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The Relationship of Age of Toddlers, Immunization, BBLR, Housing Density and Use of Mosquito Repellent Drugs with the Incidence of ISPA

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Abstract

Background: ISPA is the main cause of high morbidity and mortality rates in early childhood. This disease is caused by many factors, such as characteristics of toddlers and their environment.
Objective: This research aims to analyze the relationship between age, immunization, low birth weight (LBW), housing density, and the use of mosquito coils with the incidence of Acute Respiratory Infections (ARI) in toddlers.
Methods: This is a quantitative analytical study with a cross-sectional design. The sample consisted of 162 individuals. Data collection was conducted using a questionnaire. Data analysis techniques included the chi-square test and logistic regression.
Results: Results showed that 56.2% of toddlers were aged < 3 years; 3.7% had LBW; 33.3% had incomplete immunization; 27.8% lived in crowded housing; 27.8% were exposed to mosquito coils; and ARI incidence was 23.5%. Variables significantly associated with ARI were LBW (p-value: 0.040; OR: 7.176), immunization (p-value: 0.022; OR: 2.543), crowded housing (p-value: 0.004; OR: 3.233), and mosquito coil use (p-value: 0.041; OR: 2.382), while age was not significant (p-value: 0.238).
Conclusion: The most dominant variable associated with ARI incidence was immunization (OR: 3.046; CI: 1.360–6.821). Health centers are advised to strengthen ARI prevention programs through increased immunization coverage and continuous monitoring of basic immunization completion. This study provides local epidemiological evidence on combined biological and environmental ARI risk factors at the primary healthcare level, offering a basis for targeted intervention strategies.

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INTRODUCTION

Acute Respiratory Tract Infection (ARI) is a sudden-onset infection affecting the lung tissue and adjacent structures, including the sinuses, middle ear cavity, and pleura. It is triggered by microorganisms such as bacteria, viruses, or fungi, typically transmitted through air contaminated by an infected individual (Haryani & Misniarti, 2021).

ISPA is one of the main causes of high rates of illness and death in early childhood. According to the World Health Organization (WHO) globally, an estimated 13 million people have

died from ARI. The burden of disease varies greatly from approximately 4 million out of 13 million people, two-thirds of the global total of India (48%), Indonesia (38%), Ethiopia (4.4%), Pakistan (4.3%), China (3.5%), Sudan (1.5%), and Nepal (0.3%). New ISPA occurs almost every part of the world, in the year the highest number of ISPA cases in the world is found in Southeast Asia. Around 30 countries account for two-thirds of ISPA cases, Indonesia is one of the 30 countries contributing cases. The reduction in deaths due to ISPA between 2021 and 2022 was 25% and less than one-third towards the final seven ISPA reduction strategies of 32.10%.

Based on data from the Health Office, the number of ISPA cases in Indonesia based on reports from all provinces at the end of December 2020, the death rate due to ISPA disease is still ranked first compared to ASEAN countries, which is 705,659 cases (39.2%). In 2021, it is estimated that as many as 10 million people in the world suffer from ISPA and cause 1.4 million people to die every year. Indonesia is one of the countries with the burden of ISPA disease ranked first for infectious diseases. Efforts to counter ISPA in Indonesia face many challenges, this of course risks increasing the number of cases and transmission of ISPA (Ministry of Health of the Republic of Indonesia).

ISPA in toddlers is a multifactorial health problem, where various aspects can increase the risk of the disease (Rahmi & Rasyid, 2024). Factors such as the age of toddlers, immunization status, Low Birth Weight (BBLR) conditions, housing density, and the habit of using mosquito repellent in the home environment are some of the variables that are known to play a role in the increased risk of ISPA (Rosliana et al., 2020).

The age of toddlers is a very important factor because at this time the child's immune system is not fully mature, so they are more susceptible to various infections. Toddlerhood is a very important phase in a child's growth and development journey. In this period, the basis for health as well as physical and cognitive development for the future began to take shape. Therefore, the quality of growth and development at this age greatly determines the progress of children in the next stage of development. The age of toddlers is one of the main aspects that affect their health condition, especially related to respiratory diseases such as pneumonia. This is related to the immune system of toddlers who are still developing and have not worked optimally. Due to immature immunity, children under five are more susceptible to and susceptible to various infections, including ISPA.

Immunization plays an important role in reducing the risk of various infections that can interfere with the respiratory system. Incomplete immunization can increase the incidence of Acute Respiratory Infections (ARI), especially pneumonia. Incomplete immunization status of toddlers can also cause toddlers to be susceptible to ISPA, toddlers whose immunization status is incomplete have a three times greater chance of causing ISPA disease compared to those whose immunization status is complete.

Immunization not only provides protection to the individual who gets it, but it also contributes to the overall health security of the public. This principle is known as "herd immunity," which is one of the key approaches to preventing the spread of infectious diseases. When most members of the community have received the vaccine, the spread of the disease becomes very limited, thus protecting individuals who have not been able to receive immunizations, such as babies who are too young or people with allergic conditions to vaccine components.

