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Research Article

Living Near the Mines: Understanding the Multifactor Causes of Acute Respiratory Infection in Toddlers of Konawe Regency

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ABSTRACT

Background:
Acute Respiratory Infection (ARI) is one of the leading causes of morbidity among children under five in Indonesia. Mining areas have a higher risk of ARI occurrence. This study aimed to analyze the relationship between epidemiological, environmental, behavioral, and health service factors and the incidence of ARI among children under five in the mining area of Morosi District, Konawe Regency.

Methods: This research employed a cross-sectional design with a total of 118 mothers of children under five selected through purposive sampling. Data were analyzed using univariate analysis to describe frequency distributions and bivariate analysis using the Chi-square test.

Results: The results showed an ARI prevalence of 75.4%. The presence of black mold (p-value = 0.003), type of house ventilation (p-value = 0.029), distance from the house to the industry (p-value = 0.020), and distance from the house to the main road (p-value = 0.037) were significantly associated with ARI. Household behavior of opening windows (p-value = 0.025) and the availability of a village health post (p-value = 0.001) were also significantly related to ARI incidence.

Conclusion: It can be concluded that ARI incidence among children under five in the mining area of Morosi is influenced by environmental factors (ventilation and black mold), household behavior (window-opening habit), and access to primary health care facilities (village health post). ARI prevention efforts should focus on improving home environmental conditions, promoting clean and healthy living behaviors, and enhancing access to primary health services in mining areas.

Keywords: *ARI, children under five, home environment, behavior, mining area*

INTRODUCTION

Acute Respiratory Infection (ARI) remains one of the leading causes of morbidity and mortality among children under five in Indonesia. According to the World Health Organization, ARI accounts for approximately 20% of all deaths among children under five years of age in developing countries [1]. In Indonesia, data from the Ministry of Health (2023) indicate that the prevalence of ARI among under-five children reached 9.3%, with the highest proportions found in areas characterized by high population density and poor air quality [2].

ARI is caused by various microorganisms, including viruses and bacteria, that infect both the upper and lower respiratory tracts. Its transmission is strongly influenced by environmental and behavioral factors. Based on the epidemiological triad of infectious diseases, the interaction between the agent (pathogenic microorganism), host (under-five child), and environment (household conditions and family behavior) underlies the occurrence of ARI. A humid indoor environment, inadequate ventilation, and the presence of mold or air pollutants provide favorable conditions for the growth and transmission of respiratory pathogens [3].

Mining areas are recognized as high-risk regions for ARI due to exposure to mineral dust, heavy vehicle emissions, and altered environmental conditions. Mining activities in Morosi District, Konawe Regency, have contributed to increased concentrations of particulate matter ($PM_{2.5}$ and PM_{10}), which may penetrate nearby residential areas. Several studies have demonstrated that exposure to airborne particulate matter is associated with an increased incidence of respiratory symptoms and a decline in lung function, particularly among children living in industrial zones [4] [5].

In addition to environmental factors, household behavior plays a crucial role in determining ARI risk. Practices such as opening windows, cleaning bedrooms, sun-drying mattresses, and avoiding indoor smoking are components of Clean and Healthy Living Behavior (PHBS) that can reduce the likelihood of respiratory infections. Mahendra found that households with poor ventilation and residents who rarely opened windows had a 2.7 times higher risk of ARI compared to households with adequate air circulation [6].

Moreover, access to healthcare services is another important determinant of ARI incidence. The presence of primary healthcare facilities, such as auxiliary community health centers (puskesmas pembantu), facilitates early detection and prompt management of respiratory infections. Corden study reported a significant association between distance to healthcare facilities and ARI incidence among children the greater the distance, the lower the likelihood of seeking timely medical care during the early stages of illness [7].

Although numerous studies have investigated the determinants of ARI, research that comprehensively examines multifactorial aspects epidemiological, environmental, behavioral, and healthcare service factors within mining communities remains limited. Morosi District is a unique setting characterized by high population density, nickel mining activities, and diverse household behavioral patterns, all of which may influence respiratory health among children.

