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The Relationship Between Cigarette Smoke Exposure and Environmental Sanitation with The Incidence of Acute Respiratory Tract Infections in Toddlers

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ABSTRACT

Acute Respiratory Infections (ARI) constitute infectious pathologies affecting superior or inferior respiratory pathways, capable of producing diverse clinical manifestations ranging from mild infectious processes to severe pathological conditions. Statistical records from the Malang City Health Department documented 56,000 ARI cases over 12 months in 2022, escalating to 43,000 cases within 6 months in 2023, demonstrating significant epidemiological increases. Documentation from TPMB Endang revealed that among 110 toddlers experiencing ARI, 37 originated from Gading Village, with the remaining cases from surrounding communities. Environmental assessment observations identified suboptimal residential hygiene conditions, sugar factory proximity, and prevalent family smoking behaviours. This investigation aimed to establish the relationship between cigarette smoke exposure and environmental sanitation with acute respiratory infection incidence among toddlers in Gading Village, Bululawang District. The research methodology employed quantitative approaches utilising analytical observational design with a cross-sectional framework. The study population encompassed all toddlers residing in Gading Village, totalling 55 individuals, with a sample of 35 toddlers selected according to predetermined inclusion criteria. Multiple linear regression analysis was implemented for data examination. Data analysis results demonstrate significant associations between cigarette smoke exposure and environmental sanitation with acute respiratory tract infection occurrence. This relationship is evidenced through regression variance analysis, specifically the Fh value of 145.846 > F table. Additionally, statistical significance is confirmed by the values of 3.178 (cigarette smoke exposure) > t table 1.690 and 2.567 (environmental sanitation) > t table 1.690. The study concludes that definitive relationships exist between cigarette smoke exposure and environmental sanitation with acute respiratory tract infection incidence among toddlers in Gading Village.

Keywords: Cigarette, Environmental sanitation, Respiratory infection.

INTRODUCTION

Acute respiratory tract infections (ARI) represent a significant public health challenge, characterized by acute inflammatory processes affecting either the upper or lower respiratory pathways. These infections result from microbial invasion by bacteria, viruses, or rickettsial organisms, which may occur independently or in conjunction with pulmonary parenchymal inflammation (Amin et al., 2020). Among pediatric populations in developing nations, ARI stands as a leading mortality factor, manifesting through clinical presentations including pyrexia, persistent cough, nasal discharge, otitis media, and pharyngeal discomfort.

The pathophysiology of acute respiratory tract infections encompasses both superior and inferior respiratory system components, including alveolar

structures, alongside associated anatomical regions such as sinus cavities, pleural membranes, and middle ear spaces. The etiology of these infections involves a complex interplay of viral, fungal, and bacterial pathogens. Multiple determinants contribute to elevated ARI prevalence rates among toddler populations, which can be categorized into individual pediatric characteristics—encompassing nutritional health status, chronological age, vaccination compliance, and consistent vitamin A supplementation—and environmental determinants including indoor atmospheric contamination, adequate ventilation systems, housing infrastructure quality, and residential population density (Maryunani, 2017).

Within Indonesia's epidemiological landscape, several provinces demonstrate particularly elevated ARI case frequencies, notably the Special Capital Region of

Jakarta, Banten Province, West Papua Province, East Java Province, and Central Java Province (Dinas Kesehatan Provinsi Jawa Timur., 2020). Regarding case identification and therapeutic intervention for pediatric ARI patients in East Java Province, detection rates reached 50.93%, representing a substantial improvement from the 2020 achievement rate of 44.3% (Dinas Kesehatan Provinsi Jawa Timur., 2021). Statistical data from the Malang City Health Department indicates a concerning upward trend in ARI cases. Documentation from the Malang City Health Office (Dinkes) reveals that during the January through July 2023 period, approximately 43,000 individuals received ARI diagnoses. This figure significantly exceeds the 2022 annual total of 56,000 cases. Furthermore, by August 2023, ARI cases in Malang Regency had reached 108,830 incidents, contrasting with the 173,470 cases recorded throughout 2022 (Dinas Kesehatan Provinsi Jawa Timur., 2023).