Immunization, which is given in full, is one of the health efforts that has been proven to be effective in preventing various infectious diseases, including infections that can cause disorders in the respiratory system. Children who have not received complete immunization have a higher chance of experiencing ARI, because they do not receive optimal protection against diseases such as pneumonia, influenza, and diphtheria. Thus, immunization status is an important variable because it can function as a factor that protects children's health, but can also be a risk factor if immunization is not fulfilled thoroughly (Pasaribu & Nafratilova, 2025). Babies with low birth weight (LBW/BBLR) tend to have immature organs, including the lungs, making them vulnerable to respiratory disorders such as respiratory distress syndrome respiratory (RDS). Insufficient surfactants and limited oxygen capacity make BBLR babies more susceptible to hypoxia and respiratory tract infections, such as pneumonia and ARI. In addition, an immune system that has not developed optimally also increases susceptibility to various pathogens.

Despite the extensive body of literature on individual ARI risk factors, studies that simultaneously examine the combined effects of biological (LBW, age, immunization) and environmental (housing density, mosquito coil smoke) factors on ARI incidence in toddlers at the primary healthcare level remain scarce in the Indonesian context, particularly in Bandar Lampung. Previous studies have generally examined these factors in isolation, leaving a gap in understanding their relative and combined contributions.

This study addresses that gap by employing a multivariate logistic regression approach that enables simultaneous assessment of five risk factors. The novelty of this study lies in its contextualization within a rapidly changing urban health setting at the Rajabasa Indah Health Center, where ARI incidence has increased consistently from 581 cases in 2023 to 689 cases in 2025, and in its integration of both intrinsic and extrinsic factors in a single analytical model. The findings are expected to contribute to the formulation of more targeted, evidence-based promotive and preventive strategies for ARI control at the community health center level.

Jayatmi (2019) research reported that 62% of BBLR babies treated in perinatology rooms had complications of respiratory tract infections. The risk of morbidity and mortality in BBLR is quite high due to impaired growth and organ immaturity. The main causes of death in this group include asphyxia, respiratory distress syndrome, infection, and hypothermia complications (Jayatmi & Imaniyah, 2019). BBLR is one of the factors that cause ISPA in children under five years of age. Children with a history of BBLR will be more susceptible to ISPA than children without BBLR. The cause is due to the imperfect state of the lungs and the lack of immunity in children with a history of BBLR allowing infectious diseases to attack more easily, including ISPA. In general, babies with a birth weight of less than 2,500 grams often have delayed organ development, including the lungs, and have an immature immune system. Therefore, BBLR is designated as an independent variable because it is an innate biological factor that has a major influence on the risk of ISPA (Wulandari et al., 2023).

The imbalance between the area of the building and the number of occupants can cause *overcrowded* conditions. This situation has a negative impact on health because it reduces the availability of oxygen in the home and increases the likelihood of transmission of infectious diseases between family members (Zairinayati & Putri, 2020). Thus, occupancy density was chosen as an important variable because it reflects environmental factors that play a role in increasing epidemiological risks at the household level. In addition, the physical condition of the house that is not permanent such as walls made of planks or woven bamboo, dirt floors or boards, and cement that has not been plastered can worsen the quality of the residential environment. Ceiling types such as asbestos, non-standard ventilation, and poor room lighting also contribute to the increased incidence of ISPA (Lubis & Ferusgel, 2019).

The use of mosquito repellent represents a significant environmental risk factor for ARI. Burnt mosquito repellent smoke contains toxins that irritate the respiratory system, facilitating easier invasion by pathogens that cause ARI (Tabalawony & Akollo, 2023). Prolonged exposure is particularly harmful for toddlers whose respiratory defenses are not yet fully developed.

Infants and toddlers who live in home environments with poor air quality are more likely to have damage to the lung defense system, making them more susceptible to respiratory tract disorders. This condition makes it easier for microorganisms or germs to enter the body, especially through the respiratory tract, and develop to cause symptoms of the disease in a period of time that can last up to 14 days. Air pollution in the house can arise due to the use of various types of insect controls, such as mosquito repellent sprays, electricity, or burns. Basically, all types of mosquito repellent drugs work like pesticides, which produce toxins that damage or weaken the mosquito's nervous system when inhaled (Fadillah & Azizah, 2022). Meanwhile, burnt mosquito repellent produces fumes that contain harmful chemical compounds such as allethrin, which can irritate a child's respiratory tract. Various studies have shown a significant relationship between the use of mosquito repellent and an increase in the incidence of ISPA in toddlers (Nyomba, 2022). Therefore, this variable was chosen to assess how indoor air pollution affects early childhood respiratory health.