Therefore, this study aims to analyze the relationships between epidemiological, environmental, behavioral, and healthcare service factors and the incidence of ARI among under-five children in the mining area of Morosi District, Konawe Regency. The findings are expected to provide evidence-based insights for developing health promotion strategies and environmentally focused disease prevention programs in mining regions.

MATERIAL AND METHODS

This study employed an observational analytic design with a cross-sectional approach. The design was used to examine the relationship between epidemiological, environmental, behavioral, and healthcare service factors and the incidence of Acute Respiratory Infection (ARI) among children under five in the mining area of Morosi District, Konawe Regency.

The research was conducted in four villages within the Morosi mining area: Morosi, Paku Jaya, Porara, and Puuruy. The study sites were purposively selected, considering that these villages are densely populated and located in close proximity to nickel mining activities. Data collection took place from August to September 2025.

The study population consisted of all mothers with children aged 12–59 months who resided in the mining area of Morosi District. A total of 118 respondents were included as the research sample, determined using the population proportion formula and purposive sampling technique. The inclusion criteria were: mothers who agreed to participate as respondents, had under-five children who had lived in the same household for at least the past six months, and were able to communicate effectively.

Data were collected using a structured questionnaire that had been tested for validity and reliability on 30 respondents outside the study area. Data collection was conducted by trained enumerators through face-to-face interviews with mothers of under-five children and direct observation of household physical conditions using a standardized observation checklist.

Data analysis was performed using SPSS version 21.0 in three stages. Univariate analysis was conducted to describe the frequency distribution of each research variable. Bivariate analysis was carried out using the Chi-square (χ^2) test at a 95% confidence level ($\alpha = 0.05$) to determine the relationship between each independent variable and the incidence of ARI among under-five children. The results were interpreted as statistically significant when $p < 0.05$ and presented in tables and descriptive narratives.

RESULTS

1. Characteristics of Respondents

The study involved 118 mothers of under-five children residing in four villages within the mining area of Morosi District, namely Morosi, Paku Jaya, Porara, and Puuruy. The characteristics of respondents showed that the majority of mothers were aged 20–35 years (74.6%), had senior high school education (55.1%), and were unemployed (88.1%). Most families consisted of 3–5 household members (89%) and lived in houses with moderate residential density.

Table 1. Characteristics of Respondents in the Mining Area of Morosi District (n = 118).

Characteristic	Frequency (n)	Percentage (%)
Mother's age		
< 20 years	12	10.2
20–35 years	88	74.6
> 35 years	18	15.2
Mother's education		
No formal education	4	3.4
Primary–Junior High	49	41.5
Senior High School	65	55.1
Mother's occupation		
Employed	14	11.9
Unemployed	104	88.1
Number of family members		
≤ 2 persons	2	1.7
3–5 persons	105	89.0
> 5 persons	11	9.3

Source: Primary Data, 2025

Most mothers of under-five children had a secondary education level and worked as full-time homemakers. This condition indicates that family health knowledge is still largely influenced by the mothers' educational attainment and their access to health information provided by field health workers.

2. Distribution of ARI Incidence

The incidence of Acute Respiratory Infection (ARI) among under-five children in the past two weeks showed that 89 children (75.4%) experienced ARI, while 29 children (24.6%) did not. This finding indicates that ARI remains a significant public health problem in the mining area of Morosi District.

Table 2. Distribution of Acute Respiratory Infection (ARI) Incidence Among Under-Five Children in Morosi District.

ARI Status	Frequency (n)	Percentage (%)
Yes	89	75.4
No	29	24.6
Total	**118**	**100.0**

Source: Primary Data, 2025

3. Relationship Between Epidemiological Factors and ARI Incidence

The analysis of the relationship between epidemiological factors (maternal age, education, occupation, and number of family members) and the incidence of Acute Respiratory Infection (ARI) showed no statistically significant association ($p > 0.05$).

