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Association Between Household Ventilation and Acute Respiratory Infection Among Children Under Five in Nambangan Lor Village, Manguharjo Primary Health Care, Madiun, Indonesia

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ABSTRACT

Acute Respiratory Infection (ARI) remains a major public health problem and one of the leading causes of morbidity among children under five, particularly in developing countries. Poor household ventilation may reduce indoor air circulation, increase the accumulation of airborne contaminants, and increase the risk of ARI. This study aimed to determine the association between household ventilation and the incidence of ARI among children under five in Nambangan Lor Village, the working area of Manguharjo Primary Health Care, Madiun, Indonesia. This observational analytical study employed a case-control design involving 90 respondents, comprising 45 cases and 45 controls selected using simple random sampling. Household ventilation was assessed through direct observation and measurement based on the Indonesian Ministry of Health standards. Data were analyzed using the Chi-square test, and the strength of the association was measured using the Odds Ratio (OR). The results showed a statistically significant association between household ventilation and the incidence of ARI ($p < 0.001$). Children living in houses with inadequate ventilation were 6.059 times more likely to develop ARI than those living in adequately ventilated houses (OR = 6.059). In conclusion, household ventilation was significantly associated with ARI among children under five. Improving household ventilation according to healthy housing standards should be promoted as an important environmental health strategy to reduce the incidence of ARI.

Keywords: acute respiratory infection; children under five; household ventilation; indoor air quality; case-control study

INTRODUCTION

Acute Respiratory Infection (ARI) remains one of the leading causes of morbidity among children under five years of age worldwide, particularly in low- and middle-income countries. ARI continues to pose a major public health challenge due to its substantial impact on child health and healthcare utilization. In Indonesia, ARI is consistently reported as one of the most common diseases among children under five, emphasizing the importance of effective preventive strategies, particularly those targeting environmental risk factors (World Health Organization, 2025; Kementrian Kesehatan Republik Indonesia, 2024).

Household environmental conditions play an important role in the occurrence of ARI. Among various physical housing factors, household ventilation is one of the key determinants of indoor air quality because it facilitates air exchange, reduces indoor humidity, and removes airborne pollutants and microorganisms. Inadequate ventilation may result in poor indoor air circulation, allowing the accumulation of dust, pollutants, and pathogenic microorganisms that increase the risk of respiratory infections among children. Therefore, adequate household ventilation is considered an essential component of a healthy home environment (World Health Organization, 2025; Kementrian Kesehatan Republik Indonesia, 2024).

Previous studies have consistently demonstrated that inadequate household ventilation is associated with an increased risk of ARI among children under five. Rahmi et al., (2024) reported that poor household ventilation contributes to deteriorating indoor air quality, thereby increasing children's susceptibility to ARI. Rizaldi (2023), through a meta-analysis of studies conducted in Indonesia, identified inadequate household ventilation as one of the most consistent environmental risk factors associated with ARI among children under five. However, most previous studies evaluated household ventilation together with other physical housing

factors, making it difficult to determine the specific contribution of ventilation alone. Furthermore, evidence regarding the relationship between household ventilation and ARI among children under five in Madiun City, particularly in Nambangan Lor Village, remains limited.

Based on the 2025 ARI surveillance data from Manguharjo Primary Health Care, Nambangan Lor Village recorded the highest number of ARI cases among children under five compared with the other villages

within its working area. Considering the high burden of ARI and the limited local evidence regarding household ventilation, this study aimed to determine the association between household ventilation and the incidence of ARI among children under five in Nambangan Lor Village, Manguharjo Primary Health Care, Madiun, Indonesia.

MATERIALS AND METHODS

This observational analytical study employed a case-control design to determine the association between household ventilation and the incidence of Acute Respiratory Infection (ARI) among children under five in Nambangan Lor Village, the working area of Manguharjo Primary Health Care, Madiun, East Java, Indonesia.

The study population consisted of children aged 12–59 months residing in Nambangan Lor Village. The case group included children diagnosed with ARI based on medical records from Manguharjo Primary Health Care, whereas the control group comprised children without ARI living in the same area. A total of 90 respondents, consisting of 45 cases and 45 controls, were selected using simple random sampling according to the predetermined inclusion and exclusion criteria. Household ventilation was the independent variable, while ARI incidence was the dependent variable.