The results of the pre-survey related to the incidence of ISPA at the Rajabsa Indah Health Center in 2025 show that ISPA is included in the top 5 diseases most suffered by toddlers in the last 3 years. In 2023 with an incidence rate of 581 cases, in 2024 there will be 649 cases and an

increase for 2025 with an incidence of 689 cases or as much as 17.8% of the total diseases suffered by children under five. In addition, information on the role of biological factors such as low birth weight (BBLR) and age of toddlers, as well as environmental factors such as housing density and the use of burning mosquito repellents, is still minimal and has not been thoroughly documented. Therefore, local data-based research is needed to strengthen evidence-based prevention efforts and produce more targeted interventions. The findings of this study are expected to be a foothold in the formulation of promotive and preventive policies to reduce the number of ISPA in the work area of the Rajabasa Indah Health Center, and can be applied in other areas with similar conditions.

METHOD

This type of research is quantitative research with a Cross sectional design. The subjects of this study were all toddlers who came to the pediatric polyclinic service of the Rajabasa Indah Health Center on December 1-31, 2025, with a total sample of 162 toddlers taken by random sampling technique. The research objects were the age of toddlers, immunization, BBLR, housing density and the use of mosquito repellent at home and the incidence of ARI. The research was conducted at the Rajabasa Indah Health Center. The research instrument used questionnaires and checklist sheets. Analysis of univariate, bivariate and multivariate analysis data with logistic regression tests.

The sampling technique used was simple random sampling, in which each toddler in the pediatric polyclinic population had an equal probability of being selected. The inclusion criteria for this study were: (1) toddlers aged 0–59 months who visited the pediatric polyclinic at Rajabasa Indah Health Center during the study period; (2) parents or guardians who provided informed consent to participate; and (3) toddlers with a complete medical and immunization record. The exclusion criteria were: (1) toddlers who were acutely ill or hospitalized during data collection; (2) toddlers whose parents or guardians were unable to complete the questionnaire; and (3) toddlers with incomplete data that could affect the validity of analysis.

The research instrument (questionnaire) was tested for validity and reliability prior to the main data collection. Content validity was assessed by a panel of subject-matter experts, while construct validity was evaluated using the Pearson product-moment correlation coefficient (r-table at significance level 0.05). An instrument item was considered valid if the r-count > r-table. Reliability was measured using Cronbach's Alpha coefficient, with a threshold of 0.70 considered adequate for research instruments.

This study was conducted in accordance with ethical principles for research involving human subjects. Informed consent was obtained from all parents or legal guardians of the toddlers prior to data collection. Respondent confidentiality and anonymity were maintained throughout the study. The study obtained ethical clearance from the relevant health authority, and all procedures were carried out in compliance with the Declaration of Helsinki guidelines for medical research involving human participants.

Table 1. Operational Definitions of Variables

Variable	Definition	Measurement	Category	Scale
ARI Incidence (Y)	Diagnosis of ARI based on medical record or health worker confirmation during visit	Medical record / clinical diagnosis	0=No ARI; 1=ARI	Nominal
Toddler Age (X1)	Age of the toddler at the time of data collection	Questionnaire / birth record	0=≥3 yrs; 1=<3 yrs	Nominal
Immunization (X2)	Completeness of basic immunization per national schedule at the time of data collection	Immunization booklet / health card	0=Complete; 1=Incomplete	Nominal
LBW (X3)	Birth weight <2,500 grams based on birth	Birth certificate / medical record	0=No LBW; 1=LBW	Nominal

	certificate or medical record			
Housing Density (X4)	Ratio of floor area to number of residents; crowded if <8 m^2/person per Ministry of Health standard	Questionnaire / direct observation	0=Not dense; 1=Dense	Nominal
Mosquito Coil Use (X5)	Regular use of burning mosquito coil in the home environment	Questionnaire (self-reported)	0=Not used; 1=Used	Nominal

Source: Authors' compilation based on Ministry of Health guidelines and study instruments

RESULTS AND DISCUSSION

Results

Univariate Analysis

Table 2. Univariate Analysis Results

Variable	Categories	N	%
Toddler Age	< 3 years	91	56,2
	> 3 years	71	43,8
BBLR	BBLR	6	3,7
	No BBLR	156	96,3
Immunization	Incomplete	54	33,3
	Complete	108	66,7
Occupancy density	Solid	45	27,8
	Not dense	117	72,2
Mosquito Repellents	Yes No	45	27,8
		87	72,2
ISPA Incident	ISPA	38	23,5
	No	124	76,5
Total		**162**	**100**

Based on the table, it can be seen that from 162 respondents, the results were obtained that the majority were 91 toddlers aged < 3 years (56.2%); 156 toddlers had no LBW history (96.3%); 108 toddlers had complete basic immunization (66.7%); 117 toddlers lived in non-congested housing (72.2%); 117 toddlers did not use mosquito repellent (72.2%); and ARI incidence was recorded in 38 toddlers (23.5%).