Table 3. Relationship Between Epidemiological Aspects and ARI Incidence Among Under-Five Children.

Epidemiological Aspects	ARI				Total		Results of Statistical Analysis
	Yes		No				
	n	%	n	%	N	%	
Mother's Age							*p-value*=
< 25 Years	11	73.7	4	26.7	15	100.0	0.531
≥ 25 Years	78	75.7	25	24.3	103	100.0	
Mother's education							*p-value* =
Employed	81	77.9	23	22.1	104	100.0	0.091
Unemployed	8	57.1	6	42.9	14	100.0	
Mother's Job							*p-value* =
Low (≤ Junior High School)	31	81.6	7	18.4	38	100.0	0.400
High (≥ Senior High School)	58	72.5	22	27.5	80	100.0	
Total	**89**	**75.4**	**29**	**24.6**	**118**	**100.0**	

These findings indicate that ARI incidence was not directly influenced by mothers' demographic characteristics. Instead, environmental and behavioral factors appear to play a more dominant role in determining the occurrence of ARI among under-five children in the mining area.

4. Relationship Between Environmental Factors and ARI Incidence

Based on the Chi-square test results, two environmental variables showed significant associations with ARI incidence: type of household ventilation (p = 0.009) and presence of black mold (p = 0.003).

Table 4. Relationship Between Environmental Aspects and ARI Incidence

Environmental Aspects	ARI				Total		Results of Statistical Analysis
	Yes		No				
	n	%	n	%	N	%	
Type of ventilation							*p-value* =
Inadequate	42	85.7	7	14.3	49	100.0	**0.049**
Adequate	47	68.1	22	31.9	69	100.0	
Presence of black mold							*p-value* =
Present	22	100.0	0	0.0	22	100.0	**0.007**
Absent	67	69.8	29	30.2	96	100.0	
Distance to the main road							*p-value* =
< 5 Meter	27	64.3	15	35.7	42	100.0	**0.037**
≥ 5 Meter	62	81.6	14	18.4	76	100.0	
Distance to industrial area							*p-value* =
< 500 meter	20	95.2	1	4.8	21	100.0	**0.041**
≥ 500 meter	69	71.1	28	28.9	97	100.0	
Total	**89**	**75.4**	**29**	**24.6**	**118**	**100.0**	

Source: Primary Data, 2025

Ventilation and mold were identified as key determinants of indoor air quality. Houses with inadequate ventilation tend to be more humid, providing favorable conditions for mold growth, which in turn increases the risk of respiratory infections among children.

5. Relationship Between Behavioral Factors and ARI Incidence

Behavioral factors significantly associated with ARI incidence included daily window opening (p = 0.021) and bedroom cleaning habits (p = 0.039).

Table 5. Relationship Between Behavioral Aspects and ARI Incidence

Behavioral Aspects	ARI				Total		Results of Statistical Analysis
	Yes		No				
	n	%	n	%	N	%	
Smoking Habit							*p-value* =
Yes	66	73.3	24	26.7	90	100.0	0.488
No	23	82.1	5	17.9	28	100.0	
Passive Smoking Habit (Hand-Smoker Exposure)							*p-value* =
Yes	52	80.0	13	20.0	65	100.0	0.287
No	37	89.8	16	30.2	53	100.0	
Habit of Opening Windows							***p-value* =**
No	28	90.3	3	9.7	31	100.0	**0.045**
Yes	61	70.1	26	29.9	87	100.0	
Habit of Cleaning the Mattress							*p-value* =
Not Routine	39	72.2	15	27.8	54	100.0	0.598
Routine	50	78.1	14	21.9	64	100.0	
Use of Mosquito Coils							*p-value* =
Yes	28	75.7	9	24.3	37	100.0	1.000
No	61	75.3	20	24.7	81	100.0	
Use of Firewood/Charcoal for Cooking							*p-value* =
Yes	9	90.0	1	10.0	10	100.0	0.241
No	80	74.1	28	25.9	108	100.0	
Burning Household Waste							*p-value* =
Yes	86	75.4	28	24.6	114	100.0	0.682
No	3	75.0	1	25.0	4	100.0	
Consumption of Ultra-Processed Foods (UPF)							*p-value* =
Yes	33	68.8	15	31.3	48	100.0	0.239
No	56	80.0	14	20.0	70	100.0	
Total	**89**	**75.4**	**29**	**24.6**	**118**	**100.0**	

