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Original research

Risk Factors for Pneumonia in Children: A Rapid Survey

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Abstract

Background: Pneumonia is the leading cause of infection-related death in children globally. East Java, Indonesia, is one of the provinces with the discovery achievement of pediatric pneumonia cases under 70%. Nganjuk Regency, located in East Java, has low discovery achievement of pediatric pneumonia cases (34.64%). Nganjuk Regency also requires an up-to-date study to determine the current state of pneumonia risk factors.

Objective: This study aimed to examine the occurrence of pneumonia in toddlers and its risk factors in Nganjuk Regency East Java, Indonesia.

Methods: The design of this study was a cross-sectional using a rapid survey. The participants of this study were 210 housewives or other adult household members having children under five in Nganjuk Regency. The study procedure began by collecting data from seven districts wherein each district comprised 30 houses that were chosen purposely. Data analysis was carried out using bivariate and multivariate analysis. The data were analyzed using the statistical software STATA.

Results: This study revealed that 18 (7.96%) toddlers had developed pneumonia. The main risk factors for pneumonia among toddlers in Nganjuk Regency were the nutritional status of toddlers (OR=6.787; 95%CI=1.417-32.525; p=0.017), house cleaning (OR=3.381; 95%CI=1.160-9.851; p=0.026), and room occupancy density (OR=4.191; 95%CI=1.371-12.809; p=0.012).

Conclusion: The incidence of toddler pneumonia can be reduced by educating mothers about pneumonia and its risk factors, monitoring toddler growth and nutritional status, and conducting routine surveillance of toddler pneumonia alongside sanitation inspections.

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Background

Pneumonia is the leading cause of mortality resulting from infection in children worldwide. In 2019, pneumonia claimed the lives of 740,180 children below the age of five, constituting 14% of all deaths in this age group (World Health Organization, 2021). In addition, it accounted for 22% of all deaths in children aged 1 to 5 years. The World Health Organization (WHO) also stated that South Asia and sub-Saharan Africa have the highest mortality rates for pneumonia (World Health Organization, 2021).

Children are particularly at risk from outdoor air pollution, especially in countries with high rates of pneumonia, which is exacerbated by the growing urbanization (Ebeledike, Ahmad, & Martin, 2023). Nevertheless, the prevalence of indoor air pollution, which arises from the presence of unclean air resulting from the use of cooking and heating fuels, presents a more significant worldwide hazard (World Health Organization, 2017). According to UNICEF Indonesia, indoor air pollution is responsible for 62% of child deaths caused by pneumonia associated with the air pollution (UNICEF, 2020).

The primary risk factors that contribute to the occurrence of pneumonia include absence of exclusive breastfeeding, malnutrition, indoor air pollution, low birth weight, overcrowding, lack of immunization, and comorbid conditions (Nikmah, Rahardjo, & Qadrijati, 2017; Ragwar & Brown, 2023; Sutriana, Sitaresmi, & Wahab, 2021). Children who have compromised immune systems, such as those affected by malnutrition, particularly infants who are not exclusively breastfed, are more susceptible to developing pneumonia (Nikmah et al., 2017; Ragwar & Brown, 2023)

East Java is among the provinces in Indonesia, exhibiting the most elevated rates of pediatric pneumonia. Based on the reports from district in East Java, the total number of pneumonia cases among children under the age of five in 2022 was 92.128 (Health Office East Java Province, 2023). The incidence of pneumonia among toddlers in each district in East Java exhibits significant variation, ranging from 113 to 11.692 cases. A total of 37 districts in East Java have surpassed the target of 50% in the coverage indicator for community health centers that conduct pneumonia management examinations in accordance with the established standards, except Pacitan District. However, East Java Province's discovery achievements remain below the target (63.89%). Only seventeen districts/cities have met the 70% target. Factors influencing the unmet targets in 21 districts/cities include the COVID-19 pandemic, the number of under-five visits to health services, officers' inability to detect cases early, inadequate optical system activity reporting, and rotated employees (Health Office East Java Province, 2023).