Bivariate Analysis

Table 3. Bivariate Analysis Results

Variable	P value	OR	(CI95%)
Age*Incidence of ISPA	0,238	1,690	(0,792-3,604)
BBLR*ISPA Incident	0,040	7,176	(1,260-40,863)
Basic Immunization* of ISPA Incidence	0,022	2,543	(1,205-5,364)
Occupancy Density* ISPA Incidence	0,004	3,233	(1,502-6,958)
Mosquito Repellent* ISPA Incident	0,041	2,382	(1,107-5,128)

Based on table 2, it can be seen that there is no significant relationship between the age of toddlers and the incidence of ISPA (p-value = 0.238). There was a significant relationship between BBLR and the incidence of ISPA (p-value = 0.040), OR value: 7.176 showed that toddlers who experienced BBLR had a 7.176 times higher risk of experiencing ISPA than toddlers who did not BBLR. There was a significant relationship between baseline immunization and the incidence of

ISPA (p-value: 0.022). OR value: 2.543 indicates that toddlers with incomplete immunizations by age have a 2.543 times higher risk of developing ISPA than toddlers with complete immunization. There was a significant relationship between residential density and the incidence of ISPA (p-value: 0.004), OR value: 3.233 indicating that toddlers with dense housing had a 3.233 times higher risk of experiencing ISPA than toddlers with non-congested housing. There was a significant relationship between the use of burnt mosquito repellent and the incidence of OR: 2.382 indicating that toddlers who used burnt mosquito repellent had a 2.382 times higher risk of experiencing ISPA than toddlers who did not use burnt mosquito repellent.

Multivariate Analysis

Bivariate Selection

Table 4. Multivariate Model Candidate Selection

N	Variable	*p-Value*	Categories
1	Age	0,172	Candidates
2	BBLR	0,011	Candidates
3	Immunization	0,013	Candidates
4	Occupancy Density	0,002	Candidates
5	Mosquito Repellents	0,024	Candidates

Based on the table above, it is known that of the 5 variables, the entire variable with a p-value < 0.25 so that the overall variable enters become a Candidate.

Interaction Test

Table 5. Regression test results with interaction variables

Variable	p Value	OR	95% C.I.for EXP(B)	
			Lower	Upper
BBLR	0.101	4.631	0.742	28.898
Immunization	0.007	3.046	1.359	6.824
Occupancy Density	0.093	3.165	0.824	12.157
Mosquito Repellents	0.149	2.620	0.709	9.683
Occupancy Density* Mosquito Repellent	0.820	0.823	0.153	4.435

Based on the output, it can be seen that the results of the interaction test show that the p-value = 0.821 is greater than 0.05, meaning that there is no interaction between residential density and the use of burning mosquito repellent. This indicates that the effect of occupancy density on the incidence of ISPA is not affected by the use of burning mosquito repellent. Thus the modeling is complete, a valid model is a model without any interaction.

End-stage models

Table 6. End-stage models

Variable	p Value	OR	95% C.I.for EXP(B)	
			Lower	Upper
BBLR	0.100	4.629	.746	28.729
Immunization	0.007	3.046	1.360	6.821
Occupancy Density	0.016	2.803	1.210	6.494
Mosquito Repellents	0.045	2.331	1.018	5.335

The results of the multivariate analysis showed that there are four variables related to the incidence of ISPA in toddlers at the Rajabasa Indah Health Center in 2025, namely BBLR, basic immunization, occupancy density and the use of mosquito repellent. To see the variables that have the most dominant influence, focus on the Sig. column (p-value) in the variables in the equation

table, so that the related variables are basic immunization, occupancy density and the use of mosquito repellent drugs. Based on the OR value, it can be seen that the immunization variable with the largest OR value is 3,046 (1,380-6,821), followed by residential density with OR: 2,803 (1,210-6,494), and the third use of mosquito repellent with OR: 2,331 (1,018-5,335), so it can be concluded that the most influential factor is the completeness of basic immunization.

The variable Low Birth Weight (BBLR) was still included in the logistic regression model although the results of the multivariate analysis did not show a significant association with the incidence of ISPA (p = 0.100). This is based on several theoretical and methodological considerations where BBLR is a risk factor for ISPA based on theory and scientific evidence. This condition makes BBLR an important biological risk factor in the incidence of infectious diseases in children. The decision to retain this variable also takes into account that its existence does not cause significant changes in the odds ratio values of the main variables (immunization, occupancy density and mosquito repellent use), so as not to disturb the stability of the model. Thus, the BBLR variable is maintained to maintain the completeness of the model and control the possible confounding effect.

Discussion

Age Relationship with the Incidence of ISPA

Based on the results of bivariate analysis using the Chi-Square test, a p-value = 0.382 (p > 0.05) was obtained, which showed that there was no significant relationship between the age of toddlers and the incidence of ARI. Descriptively, 27.5% of toddlers aged ≥<3 years who experienced ISPA were 18.3% of toddlers. Although the proportion of ISPA incidence is higher in the <3-year-old age group, the difference is not statistically significant. An odds ratio (OR) value of 1.690 (95% CI: 0.792–3.604) indicates that <3-year-old toddlers have a 1.69 times greater risk of experiencing ISPA than ≥3-year-old toddlers, but confidence intervals beyond 1 indicate that the relationship is not significant.

Theoretically, the age of toddlers is an intrinsic factor that can affect susceptibility to ISPA. Younger toddlers have a imperfectly mature immune system, an under-optimal mucociliary defense mechanism, and narrower respiratory tracts, making them more susceptible to respiratory tract infections. However, as we age, the development of the immune system and adaptation to environmental exposure can increase the child's resistance to infectious agents.