Behaviors related to air circulation and bedroom cleanliness play a critical role in preventing the growth of pathogenic microorganisms responsible for ARI within the household environment.

6. Relationship Between Healthcare Service Factors and ARI Incidence

Among healthcare service variables, the presence of auxiliary community health centers (pustu) showed a significant relationship (p = 0.001) with ARI incidence.

Table 6. Relationship Between Healthcare Service Aspects and ARI Incidence

Aspek Pelayanan Kesehatan	ARI				Total		Results of Statistical Analysis
	Yes		No				
	n	%	n	%	N	%	
Availability of Auxiliary Community Health Center (Pustu)							***p-value* = 0.003**
Not Available	34	94.4	2	5.6	36	100.0	
Available	55	67.1	27	32.9	82	100.0	
Attendance at Integrated Health Post (Posyandu)							*p-value* = 1.000
Not Regular	22	75.9	7	24.1	29	100.0	
Regular	67	75.3	22	24.7	89	100.0	
Health Insurance Ownership							*p-value* = 1.000
Not Covered	8	72.7	3	27.3	11	100.0	
Covered	81	75.7	26	24.3	107	100.0	
Total	**89**	**75.4**	**29**	**24.6**	**118**	**100.0**	

Source: Primary Data, 2025

The presence of pustu plays a vital role in facilitating community access to basic healthcare services, including early examination, timely treatment, and health education on ARI prevention.

DISCUSSION

Epidemiological Aspects and ARI Incidence

The analysis of epidemiological factors including maternal age, education level, occupation, family income, child's sex, and immunization status showed no statistically significant relationship with the incidence of Acute Respiratory Infection (ARI) (p-value > 0.05). However, the distribution patterns still provide valuable insights into the socio-health characteristics of the studied population.

Most mothers were aged ≥25 years (87.3%) and had secondary to higher education levels (67.8%), indicating that respondents were generally in the productive age group with potentially adequate health literacy. Nevertheless, the persistently high ARI prevalence suggests that knowledge alone is insufficient without consistent preventive behavior. This finding not aligns in Ethiopia, who reported that higher mother age necessarily translate to lower ARI prevalence due to poor household preventive practices [8].

The majority of mothers were unemployed (88.1%) and worked as full-time homemakers, while only 46.6% of families had sufficient income. Although statistical tests showed no significant relationship between occupation and income with ARI incidence, economic limitations may restrict the family's capacity to provide proper housing, ventilation, and access to quality healthcare. This is consistent with

theory that socioeconomic status affects health outcomes through access to health resources [9].

Male toddlers were slightly more likely to experience ARI (78.3%) compared to females (72.4%), although not statistically significant (p = 0.594). Other research suggested that boys have narrower airways and different immune responses to infections, making them more susceptible to respiratory diseases. Experimental studies investigating sex-specific differences in infection-induced respiratory diseases [10].

Immunization status also showed no significant association (p-value = 0.251). Although children with complete immunization records had higher ARI proportions (77.6%) than those with incomplete immunization (69.7%), this might be due to small variation, as most children had already completed their basic immunization schedule. However, immunization remains an essential protective factor against respiratory infections. The Indonesian Ministry of Health reported that high immunization coverage reduces the risk of pneumonia and severe ARI among children [11].

Overall, these findings indicate that epidemiological characteristics in the Morosi mining area were relatively homogeneous, contributing minimally to ARI variation. Thus, environmental and behavioral determinants play a more significant role and deserve deeper examination.