Preliminary investigative work conducted by researchers at the Independent Practice Midwife (TPMB) facility in Gading Village, Bululawang District, involved comprehensive interviews with Bd. Endang Suprihati S.Tr.Keb. The findings revealed that 110 toddlers had experienced ARI episodes, with 37 cases originating from Gading Village itself, while the remaining cases were distributed across neighboring communities: Krebet Village contributed 25 cases, Kasembon Village recorded 23 cases, and Krebetsenggrong Village documented 25 cases. This demographic data was compiled during the December 2023 to February 2024 timeframe. The affected toddler population predominantly fell within the age range of less than one year to five years old. Environmental observations of the surrounding residential areas revealed suboptimal sanitary conditions in several households, compounded by the proximity of a sugar processing facility to Gading Village and prevalent tobacco use among family members.

Population groups demonstrating highest susceptibility to ARI include toddlers, children, and elderly individuals, particularly within nations characterized by low to moderate per capita income levels (Septian et al., 2021). According to (Putri & Dwi, 2020), risk determinants for pediatric ARI are influenced by intrinsic variables including age, gender, nutritional status, and immunization compliance, alongside extrinsic factors encompassing residential density, atmospheric pollution, ventilation adequacy, kitchen positioning, fuel type utilization, mosquito repellent usage, tobacco smoke exposure, household economic status, maternal educational attainment, age, and knowledge level.

The development of Acute Respiratory Infections results from complex interactions among host characteristics, pathogenic agents, and environmental circumstances. Disruption of equilibrium among these components leads to ARI manifestation (Arihta Tarigan & Heryanti, 2021). Parental tobacco consumption within domestic settings creates passive smoking conditions for toddlers, who experience continuous exposure to cigarette smoke, thereby increasing ARI incidence probability in

households where smoking habits are prevalent (Kurniawan et al., 2021). Tobacco smoke represents a primary ARI risk factor due to its challenging mitigation nature, while the substantial number of smokers within family units is concerning, as individuals surrounding smokers or passive smokers face elevated health risks compared to active smokers (Yusuf et al., 2023).

Research conducted by (Amin et al., 2020) demonstrated that among 21 toddlers whose family members practiced smoking habits, 57.1% developed ARI, while among 19 toddlers from non-smoking families, only 21.1% experienced ARI. Chi Square statistical analysis confirmed a significant association between family member smoking practices and pediatric ARI occurrence. Similarly, investigations by (Arihta Tarigan & Heryanti, 2021) established relationships between residential density, housing ventilation, and humidity levels with ARI incidence patterns. These studies collectively demonstrate correlations between cigarette smoke exposure and domestic environmental conditions with ARI development.

Given the presented data, identified problems, and observed phenomena, researchers have developed interest in conducting an investigation titled "The Relationship between Exposure to Cigarette Smoke and Environmental Sanitation with the Incidence of ARI in Toddlers in G Village, Bululawang District."

METHODS

This investigation employed a quantitative research methodology utilizing an analytical observational framework. Analytical observational studies constitute survey-based research that investigates the mechanisms and causative factors underlying health phenomena (Adiputra et al., 2021). The study design implemented a cross-sectional approach, characterized by data acquisition occurring at a single temporal point, where the investigated phenomenon is examined during one data collection interval. Cross-sectional design represents a research framework that examines risk factors and outcomes through observational methods, with the objective of simultaneous data gathering at a specific time period (Abduh et al., 2023). The research methodology involved conducting respondent surveys at a predetermined timeframe through questionnaire distribution to study participants selected as samples for data acquisition purposes. The study population comprised all toddlers residing in Gading Village, Bululawang District, totaling 55 children. The sample selection involved mothers of toddlers diagnosed with ARI in Gading Village who satisfied predetermined inclusion criteria, encompassing 35 toddlers. Sample determination utilized specific inclusion criteria whereby toddlers affected by acute respiratory infections were included. Maternal inclusion criteria stipulated that mothers possessed toddlers aged 1-3 years, demonstrated willingness to participate as respondents, and possessed literacy capabilities for reading and writing comprehension. Data collection procedures employed questionnaire instruments

that underwent subsequent editing, coding, data entry, scoring, and tabulation processes. Prior to questionnaire administration to respondents, validity and reliability assessments were conducted to ensure instrument quality. The analytical approach for this investigation utilized multiple linear regression and regression analysis of variance methodologies to demonstrate both individual and collective relationships between study variables. This methodological framework enabled comprehensive examination of the relationship between cigarette smoke exposure and environmental sanitation factors with acute respiratory infection incidence among the toddler population in the specified geographical area.