Primary data were collected through direct household observations and measurements using a structured observation checklist, whereas secondary data were obtained from medical records at Manguharjo Primary Health Care. Household ventilation was classified according to the Indonesian Ministry of Health standard, in which ventilation was considered adequate if the total ventilation area was at least 10% of the floor area and inadequate if it was less than 10%. Data were analyzed using IBM SPSS Statistics version 25. Descriptive statistics were used to summarize the data, and the Chi-square test was performed to examine the association between household ventilation and ARI incidence. The strength of the association was expressed as the Odds Ratio (OR) with a 95% confidence interval (95% CI), and statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

The distribution of household ventilation conditions among the respondents is presented in Table 1. Household ventilation was classified as adequate and inadequate based on the Indonesian Ministry of Health standards.

Table 1. 1 Distribution of Household Ventilation Conditions

Household Ventilation	Frequency (n)	Percentage (%)
Inadequate	52	57.8
Adequate	38	42.2
Total	90	100.0

More than half of the respondents (57.8%) lived in houses with inadequate household ventilation, whereas 42.2% lived in houses with adequate ventilation. These findings indicate that a considerable proportion of households in Nambangan Lor Village have not yet met the recommended healthy housing standard for ventilation.

The association between household ventilation and the incidence of Acute Respiratory Infection (ARI) among children under five is presented in Table 2.

Table 1. 2 Association Between Household Ventilation and ARI Among Children Under Five

Household Ventilation	Cases n (%)	Controls n (%)	OR (95% CI)	p-value
Inadequate	34 (75.6)	14 (31.1)		
Adequate	11 (24.4)	31 (68.9)	6.059 (2.435–15.078)	<0.001

The Chi-square test demonstrated a statistically significant association between household ventilation and ARI incidence ($p < 0.001$). Children living in houses with inadequate ventilation had a 6.059-fold higher risk of developing ARI than those living in houses with adequate ventilation (OR = 6.059; 95% CI = 2.435–15.078).

Household ventilation plays a crucial role in maintaining indoor air quality because it facilitates air exchange, reduces indoor humidity, and removes airborne pollutants and microorganisms. Inadequate

ventilation restricts air circulation, allowing contaminants and infectious microorganisms to accumulate indoors. As a result, children under five, who spend most of their time inside the home, are more likely to be exposed to respiratory pathogens that may increase the risk of ARI (World Health Organization, 2025; Kementrian Kesehatan Republik Indonesia, 2024).

The findings of this study are consistent with those reported by Rahmi et al., (2024), who concluded that inadequate household ventilation is an important environmental factor associated with ARI among children under five. Poor ventilation contributes to poor indoor air quality by reducing air circulation and increasing the accumulation of dust, humidity, and pathogenic microorganisms. Rizaldi (2023), through a meta-analysis of studies conducted in Indonesia, identified inadequate household ventilation as one of the most consistent environmental risk factors associated with ARI among children under five.

The odds ratio obtained in this study (OR = 6.059) indicates a strong association between inadequate household ventilation and ARI incidence. Although ARI is influenced by multiple factors, including host susceptibility, environmental conditions, and behavioral factors, improving household ventilation remains an important environmental health intervention because it enhances indoor air quality and reduces children's exposure to airborne contaminants and respiratory pathogens. Therefore, promoting healthy housing standards and increasing community awareness regarding adequate household ventilation should be prioritized to reduce the incidence of ARI among children under five.

CONCLUSION

This study demonstrated a significant association between household ventilation and the incidence of Acute Respiratory Infection (ARI) among children under five in Nambangan Lor Village, the working area of Manguharjo Primary Health Care, Madiun. Children living in houses with inadequate ventilation were 6.059 times more likely to develop ARI than those living in adequately ventilated houses (OR = 6.059; 95% CI = 2.435–15.078; $p < 0.001$). These findings emphasize the importance of adequate household ventilation as an environmental determinant of children's respiratory health. Improving household ventilation in accordance with healthy housing standards should be promoted as an effective environmental health strategy to reduce the incidence of ARI among children under five and support disease prevention programs at the community level.

CONFLICT OF INTEREST (if any)

The authors declare that there is no conflict of interest regarding the publication of this paper.

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