A study conducted in East Java revealed that the consumption of vitamin A and immunization of toddlers had a statistically significant impact (p value 0.01) on the incidence of pneumonia in the year 2012 (Santoso & Purhadi, 2012). Santoso and Purhadi (2012) found that Nganjuk district exhibited satisfactory immunization coverage but had a relatively low level of vitamin A coverage. In 2022, Nganjuk district reported 1.124 pneumonia cases with 36.4% discovery achievement (Health Office East Java Province, 2023). An up-to-date study is necessary to present the incidence and current status of risk factors for pneumonia in East Java, especially Nganjuk District.

This study aimed to examine the occurrence of pneumonia in toddlers in residential areas of Nganjuk Regency, East Java, Indonesia. This study also identified the factors that contribute to the risk of the disease in the research location.

Methods

Study Design

The study was carried out using a rapid survey conducted from March 13 to 16, 2023, in Nganjuk Regency. The survey team consisted of the Center for Disease Control and Prevention Surabaya, Nganjuk District Health Office, and Community Health Center.

Samples

Participants were chosen from those who identified as housewives or other adult members of the household. The inclusion criteria for this study were housewives or other adult household members

with children under the age of five in Nganjuk Regency. The study's sample included 210 housewives or adults recruited from seven districts: 1) Jatikalen District, 2) Loceret District, 3) Ngluyu District, 4) Pace District, 5) Rejoso District, 6) Sukomoro District, and 7) Wilangan. In each district, 30 houses were purposefully selected under the assumption of a statistically sound population conclusion (Kwak & Kim, 2017). Before participation, each participant provided informed consent to ensure the study's confidentiality and voluntariness.

Data Collection

The data were gathered via interviews with participants utilizing a questionnaire that adhered to the guidelines outlined in Ministry of Health Regulation Number 1077 of 2011. The regulation is related to Guidelines for Indoor Air Sanitation in Houses (Ministry of Health Indonesia, 2011). The questionnaire consisted of demographic data (respondents and their toddlers), health condition (has been diagnosed pneumonia, symptoms), special data (such as cookware, oil lamp, fuel), room density, observation (such as house wall, floor type, spatial), and knowledge of pneumonia. The questionnaire is a standard procedure in Ministry of Health regulation to collect data in the community with additional knowledge of pneumonia. There is no validity and reliability test for the questionnaire of this study.

Data Analysis

Data analysis was carried out descriptively and analytically. The data were analyzed using the statistical software STATA. The analysis of factors related to pneumonia was conducted using bivariate and multivariate logistic regression. Variables that exhibited risk factors with a p-value of ≤0.25 in bivariate analysis were eligible for further examination in multivariate analysis. The effect sizes were measured using odds ratios, accompanied by 95% confidence intervals and corresponding p-values. Variables with a p-value ≤ 0.05 were considered statistically significant in the multivariate analysis. The data analysis is presented in tabular and narrative formats.

Ethical Consideration

The researcher ensured to protect the respondents' privacy and assured them that any information they submitted would be kept private. The respondents' informed consent was acquired in order to acquire their permission to collect data. The Ethical Committee at Universitas Kadiri (Number: 055/05/VI/EC/KEP/UNIK/2023) approved this study.

Results

The study was conducted in Ngajuk Regency East Java Indonesia at seven designated locations, including: 1) Jatikalen District, 2) Loceret District, 3) Ngluyu District, 4) Pace District, 5) Rejoso District, 6) Sukomoro District, 7) Wilangan District.