RESULTS AND DISCUSSION

Average Value, Description and Regression Analysis

Table 1

Average Value of Cigarette Smoke Exposure and Home Environmental Sanitation with The Incidence of Ari in Toddlers

Variabel	N	Value		
		Lowest	Highest	Average
Cigarette Smoke Exposure (X ₁)	35	4	12	7,43
Home Environmental Sanitation (X ₂)	35	4	12	7,31
Environmental Sanitation for ARI in toddlers (Y)	35	1	3	1,91

The statistical analysis presented in Table 1 demonstrates the descriptive characteristics of the study variables. The Cigarette Smoke Exposure variable (X₁) exhibited a minimum value of 4, maximum value of 12, and mean value of 7.43. Similarly, the Home Environmental Sanitation variable (X₂) displayed a minimum value of 4, maximum value of 12, and average of 7.31. The Environmental Sanitation for ARI in toddlers (Y) demonstrated values ranging from 1 to 3 with a mean of 1.91. The proximity of average values to the minimum range indicates that within this investigation, numerous toddlers experienced cigarette smoke exposure alongside suboptimal home environmental sanitation conditions.

Multiple determinants contribute to ARI occurrence, encompassing sociodemographic characteristics, environmental and housing conditions, along with pediatric nutritional status and immunization compliance (Hassen et al., 2020). Sociodemographic variables encompass child gender, pediatric age, maternal educational attainment, maternal employment circumstances, maternal age, household economic status, family size, number of children, and inter-birth intervals. Environmental and housing determinants significantly influence pediatric ARI incidence, including family member smoking behaviors, dust exposure levels, window quantity, residential ventilation conditions, cooking stove

types, fuel varieties, kitchen window numbers, and practices of bringing children during cooking activities (Fadila & Siyam, 2022). Research by (Yusuf et al., 2023) emphasizes that tobacco smoke constitutes a primary ARI risk factor due to its challenging mitigation nature, while the prevalence of multiple smokers within households remains considerably high. Individuals surrounding smokers or passive smokers face elevated health risks compared to active smokers themselves. Simple linear regression analysis results examining the association between cigarette smoke exposure and home environmental sanitation with pediatric ARI incidence in Gading Village, Bululawang District, yielded the following equation:

$$Y = -1,61 + 0,157X_1 + 0,125X_2$$

This equation reveals positive constant and regression coefficient values, indicating that improved environmental conditions regarding cigarette smoke exposure and enhanced home environmental sanitation correlate with reduced pediatric ARI cases. Specifically, each unit increase in variable X₁ influences variable Y by 0.157, while each unit increase in variable X₂ affects Y by 0.125. According to Rahmayatul, as cited in (Kurniawan et al., 2021), parental smoking habits within domestic environments create passive smoking conditions for toddlers who experience continuous cigarette smoke exposure. Households where parents engage in smoking behaviors demonstrate 7.83 times higher potential for ARI incidence compared to residences where parents abstain from indoor smoking. Acute respiratory tract infections represent infectious diseases affecting the respiratory system, characterized by contagious properties and symptom severity ranging from mild to severe, potentially resulting in mortality. Various causative factors contribute to ARI development, including environmental and host factors, with cigarette smoke exposure being a significant contributing element (Sudiarti et al., 2023). Environmental factors demonstrate the strongest association with disease transmission, particularly infectious diseases such as Acute Respiratory Tract Infection (ARI). Home sanitation failing to meet health standards, including inadequate humidity, temperature, and natural lighting conditions, creates favorable environments for ARI bacterial growth, especially facilitating transmission to toddlers who have not yet developed immunity (Septian et al., 2021). Pediatric ARI incidence demonstrates strong correlations with residential physical environmental conditions, evidenced by research findings indicating that daily window opening habits, adequate ventilation systems, and sufficient bedroom lighting maintain significant relationships with ARI occurrence.

