Alamsyahi et al., 2021; Hassen et al., 2020).

Unfavorable environmental conditions significantly contribute to ARI risk. In this study, 95.9% of toddlers with ARI were exposed to poor environmental factors, while only 4.1% lived in favorable environments. Among toddlers without ARI, 71.9% lived in good environmental conditions, whereas 28.3% were exposed to poor ones. Children residing in households with protective family behaviors—such as smoke-free living environments, absence of factory emissions, and homes situated away from major roads—benefited from reduced ARI risk(Windi et al., 2021; Saputri et al., 2025). Toddlers living in environments with cigarette smoke and indoor pollutants are more susceptible to ARI. When parents smoke near children or use mosquito repellents and burn materials indoors, the risk of ARI increases by approximately 48%(Zebua et al., 2023). Poor ventilation allows pollutants, bacteria, and viruses to accumulate, while high occupancy density facilitates transmission and elevates ARI risk(Dingis et al., 2023). Homes with earthen or cement flooring that cannot be adequately

cleaned create humid conditions favorable for bacterial growth (multiply at humid temperatures) (Nabiha et al., 2023). Previous research has established a link between housing density, ventilation quality, and the incidence of respiratory infections(Sudirman et al., 2024). The presence of fixed, non-operable windows reduces air circulation and increases indoor humidity, fostering the proliferation of microorganisms and bacteria(Rafaditya et al., 2022).

This study's findings reinforce the relationship between individual health factors and environmental conditions. Built environments clearly influence the incidence of respiratory infections, as supported by research examining their correlation with communicable diseases(Indriyani et al., 2022). Individual factors play a vital role in shaping environmental outcomes. Adequate individual awareness and behavior can ensure air pollution control, functional ventilation with permanent natural airflow covering at least 10% of floor area, sufficient air exchange of five cubic meters per minute per inhabitant, and maintenance of comfortable indoor temperatures between 18°C and 30°C. Additionally, proper occupancy density must be maintained to reduce infection risk(Koirala, 2019).

CONCLUSION

This study demonstrates a significant association between individual and environmental factors and the incidence of ARI among children under five in Boyolali Regency. Children with poor individual health indicators—such as inadequate breastfeeding, incomplete immunization, and poor nutritional status—were more susceptible to ARI. Additionally, unfavorable environmental conditions, including exposure to pollutants, poor ventilation, and overcrowded housing, markedly increased the risk of ARI. These findings underscore the importance of enhancing both individual and environmental determinants to mitigate ARI incidence. In the short term, preventive strategies such as mask usage, maintaining personal hygiene, ensuring adequate rest and nutrition, and minimizing exposure to cigarette smoke and environmental pollutants can contribute to reducing ARI prevalence and related morbidity and mortality.

Long-term interventions should focus on promoting exclusive breastfeeding, ensuring complete immunization, encouraging clean and healthy living practices, and improving public health infrastructure. Given the increasing prevalence and severity of ARI, particularly in rural areas, the study highlights the need for government prioritization of ARI prevention and control as a critical public health concern.

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