Table 1 shows that most respondents were female (99.0%), with age within range of 18-30 years (45.7%) and 31-45 years (45.7%), completed high school (49.1%), and housewives (78.3%). Of the 210 respondents of households who participated in the survey, 226 toddlers were identified. Table 1 also shows that the majority of toddlers were 12-35 months (45.1%), female (51.8%), and located in the seven districts (30-35 each). In addition, 18 toddlers (7.96%) out of 226 toddlers were infected with pneumonia

Table 2 reveals that 5.75% of respondents under the age of five were born with low birth weight (LBW), 26.11% did not receive exclusive breastfeeding, 1.33% had an incomplete immunization status, and 4.87% had a malnutrition status. The biggest environmental risk factors for toddlers included the habit of not opening windows in the morning (66.81%), smoking at home (72.57%) and having guests who smoke when visiting (84.07%). In addition, the majority of respondents (80.09%) cleaned the house at least twice a day, while 95.6% mopped the house less than twice a day and the cause of indoor air pollution was kitchen smoke (82.30%). Table 2 also shows that 69.9% of children's houses were equipped with kitchen ventilation; however, only 50.88% of this ventilation met the requirement. In addition, 54.4% of the respondents had a lower level of knowledge regarding pneumonia.

Table 1 Respondent and toddler characteristics

Respondent Characteristics	N	%
Age (year)		
<18	2	1
18-30	96	45.7
31-45	96	45.7
46-59	13	6.2
≥ 60	3	1.4
Relation in Family		
Father	2	1
Aunt	2	1
Mother	192	91.4
Babysitter	1	0.5
Grandmother	13	6.2
Gender		
Female	208	99.0
Male	2	1
Education		
Elementary School	27	11.9
Junior High School	68	30.1
Senior High School	111	49.1
University	20	8.8
Employment		
Teacher	6	2.7
Foster Mother	2	0.9
Housewife	177	78.3
Private Employee	14	6.2
Trader	14	6.2
Fisheries' Department Employee	1	0.4
Nurse	1	0.4
Farmer	2	0.9
Village Office Staff	4	1.8
Businessman	5	2.2
Toddler Characteristics	**N**	**%**
Age (Month)		
<12	57	25.2
12-35	102	45.1
36-59	64	28.3
>60	3	1.3
Distribution per Area		
Jatikalen	35	15.5
Nglaban	33	14.6
Ngluyu	30	13.3
Pace	33	14.6
Rejoso	33	14.6

Respondent Characteristics	N	%
Sukomoro	30	13.3
Gender		
Female	117	51.8
Male	109	48.2
Pneumonia Status		
Yes	18	7.96
No	208	92.04

Table 2 Risk factors of pneumonia

Variable	N	%
Low Birth Weight		
Yes	13	5.75
No	213	94.25
Exclusive Breastfeeding		
No	59	26.11
Yes	167	73.89
Immunization Status		
Incomplete	3	1.33
Complete	223	98.67
Nutrition Status		
Normal	11	4.87
Poor	215	95.13
Cookware		
No gas or electronic stove	56	24.78
Gas or electronic stove	170	75.22
Fuel		
Firewood	63	27.88
Gas or electric	163	72.12
Oil Lamp		
Yes	1	0.44
No	225	99.56
Open the Window		
No	151	66.81
Yes	75	33.19
Smoking in the Family		
Yes	164	72.57
No	62	27.43
Smoking Guest		
Yes	190	84.07
No	36	15.93
Mosquito Coils		
Yes	97	42.92
No	129	57.08
Cooking with the Toddlers		

Yes	103	45.58
No	123	54.42
Cleaning the House		
No	45	19.91
Yes	181	80.09
Mopping in the House		
No	216	95.58
Yes	10	4.42
Housing Density		
Not Qualify	11	4.87
Qualify	215	95.13
Room Occupancy Density		
Not qualify	102	45.13
Qualify	124	54.87
House Wall		
Not Permanent	60	26.55
Permanent	166	73.45
Floor Type		
Soil	70	30.97
Ceramic	156	69.03
Spatial		
Not Partitioned	11	4.89
Partitioned	214	95.11
Kitchen Partition Wall		
No	26	11.50
Yes	200	88.50
Chimney		
No	40	16.67
Yes	186	82.30
Ceiling		
No	191	84.51
Yes	35	15.49
Ventilation for the Toddler's Room		
No	75	33.19
Yes	151	66.81
Extensive Ventilation in the Toddler's Room		
Not qualify	125	55.31
Qualify	101	44.69
Ventilation of Gathering Spaces		
No	83	36.73
Yes	143	63.27
Extensive Ventilation of Gathering Spaces		
Not qualify	121	53.54
Qualify	105	46.46
Ventilation of the Kitchen		
No	68	30.09