According to (Aryanti, 2021), Acute Respiratory Tract Infection represents a persistent health challenge across both developing and developed nations, with continued morbidity and mortality rates attributed to ARI. Environmental factors significantly affecting human health encompass housing density, ventilation area adequacy,

natural lighting availability, humidity levels, temperature conditions, wall conditions and types, and flooring characteristics. Research by Cookson and Strik, as referenced in (Hariningsih et al., 2023), demonstrates that ARI case distribution based on preliminary examinations results from population density, room physical environment, lighting conditions, floor circumstances, humidity levels, and air circulation systems that fail to meet health requirements. Optimal health achievement requires healthy residential environments. Quality healthy housing must incorporate adequate MCK (Mandi, Cuci, Kakus - bathing, washing, toilet) facilities, where sanitation represents the primary effort complementing residential physical structure and influencing human health outcomes. Residential environments must provide security, comfort, and health conditions enabling residents to maintain productive activities. The interplay between cigarette smoke exposure and environmental sanitation factors creates complex health challenges for toddler populations. The regression analysis demonstrates quantifiable relationships between these variables and ARI incidence, providing empirical evidence for public health interventions.

The statistical findings underscore the importance of comprehensive environmental health approaches addressing both tobacco smoke exposure and sanitation conditions simultaneously. These results support evidence-based interventions targeting multiple environmental risk factors to reduce pediatric ARI burden in community settings. The positive regression coefficients confirm that improvements in both cigarette smoke

exposure reduction and environmental sanitation enhancement contribute to decreased ARI incidence among toddlers. This analytical framework provides valuable insights for public health professionals, policymakers, and community health workers developing targeted interventions for pediatric respiratory health protection. The quantitative relationships identified through regression analysis enable evidence-based resource allocation and intervention prioritization for maximum health impact in vulnerable toddler populations.

Analysis of Determination Coefficient

The statistical analysis presented in Table 2 reveals significant associations between independent variables, as determined through t-value calculations. The calculated t-value for cigarette smoke exposure variable (X1) demonstrates $3.178 > t\text{-table } 1.690$, while home environmental sanitation (X2) exhibits $2.567 > t\text{-table } 1.690$. These findings indicate statistically significant relationships between cigarette smoke exposure (X1) and home environmental sanitation (X2) with pediatric ARI incidence (Y). The determination coefficient value of 0.901 demonstrates that cigarette smoke exposure (X1) and home environmental sanitation (X2) collectively account for 90.1% of the variance in pediatric ARI occurrence (Y). The remaining 9.9% represents influence from additional factors not investigated in this study. These findings align with research conducted by (Simbolon & Wulandari, 2023), which identified negative and moderate linear relationships between daily window opening habits, adequate ventilation systems, and sufficient lighting conditions with toddler ARI incidence.

Tabel 2

Analysis of Determination Coefficient of Cigarette Smoke Exposure (X1) and Home Environmental Sanitation (X2) with Ari Incidence in Toddlers (Y)

Variable	Determination Coefficient	Standard Error		
			tcount	t0,05
Variable (X ₁) against (Y)	0.901	0.049	3.178	1.690
Variable (X ₂) against (Y)		0.049	2.576	

The current study's results demonstrate consistency with investigations by (Setiawati et al., 2021), where findings revealed significant associations between cigarette smoke exposure and pediatric ARI incidence at Sukaraya Health Center, OKU Regency in 2021. The obtained OR value of 17.143 indicates that toddlers experiencing cigarette smoke exposure demonstrate 17.143 times higher probability of developing ARI compared to unexposed toddlers. Furthermore, these findings corroborate research by (Amin et al., 2020), which found that among 21 toddlers whose family members practiced smoking habits, 57.1% developed ARI, while among 19 toddlers from non-smoking families, only 21.1% experienced ARI. Toddlers from smoking households demonstrated 5 times greater likelihood of developing ARI compared to those from non-smoking environments. According to (Lalu et al., 2020), respondents experiencing

ARI exhibited household ceiling conditions that failed to meet requirements, floor types that met standards, and wall types that did not satisfy requirements. These environmental factors contribute to the complex etiology of respiratory infections in pediatric populations.