Environmental Aspects and ARI Incidence

Environmental variables analyzed in this study included ventilation type, presence of black mold, distance from the house to the main road, distance to industrial sites, and daily window-opening habits. The bivariate analysis revealed that ventilation type, presence of black mold, proximity to main roads, proximity to industrial areas, and window-opening behavior were significantly associated with ARI incidence among toddlers. These results highlight the substantial influence of home environmental conditions in determining respiratory health risks in the mining community of Morosi District.

The findings are consistent with previous studies indicating that ventilation and indoor air circulation are key determinants of respiratory infections in children. Poor physical environments, such as inadequate sanitation and exposure to pollution, can affect the respiratoryhealth of toddlers by creating conditions that favor the growth of pathogens [12]. Similarly, there is an influence of air ventilation, residential density and room lighting on the incidence of ISPA in toddlers in Larangan Hamlet, Rejosari Village, Wonosobo [13]. In mining zones, poor ventilation may be further exacerbated by industrial dust exposure, increasing the respiratory burden among children.

The presence of black mold indicates high humidity and inadequate air circulation, which promote fungal growth and spore release that can irritate the respiratory tract. Although few recent studies have directly examined black mold, the role of humidity as a risk factor is well established. Black mold exposure frequently occurs in damp indoor spaces. Populations at greater risk include children, the elderly, individuals with weakened immune systems, and those with chronic respiratory diseases. Health effects range from mild symptoms, such as eye and nasal irritation, to severe conditions like lung infections and neurological disorders, especially with prolonged exposure [14]. Other research reported that indoor humidity

levels outside the optimal range (40–60% RH) could increase ARI risk up to fivefold [15].

Proximity to main roads and industrial areas represents higher exposure to particulate matter and toxic emissions. Fine particulate matter (PM2.5 and PM10) from traffic and industrial activities has been widely linked to respiratory morbidity among children. Therefore, shorter residential distance to these pollution sources is biologically plausible as a determinant of ARI risk.

Window-opening habits, although behavioral, directly affect ventilation efficiency. This study found that children living in homes where windows were not opened regularly had higher ARI prevalence (90.3%) compared to those with daily ventilation (70.1%). This emphasizes the protective effect of simple behavioral interventions, such as daily window opening, in reducing ARI incidence.

Behavioral Aspects and ARI Incidence

Most households reported indoor smoking habits (76.3%), and more than half had family members identified as hand-smokers (55.1%). Additionally, 26.3% of households did not routinely open windows, 45.8% of mothers did not regularly clean or sun-dry mattresses, 31.4% used mosquito coils, and 8.5% still used wood or charcoal as cooking fuel. Nearly all respondents (96.6%) burned household waste in their yards.

Bivariate analysis showed that window-opening behavior was significantly associated with ARI ($p = 0.045$). Toddlers living in homes where windows were rarely opened were at greater risk of ARI compared to those in well-ventilated homes. Other behaviors such as smoking indoors, hand-smoking exposure, waste burning, and use of solid fuels were not statistically significant but remain biologically relevant risk factors.

Household behavior plays a key role in determining indoor air quality. Regular window opening reduces humidity, carbon dioxide accumulation, and dust concentration, all of which contribute to respiratory infections. Households with low window-opening frequency had 2.7 times in hours can increase air quality and prevent ARI risk [16]. Similarly, Rahmawati & Sari (2022) reported that routine ventilation and cleaning behaviors significantly decreased ARI incidence among children in South Sumatra [17].

Although smoking behavior was not statistically significant, its high prevalence (>70%) indicates a serious public health concern. Tobacco smoke contains thousands of harmful chemicals, including nicotine, carbon monoxide, and fine particulates (PM2.5). The World Health Organization reported that children exposed to secondhand smoke are 1.5–2 times more likely to develop ARI [18]. This aligns with Sitorus et al. (2022), who found a significant relationship between indoor smoking and ARI incidence in Makassar ($p < 0.05$) [19].