Yes	158	69.91
Extensive Ventilation in the Kitchen		
Not qualify	115	50.88
Qualify	111	49.12
Knowledge of Pneumonia		
Poor	123	54.42
Good	103	45.58

Table 3 Bivariate analysis of factors associated with pneumonia incidence in toddler

Variable	Pneumonia Status		(%) Case	OR	p-value	CI (95%)	
	Yes	No				Low	Up
Low Birth Weight							
Yes	1	12	7.69	0.961	1.000	0.021242	7.281146
No	17	196	7.98				
Exclusive Breastfeeding							
No	3	56	5.08	0.543	0.4154	0.0973441	2.028538
Yes	15	152	8.98				
Immunization Status							
Incomplete	0	3	0.00	0	1	0	15.4288
Complete	18	205	8.07				
Nutrition Status							
Poor	3	8	27.27	5	0.0469**	0.765791	23.53256
Normal	15	200	6.98				
Cookware							
No gas or electronic stove	5	51	8.93	1.184012	0.778	0.3147396	3.754898
Gas or electronic stove	13	157	7.65				
Fuel							
Firewood	7	56	11.11	1.727273	0.2774	0.5381181	5.143725
Gas or electric	11	152	6.75				
Watery eyes							
Yes	13	122	9.63	1.832787	0.2601	0.5844481	6.79681
No	5	86	5.49				
Oil Lamp							
Yes	1	0	100.00	-	0.0796*	-	-
No	17	208	7.56				
Open the Window							
No	10	141	6.62	0.5939716	0.2903	0.2011159	1.821158
Yes	8	67	10.67				

Variable	Pneumonia Status		(%) Case	OR	p-value	CI (95%)	
	Yes	No				Low	Up
Smoking in the Family							
Yes	16	148	9.76	3.243243	0.1662*	0.723922	29.81843
No	2	60	3.23				
Smoking Guest							
Yes	16	174	8.42	1.563218	0.7451	0.341166	14.61318
No	2	34	5.56				
Mosquito Coils							
Yes	8	89	8.25	1.069663	0.8917	0.3513273	3.14835
No	10	119	7.75				
Cooking with the Toddlers							
Yes	10	93	9.71	1.545699	0.3755	0.5244011	4.694288
No	8	115	6.50				
Cleaning the House							
No	7	38	15.56	2.84689	0.0585*	0.870638	8.620209
Yes	11	170	6.08				
Mopping in the House							
No	15	201	6.94	0.1741294	0.0359**	0.035485	1.164244
Yes	3	7	30.00				
Housing Density							
Not qualify	1	10	9.09	1.164706	1	0.0253645	9.123332
Qualify	17	198	7.91				
Room Occupancy Density							
Not qualify	13	89	12.75	3.476404	0.0161**	1.10538	12.85161
Qualify	5	119	4.03				
House Wall							
Not permanent	7	53	11.67	1.861063	0.2649	0.578538	5.552469
Permanent	11	155	6.63				
Floor Type							
Soil	9	61	12.86	2.409836	0.0688*	0.8013944	7.190749
Ceramic	9	147	5.77				
Spatial							
Not Partitioned	3	8	27.27	4.975	0.0474**	0.761948	23.41628
Partitioned	15	199	7.01				
Kitchen Partition Wall							
No	4	22	15.38	2.415584	0.1364*	0.5296751	8.599136
Yes	14	186	7.00				