Regression Variance Analysis

The regression variance analysis presented in Table 3 demonstrates F calculated value of 145.85 exceeding F table value of 4.139, indicating that simultaneous exposure to cigarette smoke (X1) and home environmental sanitation conditions (X2) maintain significant relationships with pediatric ARI incidence (Y) in Gading Village, Bululawang District. These results correspond with findings by (Setiawati et al., 2021), where cigarette smoke exposure demonstrated capacity to disrupt respiratory tract function and increase respiratory infection risks,

including ARI, particularly among toddler age groups possessing compromised immune systems. When smoke exposure occurs, toddler respiratory systems experience more rapid disruption. Study results indicated that the proportion of toddlers exposed to cigarette smoke exceeded those unexposed, reaching 89%. Researcher observations suggest that family member smoking habits create negative health impacts for other household members, particularly toddlers. Indoor smoking or smoking near toddlers presents significant risks, causing toddlers to experience cigarette smoke exposure (becoming passive smokers), thereby increasing ARI susceptibility due to immature immune system development compared to adults. Additionally, smoking habits indicate insufficient awareness among elderly parents or families regarding healthy living behavior (PHBS) importance.

Table 3

Analysis of Regression Variations of Cigarette Smoke Exposure (X1) and Home Environmental Sanitation (X2) with The Incidence of Ari in Toddlers (Y)

Source of Variation	Degrees of Freedom	Number of Quadrants	Middle Quadrant Number	Fh	F0,05
Regresi	15.08	2	7.044	145.85	4.139
Galat	1.655	32	0.052		
Total	16.743	34			

Environmental sanitation encompasses multiple indicators including floor conditions, house ventilation, housing density, and waste bin provision. Current study results demonstrate that all these indicators correlate with ARI incidence. Dense housing conditions facilitate disease transmission, particularly respiratory diseases. Toddlers residing in areas where housing density fails to meet requirements face greater ARI contraction risks compared to those living in houses with appropriate density standards (Arihta Tarigan & Heryanti, 2021). Narrow residential areas accommodating large family numbers create imbalanced occupant-to-area ratios, enabling bacterial and viral transmission through respiratory routes between household members (Septian et al., 2021). Ventilation serves as air entry and exit points for rooms, maintaining stable indoor air quality. Houses with inadequate ventilation areas, where ventilation size exceeds 10% of floor area, increase room stuffiness and humidity, facilitating disease transmission (Septian et al., 2021). Adequate ventilation systems enable sunlight penetration into houses. Sunlight possesses pathogenic germ-killing properties that combat infectious disease causative agents, particularly when household occupants routinely open windows to allow sunlight entry (Rosiana, 2013).

Study findings revealed respondents with earthen floors, though more commonly ceramic, tile, or plaster floors were observed, with suboptimal cleanliness

conditions. Required flooring should be waterproof and easily cleanable. Appropriate flooring remains dust-free during dry seasons and moisture-free during rainy seasons (Septian et al., 2021). This investigation identifies potential confounding variables, including respondent location proximity to sugar factories producing smoke emissions that may affect respiratory tract function. Cross-sectional research methodology limitations include researcher constraints in identifying causal relationships influenced by unstudied factors. The comprehensive analysis demonstrates that environmental factors significantly influence pediatric ARI development through multiple pathways. The strong determination coefficient and significant F-value provide robust evidence for the relationship between cigarette smoke exposure and environmental sanitation with ARI incidence. These findings support multi-factorial intervention approaches addressing both direct exposure risks and environmental conditions to reduce pediatric respiratory infection burden in community settings. The statistical significance observed across multiple analytical approaches reinforces the validity of the relationships identified, providing evidence-based foundation for public health interventions targeting environmental risk factor modification in vulnerable toddler populations.

CONCLUSIONS

The findings of this investigation demonstrate statistically significant associations between cigarette smoke exposure and environmental sanitation with ARI occurrence, as evidenced by regression variance analysis values, individual testing through t_{value} calculations, and regression variance analysis via F_{value} determinations. The study established that numerous toddlers experienced cigarette smoke exposure, while unsanitary residential floor conditions contributed to pediatric ARI incidence. These circumstances indicate that smoke-free advocacy initiatives and enhanced domestic sanitation practices are essential for the Gading Bululawang village community to promote healthy living awareness.

SUGGESTION

This investigation acknowledges researcher limitations in examining all contributing factors to ARI development. Future research recommendations include implementing longitudinal methodological approaches and incorporating additional variables such as ventilation adequacy, nutritional status, pediatric personal hygiene practices, and sugar factory conditions within the Gading Bululawang village area that may influence ARI occurrence. Comprehensive multi-factorial studies would provide more robust evidence for understanding complex relationships between environmental determinants and respiratory infection patterns in vulnerable pediatric populations.

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