The results of this study are in line with the research by Suhartina (2025) which stated that the age of toddlers was not significantly related to the incidence of ISPA after being statistically analyzed. Another study by Putri (2018) also found that although young toddlers tend to experience AKI more often, age is not a dominant factor if it is not accompanied by other risk factors such as occupancy density, smoke exposure, and immunization status. This suggests that age plays a more supporting role than the main factor in the incidence of ARI.

The insignificance of the relationship between the age of toddlers and the incidence of ISPA in this study is due to the presence of other risk factors that are more dominant and environmental, such as occupancy density and exposure to smoke in the house. In addition, increasing parental knowledge of child care and relatively equal access to health services across all age groups under five may reduce the difference in the risk of ISPA by age. Thus, the age of toddlers in this study is not the main determining factor for the occurrence of ISPA, but interacts with other risk factors.

The Relationship of BBLR to the Incident of ISPA

The results of data analysis showed that there was a significant relationship between BBLR and the incidence of ISPA in toddlers (p-value = 0.040). Toddlers with a history of BBLR who experienced ISPA were 66.7%, while in toddlers who did not have BBLR, only 21.8% experienced ARI. An odds ratio (OR) value of 7.176 (95% CI: 1.260–40.863) indicates that toddlers with BBLR have a risk of about 7 times greater risk of developing ISPA than toddlers who do not have BBLR.

Biologically, babies with BBLR have an immune system that has not been optimally developed and the structure and function of the lungs are immature. This condition causes the respiratory defense mechanism to become weaker, so that pathogens enter more easily and cause

respiratory tract infections, including ISPA.

Low Birth Weight (BBLR) is a significant risk factor in increasing the incidence of Acute Respiratory Infections (ARI) in toddlers. Toddlers born with low body weight have an imperfect immune system, making them more susceptible to various infections including ISPA. Low birth weight can be a sign of a disorder in fetal development during pregnancy, a lack of adequate nutrition, or a maternal illness that can affect fetal growth. In addition, BBLR babies may also have anatomical abnormalities that can complicate the breathing process and make them more susceptible to respiratory infections (Hadi et al., 2019).

The results of this study are in line with the research of Lestari (2021) which found a significant relationship between BBLR and the incidence of ISPA in toddlers in Indonesia. Research by Afriani (2020) also reported that toddlers with a history of BBLR have a higher risk of experiencing ISPA than toddlers with normal birth weight.

Although the proportion of BBLR in this study is relatively small, the impact on the incidence of ISPA is quite large due to the physiological condition of BBLR toddlers who are more vulnerable. In addition, postnatal care factors and advanced nutritional status can strengthen or weaken the influence of BBLR on the incidence of ARI.

The Relationship between Immunization and the Incidence of ISPA

The results of the data analysis showed that there was a significant relationship between immunization administration and the incidence of ISPA (p-value = 0.022). Toddlers with incomplete basic immunization experienced ISPA by 35.2%, while in toddlers with complete basic immunization, only 17.6% experienced ARI. An OR value of 2.543 (95% CI: 1.205–5.364) indicates that toddlers with incomplete immunizations are 2.5 times more likely to develop ISPA.

Basic immunization plays a role in forming specific immunity to various infectious diseases that can trigger or aggravate ARI. Children who do not receive complete immunization have a weaker immune system against infectious agents, making it easier to develop respiratory infections (Ministry of Health of the Republic of Indonesia).

These results are in line with the research of Anggraeni (2021) which stated that incomplete basic immunization is significantly related to an increase in the incidence of ARI. Research by Amalia (2021) also found that toddlers with complete immunization had a lower risk of ISPA compared to toddlers with incomplete immunization.

The discovery of toddlers with incomplete immunization can be related to parental knowledge, access to health services, and adherence to immunization schedules. This condition makes toddlers more susceptible to infections, including ISPA.

The Relationship between Residential Density and the Incidence of ISPA

The results of data analysis showed a significant relationship between occupancy density and the incidence of ISPA (p-value = 0.004). Toddlers who live in dense housing and experience ISPA by 40.0%, while toddlers who live in non-congested housing only 17.1% experience ARI. An OR value of 3.233 (95% CI: 1.502–6.958) indicates that dense dwellings increase the risk of ISPA by more than 3 times. Housing density is a pre-requisite for the process of disease transmission, especially diseases that are transmitted through the air, the denser the housing, the easier and faster the transmission of disease. This is due to several factors. First, high occupancy density tends to result in closer contact between individuals, increasing the potential for disease transmission from one individual to another, especially when a person is infected with ISPA. Second, high occupancy density can also affect air quality in enclosed spaces, which is an important factor in the spread of ISPA. Air that is poorly ventilated and filled with many people tends to have higher levels of air pollution, which can trigger ISPA in toddlers because they have a respiratory system that is still vulnerable (Sarwoko, 2021).