Variable	Pneumonia Status		(%) Case	OR	p-value	CI (95%)	
	Yes	No				Low	Up
Chimney							
No	2	38	5.00	0.5592105	0.7468	0.0600544	2.547575
Yes	16	170	8.60				
Ceiling							
No	16	175	8.38	1.508571	1	0.328682	14.11878
Yes	2	33	5.71				
Ventilation for the Toddler's Room							
No	7	68	9.33	1.31016	0.5922	0.410868	3.889171
Yes	11	140	7.28				
Extensive Ventilation in the Toddler's Room							
Not qualify	11	114	8.80	1.295739	0.6058	0.438036	4.101647
Qualify	7	94	6.93				
Ventilation of Gathering Spaces							
No	5	78	6.02	0.6410256	0.4117	0.1725379	2.012176
Yes	13	130	9.09				
Extensive Ventilation of Gathering Spaces							
Not qualify	8	113	6.61	0.6725664	0.42	0.2214483	1.982036
Qualify	10	95	9.52				
Ventilation of the Kitchen							
No	1	67	1.47	0.1237928	0.018**	0.002919	0.8278886
Yes	17	141	10.76				
Extensive Ventilation in the Kitchen							
Not qualify	10	105	8.70	1.22619	0.6795	0.4165887	3.725782
Qualify	8	103	7.21				
Knowledge of Pneumonia							
Poor	6	117	4.88	0.3888889	0.0611*	0.1156339	1.174677
Good	12	91	11.65				

*p <0.25 **p<0.05

Table 3 presents the bivariate analysis of the occurrence of toddler pneumonia in Nganjuk Regency and also presents the risk factors associated with the occurrence of toddler pneumonia in Nganjuk Regency (p value <0.05). These factors included the nutritional status of toddlers (OR=5. 95% CI=0.766-23.533, p=0.0469), mopping the house (OR=0.174, 95% CI=0.036-1.164, p=0.036), room

occupancy density (OR=3.476, 95%, CI=1.105-12.852, p=0.016), spatial layout (OR=4.975, 95% CI=0.762-23.416 p=0.047), and kitchen ventilation (OR=0.124, 95%, CI=0.003-0.828 p=0.018).

Variables eligible for inclusion in the multivariate analysis were those with p-values <0.25 in the bivariate analysis, including nutrition status, oil lamp, smoking, cleaning the house, mopping in the house, room occupancy density, floor type, spatial, kitchen partition wall, ventilation of the kitchen, and knowledge of pneumonia. The results of the logistic regression multivariate analysis are presented in **Table 4.**

Table 4 Primary risk factors of pneumonia in toddler

Variable	OR	p-value	C I (95%)
Nutrition Status	6.787818	0.017	1.416569 – 32.52539
Cleaning the House	3.380864	0.026	1.160278 – 9.851294
Room Occupancy Density	4.191382	0.012	1.371491 – 12.80918
_cons	0.0226184	<0.0001	0.0076843 – 0.0665759

**p <0.05*

Table 4 demonstrates that the primary risk factors for pneumonia among toddlers in Nganjuk Regency were the nutritional status of toddlers (OR=6.787, 95% CI=1.417-32.525, p=0.017), house cleaning (OR=3.381, 95% CI=1.160-9.851, p=0.026), and the room occupancy density (OR=4.191, 95% CI=1.371-12.809, p=0.012). Toddlers with poor nutritional status were 6.787 times more likely to experience pneumonia compared to toddlers with good nutritional status. The probability of toddlers who have their homes cleaned less than twice a day experiencing pneumonia was 3.381 times higher compared to toddlers whose homes are cleaned at least twice a day. Toddlers living in houses with room densities that did not meet the requirements were 4.191 times more likely to experience pneumonia compared to toddlers living in houses with room densities that met the requirements.

Discussion

The results of this study show that 7.96% toddlers were infected with pneumonia in Nganjuk Regency. The main risk factors for pneumonia among the toddlers in this current study were the nutritional status of toddlers, house cleaning and the room occupancy density. A study by Ningsih Salimo, and Rahardjo (2019) in West Nusa Tenggara Indonesia supported that there was an effect of nutritional status on the incidence of pneumonia. Howie et al. (2016) stated that malnutrition had a strong role and caused an immune system disorder in the occurrence of severity. Nutritional status can indicate immune and immune systems for example iron, zinc, vitamin A and vitamin D levels can influence the occurrence of pneumonia in infants (Zhou, Zuo, Li, & Yu, 2016).