Other observed behaviors, such as waste burning and solid fuel use, also contribute to indoor air pollution through fine particulates and toxic gases (CO, NO_2). Prasetya et al. (2023) found that households using solid fuels had 3.4 times higher ARI risk compared to those using clean fuels like LPG or electricity [20]. Furthermore, irregular mattress cleaning creates moist environments conducive to dust mites and mold growth. Lestari et al. (2021) observed that households that sun-dried mattresses less than once a week had twice the ARI risk among toddlers [21].

Overall, the results suggest that household behaviors substantially influence ARI risk. Even when individual variables are not statistically significant, the combined exposure to multiple behavioral and environmental risks especially in polluted mining areas may create a cumulative effect that increases respiratory infection risk among toddlers.

Health Service Aspects and ARI Incidence

This study examined four key health service variables: availability of auxiliary health centers (pustu), distance to the nearest health center, frequency of visiting posyandu (integrated service posts), and health insurance ownership.

The results showed that most respondents (69.5%) had access to a pustu within their residential area, 54.2% lived within 3 km of a health center, 75.4% regularly attended posyandu, and 90.7% possessed health insurance. Chi-square analysis revealed a significant relationship between pustu availability and ARI incidence, while other variables distance to the health center, posyandu attendance and health insurance ownership were not statistically significant. These findings highlight the importance of accessible primary healthcare facilities in reducing ARI risk among children. The presence of pustu in mining villages enables faster access to basic health services, including child examinations, immunization, nutrition counseling, and environmental health education. This is consistent with Nurhidayah et al. (2022), who found that local healthcare availability significantly reduced ARI prevalence in Luwu Timur District ($p = 0.004$). Frequent contact with pustu staff facilitates early detection and treatment of respiratory symptoms [22].

Although proximity to health centers was not statistically significant, households located closer tended to report lower ARI prevalence. The Indonesian Ministry of Health also emphasizes that a service distance of less than 3 km enhances the effectiveness of child health programs, especially in rural and mining areas. Regular posyandu attendance, while not statistically significant, reflects good community health awareness. Posyandu serves as a frontline facility for monitoring child growth, nutrition, and health education. Pertiwi et al. (2021) found that active maternal participation in posyandu improves early ARI symptom recognition and home-based care practices [23].

Health insurance ownership showed no significant association with ARI, likely because insurance primarily supports treatment costs rather than preventive efforts. Therefore, even with widespread coverage, the impact on ARI prevention remains limited without strong promotive and preventive health behaviors.

In conclusion, these results reinforce the critical role of local and accessible primary healthcare systems in ARI control. Among all service-related variables, the presence of pustu emerged as the most influential factor in reducing ARI incidence among toddlers in the Morosi mining area.

CONCLUSION

This study revealed that the incidence of Acute Respiratory Infection (ARI) among under-five children in the mining area of Morosi District is influenced by various environmental factors, household behavioral factors, and health service accessibility. Meanwhile, epidemiological factors such as maternal age, education, occupation, and household size showed no significant

association with ARI incidence. Overall, these findings emphasize that physical environmental conditions of the home, air management behaviors, and access to basic health services are the most influential determinants of ARI occurrence among under-five children living in mining areas.

Recommendations

Recomendations for local government and community health centers (puskesmas) are Conduct regular monitoring of air quality in and around mining areas, implement community education and empowerment programs related to Clean and Healthy Living Behavior (PHBS), Optimize the role of auxiliary health centers (pustu) in early detection, treatment, and education for ARI prevention. Recomendation for Mining Industry Stakeholders are improve emission and dust management around mining operations, support community environmental health initiatives through Corporate Social Responsibility (CSR) programs, such as providing healthy ventilation systems and routine child health check-ups. Recomendation for Further studies using multivariate analytical or longitudinal designs are recommended to measure the strength and causal relationships between environmental and behavioral factors and ARI incidence among under-five children in mining areas.

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