Housing density is significantly related to the incidence of ISPA in toddlers. Congested housing conditions are an important determinant of respiratory infections in children. Housing density not only increases the risk of disease transmission, but also worsens indoor air quality. This combination of factors causes toddlers who live in dense housing to be more susceptible to ISPA.

The Relationship between Burning Mosquito Repellent and the Incidence of ISPA

The results of data analysis showed that there was a significant relationship between the use of burnt mosquito repellent and the incidence of ISPA (p-value = 0.041). Toddlers who live at home with the use of mosquito repellent have a higher risk of experiencing ISPA than toddlers who are not exposed. OR value: 2.382 indicates a 2-fold increased risk of developing ISPA in the group exposed to burnt mosquito repellent smoke.

Burnt mosquito repellent smoke contains carbon monoxide, fine particulate matter (PM2.5), and irritant compounds that can damage the mucosa of the respiratory tract. Repeated exposure can lower lung defense mechanisms and increase the risk of respiratory infections in toddlers. Toddlers are said to be susceptible to mosquito repellent, because their organs are not perfect and their immune system is not good and their cough reflex is not good. More dangerous effects will also occur in children who have allergies and have a history of asthma (Nyomba, 2022).

Research by Liu (2003) states that burning one burning mosquito repellent is related to the risk of ISPA because burning mosquito repellent can produce particulate matter equivalent to dozens of cigarettes. Significant relationship between exposure to burnt mosquito repellent smoke and the incidence of ISPA in children. The dominant factors influencing the incidence of Acute Respiratory Infections in toddlers are the factors of mosquito repellent use and air pollution, namely with a variance of 30.681% and an eigen value of 2.454. The use of burnt mosquito repellent is still a habit of the community because it is cheap and easy to obtain. Lack of knowledge about the health effects of burnt mosquito repellent smoke causes toddlers to continue to be exposed, thus increasing the risk of ISPA.

Multivariate Discussion

Based on the results of multivariate analysis using logistic regression, it was found that of the four variables included in the model, namely BBLR, immunization, occupancy density, and the use of burning mosquito repellent, there were three variables that were significantly related to the incidence of ISPA, namely immunization (p = 0.007), occupancy density (p = 0.016), and use of burning mosquito repellent (p = 0.045). Meanwhile, the BBLR variable did not show a statistically significant relationship (p = 0.100), but was maintained in the model. This shows that the logistic regression model formed is able to identify factors that play an independent role in the incidence of ISPA in toddlers.

Based on the Exp(B) value, the baseline immunization variable had the largest odds ratio of OR = 3.046 (95% CI: 1.360–6.821), which suggests that toddlers with incomplete immunization had a approximately 3-fold greater risk of developing ISPA than toddlers with complete baseline immunization after being controlled for by other variables in the model. This OR value is higher than residential density (OR = 2.803) and mosquito repellent use (OR = 2.331), so it can be concluded that basic immunization is the variable that has the closest and most dominant relationship with the incidence of ISPA in this regression model.

In theory, immunization plays an important role in forming a child's immunity against various infectious diseases that can trigger ARI. Children who do not receive complete immunization have a lower immune system, making them more susceptible to respiratory infections. Basic immunization is the most dominant factor in the incidence of ARI in this study due to its critical role in building both specific and non-specific immunity in children. It stimulates antibody production and immune memory cell formation against respiratory pathogens, including Bordetella pertussis, Corynebacterium diphtheriae, measles virus, and Haemophilus influenzae. Without complete immunization, toddlers lack optimal protection against these organisms and are therefore more susceptible to respiratory tract inflammation.

Pathophysiologically, toddlers with incomplete immunization have weaker humoral and cellular immune responses. When pathogens enter through the respiratory tract, mucosal defense mechanisms such as secretory IgA and alveolar macrophage activity do not work optimally. As a result, pathogens can multiply faster, triggering an excessive inflammatory response, mucosal edema, increased secretion production, and airway obstruction, which clinically gives rise to symptoms of ISPA such as cough, shortness of breath, and fever. This condition explains why toddlers who are not immunized or immunized are more susceptible to STI than toddlers who are

fully immunized.

In addition to biological mechanisms, the dominant influence of basic immunization is also supported by empirical evidence from various studies. A study by Anggraeni (2021) shows that toddlers with incomplete basic immunizations have up to three times greater risk of ISPA than toddlers who have been fully immunized. Similar research by Amalia (2021) confirms that basic immunization contributes significantly to reducing the incidence of ISPA and pneumonia in toddlers, even when environmental factors such as housing density and smoke exposure persist. Occupancy density and exposure to burning mosquito repellent smoke have also been consistently reported as environmental determinants of ISPA in various studies (Liu et al., 2003). . This reinforces the study's finding that basic immunization plays a role as the main protective factor against ARI.

The dominance of the influence of basic immunization in this regression model shows that biological protective factors have a very important role in preventing the occurrence of ISPA in toddlers, even in the midst of exposure to environmental risk factors. The insignificant BBLR variable in the model is thought to be influenced by the low proportion of BBLR toddlers in this study, but it still has the potential to be a confounding variable. Thus, the results of this multivariate analysis confirm that efforts to prevent ISPA in toddlers need to be focused on increasing basic immunization coverage, accompanied by improving home environmental conditions.