The nutritional status of children under the age of five was significantly associated with the incidence of pneumonia in the Nganjuk Regency. Pneumonia is an infectious disease that can affect toddlers with low nutritional status. Toddlers with poor nutritional status are more vulnerable to infectious diseases because their immune systems are compromised, and they lack appetite (Alvionita, Sulfatimah, Astuti, & Nurfitri, 2022). Toddler nutritional intake is not intended to provide direct immunity against upper respiratory tract infections, but rather to reduce risk factors for pneumonia (Rahayuningrum & Nur, 2021). Ehsanul Huq et al. (2021) further revealed that malnourished children suffered more from rapid breathing, lower chest wall in-drawing, and fever compared to well-nourished children . A previous study showed that the immune response of malnourished children is inadequate, and the observed clinical features may be explained by that observation; thus, they need greater care with more observance than the well-nourished (Bourke, Berkley, & Prendergast, 2016).

Cleaning the house is an effort to reduce the amount of dust and dirt in the house. According to this study, cleaning the house less than twice a day increases the risk of toddlers developing pneumonia. Mothers were expected to understand that environmental factors could influence pneumonia incidence. A previous study in central Java discovered a link between household cleanliness and the prevalence of pneumonia (Dewiningsih, 2018). According to Dewiningsih (2018) , mothers who do not engage in household cleaning activities are 5.12 times more likely to expose their toddlers to pneumonia than mothers who clean the house Furthermore, Ningsih et al. (2019) reported there was an effect on the physical quality of the house with the incidence of pneumonia. Children

under five living in a house with a healthy physical quality can reduce the risk of pneumonia in infants, which was 1.16 times higher compared to children under five whose homes have unhealthy physical qualities. A hospital-based case-control study in Egypt supported that poor home aeration (OR = 3.586), and exposure to outdoor air pollution (OR = 2.403) were associated with pneumonia (Fadl, Ashour, & Yousry Muhammad, 2020). Moreover, other indoor environmental factors, such as dampness, chemical emissions, parental smoking, and household use of solid/gas fuel, were found to significantly increase the risk of childhood pneumonia in China (Zhuge et al., 2018). In order to improve the health of toddlers, further research is required to examine mothers' awareness of the impact of environmental factors on pneumonia.

This study also found a correlation between the room occupancy density and the prevalence of pneumonia. A room not occupied to the required degree suggests it is congested, which might exacerbate the pollution factors already present in the home (Mardani, Wardani, & Gayatri, 2016). The desire for clean air is not satisfied because there is less space in a crowded environment. These rooms' occupancy density may also make it easier for germs that cause infectious diseases to spread from one resident of the home to another through breathing (Wahyuni, Hardianti, & Sartika, 2023). Furthermore, the number of persons in the room will hasten the spread of pathogenic bacteria from one individual to another. One attempt to lower the room occupancy density is to increase the ventilation in the space (Saragih, Eskana Sihombing, & Boni Yolanda Pardede, 2022).

Two significant limitations of this study could be addressed in future research. First, the study is cross-sectional, so a causal relationship cannot be established. Second, while each district provided a sufficient sample for statistical analysis, generalization should be exercised cautiously. The recruitment process is based on available data in a short period of time.

Conclusion

This study concluded that the most dominant risk factors are nutritional status, house cleaning habits, and overcrowding in toddler rooms. This study recommended promoting nutritional interventions, implementing hygiene education programs, and improving housing conditions to reduce room density. Moreover, routines to prevent delays in handling growth and development nutrition problems of infants and toddlers, increased surveillance of toddler pneumonia, and sanitation inspections of healthy settlements are also significant. In order to enhance the health of toddlers, more research is required to investigate mothers' awareness of the impact of environmental factors on pneumonia.

Declaration Conflicting Interest
Authors declare no conflict interest

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Author Contribution
YAM, ES, ENL, HH, and NE developed and discussed the topics. YAM, ES, ENL, and HH helped conceptualize and design the study and collect field data. YAM, ES and NE analyzed the data and developed first draft of manuscript. All authors critically reviewed the manuscript and participated in its further development. All authors read and approved the final manuscript for publication.

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