This study has several limitations that should be noted. First, the cross-sectional design does not allow causal inference; associations identified cannot be interpreted as causal relationships. Second, the study was conducted at a single health center (Rajabasa Indah), which may limit generalizability to other settings. Third, data on mosquito coil use and housing density were based on self-reporting, which may introduce recall bias. Fourth, the proportion of LBW toddlers in the sample was relatively small (3.7%), potentially reducing the statistical power to detect significant effects for this variable in the multivariate model. Future studies should consider longitudinal designs, larger and more diverse samples, and objectively measured environmental exposures to strengthen causal inferences and improve the generalizability of findings.

CONCLUSION

This study found that toddlers aged < 3 years (56.2%), with a history of LBW (3.7%), incomplete immunization (33.3%), crowded housing (27.8%), and mosquito coil exposure (27.8%) had an overall ARI incidence of 23.5%. Significant risk factors for ARI included immunization status (p-value: 0.040; OR: 7.176), LBW (p-value: 0.022; OR: 2.543), occupancy density (p-value: 0.004; OR: 3.233), and mosquito coil use (p-value: 0.041; OR: 2.382), while age was not significantly associated (p-value: 0.238). Multivariate analysis identified basic immunization completeness as the most dominant factor (OR: 3.046; 95% CI: 1.210–6.821), followed by occupancy density (OR: 2.803) and mosquito coil use (OR: 2.331).

These findings underscore the importance of basic immunization as the primary preventive measure against ARI in toddlers. Health centers are advised to strengthen ARI prevention programs through improving immunization coverage, monitoring completion rates, and addressing environmental risk factors — particularly residential crowding and household mosquito coil use. Future research should investigate the combined effect of immunization status and environmental exposures in larger, multi-center samples to confirm these associations and develop more targeted community health interventions.

Future research is recommended to use longitudinal designs to establish causal relationships, expand sample sizes across multiple health centers, and include objective measurements of environmental exposures. Additionally, community-level interventions targeting immunization coverage, housing improvement, and reduction of indoor air pollution from mosquito coil use are recommended as integrated strategies to reduce ARI burden in toddlers.

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AUTHOR CONTRIBUTION STATEMENT

Dina Dwi Nuryani and Dessy Hermawan conceptualized and designed the study. Fitri Eka Sari and Ani Oktasari conducted data collection, performed analyses, and assisted in drafting the manuscript. All authors contributed to the interpretation of results, critically revised the manuscript, and approved the final version, taking full responsibility for its content.

REFERENCES

Afriani, B. (2020). Faktor-faktor yang berhubungan dengan kejadian ispa pada balita. *Cendekia Medika: Jurnal Stikes Al-Maarif Baturaja*, *5*(1), 1–15. https://doi.org/10.52235/cendekiamedika.v5i1.8 medika. v5i1.8

Amalia, I., Nuryani, D. D., & Aryastuti, N. (2021). Analisis Faktor Intrinsik Risiko Kejadian ISPA pada Balitadi Wilayah Kerja Puskesmas Panjang Kota Bandar Lampung Tahun 2019. *Indonesian Journal Of Health and Medical*, *1*(3), 365–385.

Anggraeni, E. A., Mansur, H., & Sondakh, J. J. S. (2021). Kelengkapan dan Ketepatan Pemberian Imunisasi Dasar Pentabio Dengan Kejadian Infeksi Saluran Pernafasan Akut (ISPA) Pada Batita: Indonesian. *Malang Journal of Midwifery (MAJORY)*, *3*(1), 20–28. https://doi.org/10.31290/majory.v3i1.2177

Fadillah, G., & Azizah, R. (2022). Analisis Faktor Risiko Perilaku dengan Kasus Malaria pada Masyarakat di Indonesia-Meta Analysis 2016-2021: Literature Review. *Media Publikasi Promosi Kesehatan Indonesia (MPPKI)*, *5*(11), 1336–1345. https://doi.org/10.56338/mppki.v5i11.2733

Hadi, M., Kumalasari, M. L. F., & Kusumawati, E. (2019). Faktor Risiko yang Berhubungan dengan Kejadian Stunting di Indonesia: Studi Literatur. *Journal of Health Science and Prevention*, *3*(2), 86–93. https://doi.org/10.29080/jhsp.v3i2.238.238

Haryani, S., & Misniarti, M. (2021). Faktor Yang Mempengaruhi Kejadian Infeksi Saluran Pernafasan Akut (Ispa) Di Provinsi Bengkulu: Factors Affecting The Incidence Of Above Respiratory Channel Infection (Ari) In Working Area Of Puskesmas Perumnas. *Quality: Jurnal Kesehatan*, *15*(2), 95–104. https://doi.org/10.36082/qjk.v15i2.240.

Jayatmi, I., & Imaniyah, E. (2019). Determinan Kejadian Infeksi Saluran Pernapasan Akut (ISPA) pada Balita. *Jurnal Ilmiah Kebidanan Indonesia*, *9*(01), 18–25. https://doi.org/10.33221/jiki.v9i01.212

Lestari, D. A., & Adisasmita Prof, A. (2021). Berat Badan Lahir Rendah (BBLR) sebagai Determinan Terjadinya ISPA pada Balita Analisis Data SDKI Tahun 2017. *Jurnal Epidemiologi Kesehatan Indonesia*, *5*(1), 3. https://doi.org/10.7454/epidkes.v5i1.4083 i1.4083

Liu, W., Zhang, J., Hashim, J. H., Jalaludin, J., Hashim, Z., & Goldstein, B. D. (2003). Mosquito coil emissions and health implications. *Environmental Health Perspectives*, *111*(12), 1454.

Lubis, I. P. L., & Ferusgel, A. (2019). Hubungan Kondisi Fisik Rumah dan Keberadaan Perokok dalam Rumah dengan Kejadian ISPA pada Balita di Desa Silo Bonto Kecamatan Silau Laut Kabupaten Asahan. *Jurnal Ilmiah Kesehatan Masyarakat: Media Komunikasi Komunitas Kesehatan Masyarakat*, *11*(2), 166–173. https://doi.org/10.52022/jikm.v11i2.5

Nyomba, M. (2022). *Faktor Yang Berhubungan Dengan Kejadian Infeksi Saluran Pernapasan Akut (ISPA) Pada Balita di Sekitar Wilayah Tempat Pembuangan Akhir (TPA) Sampah Antang Kota Makassar Tahun 2021= Factors Associated of The Incidence of Acute Respiratory Infection (ARI) in Toddlers Around The Antang Waste Disposal Site Makassar City in 2021*. Universitas Hasanuddin.

Pasaribu, A., & Nafratilova, M. (2025). *Asuhan Keperawatan Anak dengan ISPA*.

Putri, M. D. A., & Adriyani, R. (2018). Hubungan usia balita dan sanitasi fisik rumah dengan kejadian ISPA di Desa Tumapel Kabupaten Mojokerto tahun 2017. *The Indonesian Journal of Public Health*, *13*(1), 98. https://doi.org/10.20473/ijph.v13i1.2018.95-106.

Rahmi, I. R., & Rasyid, K. (2024). Home Environmental factors with the Incidence of ISPA in Toddlers Indonesia: Literature Review. *Media Publikasi Promosi Kesehatan Indonesia*

(MPPKI), *7*(12), 2877-2885.

Rosliana, L., Widowati, R., & Kurniati, D. (2020). Hubungan Pola Asuh, Penyakit Penyerta, Dan Pengetahuan Ibu Dengan Status Gizi Pada Anak Usia 12-24 Bulan Di Posyandu Teratai Wilayah Kerja Puskesmas Ciasem Kabupaten Subang Tahun 2020. *Syntax Idea*, *2*(8), 415–428.

Sarwoko, S. (2021). Hubungan Kepadatan Hunian, Ventilasi, dan Pencahayaan dengan Kejadian ISPA pada Balita di Desa Talang Jawa Wilayah Kerja UPTD Puskesmas Tanjung Agung Kecamatan Baturaja Barat Kabupaten Ogan Komering Ulu Tahun 2020. *Cendekia Medika: Jurnal Stikes Al-Maarif Baturaja*, *6*(1), 31–36.

Suhartina, S., Siregar, S. D., & Zaluchu, S. O. (2025). Analysis Of Factors Related To The Incidence Of Acute Respiratory Infection In Toddlers In The Area Of Tuntungan Community Health Center, Deli Serdang Regency 2024. *International Journal of Health and Pharmaceutical (IJHP)*, *5*(2), 216–223.

Tabalawony, S. L., & Akollo, I. R. (2023). Pengaruh Perilaku Merokok Dan Pemakaian Obat Nyamuk Bakar Terhadap Kejadian Ispa Pada Balita Di Wilayah Kerja Puskesmas Jazirah Tenggara. *Jurnal Riset Kesehatan Poltekkes Depkes Bandung*, *15*(1), 230–237. https://doi.org/10.34011/juriskesbd.v15i1.2216

Wulandari, P., Siregar, S. M. F., Fera, D., & Jihad, F. F. (2023). Hubungan Riwayat Bblr, Kelengkapan Imunisasi Dan Perilaku Merokok Anggota Keluarga Terhadap Risiko Ispa Pada Balita Di Wilayah Kerja Puskesmas Meukek. *JKM (Jurnal Kesehatan Masyarakat) Cendekia Utama*, *11*(3), 305–318.

Zairinayati, Z., & Putri, D. H. (2020). Hubungan Kepadatan Hunian Dan Luas Ventilasi Ï»¿ Dengan Kejadian Ispa Pada Rumah Susun ï»¿ Palembang. *Indonesian Journal for Health Sciences*, *4*(2), 121–128. https://doi.org/10.24269/ijhs.v4i2.2488. 2488