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Crowded Housing and Urban Residence as Risk Factors for Under-Five Children's Pneumonia in Indonesia: Analysis of SSGI 2024 Data

Kepadatan Hunian dan Wilayah Perkotaan sebagai Faktor Risiko Pneumonia pada Balita di Indonesia: Analisis Data SSGI 2024

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ABSTRACT

Pneumonia remains the leading cause of morbidity and mortality among under-five children in Indonesia, with cases tending to increase each year. This study aimed to examine the association between crowded housing, cooking fuel type, nutritional status, sex, and classification of residence with the incidence of under-five children under five years old in Indonesia. This study used a cross-sectional design with secondary data from the 2024 Indonesian Nutritional Status Survey. The sample included 201,017 children aged 12-59 months. Bivariate analysis was performed using the chi-square test. The bivariate analysis of five variables showed that crowded housing (p=0.008; POR=1.273) and urban residence (p<0.001; POR=1.918) were significant risk factors for under-five children's pneumonia. Meanwhile, sex (p=0.412), nutritional status (p=0.216), and cooking fuel type (p=0.290) did not show statistically significant associations. Crowded housing conditions and living in urban areas are significant risk factors for pneumonia in children under five in Indonesia. Public health interventions should prioritize improving household ventilation, reducing indoor crowding, and developing targeted pneumonia prevention programs in urban areas.

Keywords: pneumonia, under-five children, crowded housing, urban residence, SSGI 2024

ABSTRAK

Pneumonia masih menjadi penyebab utama morbiditas dan mortalitas pada balita di Indonesia dengan kasus yang cenderung meningkat setiap tahunnya. Penelitian ini bertujuan untuk melihat hubungan antara kepadatan hunian, bahan bakar memasak, status gizi, jenis kelamin, serta klasifikasi tempat tinggal dengan kejadian pneumonia pada balita di Indonesia. Penelitian ini menggunakan desain cross sectional dengan data sekunder dari Survei Status Gizi Indonesia (SSGI) 2024. Sampel mencakup 201.017 balita usia 12-59 bulan. Analisis data dilakukan secara bivariat dengan menggunakan uji chi-square. Hasil analisis bivariat dari lima variabel menunjukkan bahwa kepadatan hunian (p=0,008; POR=1,273) dan klasifikasi tempat tinggal di wilayah urban (p<0,001; POR=1,918) merupakan faktor risiko signifikan terhadap kejadian pneumonia pada balita. Sementara itu, jenis kelamin (p=0,412), status gizi (p=0,216), dan penggunaan bahan bakar memasak (p=0,290) tidak menunjukkan hubungan yang bermakna secara statistik. Hunian yang padat dan tinggal di wilayah perkotaan terbukti meningkatkan risiko pneumonia pada balita di Indonesia. Untuk itu, upaya pencegahan pneumonia perlu difokuskan pada pengurangan kepadatan hunian dan pengembangan program yang lebih terarah khususnya di daerah perkotaan.

Kata Kunci : Pneumonia, balita, kepadatan hunian, wilayah perkotaan, SSGI 2024

INTRODUCTION

Pneumonia is an acute respiratory infection that affects the alveoli and the distal bronchial tree of the lungs. It is caused by various agents, including bacteria, viruses, parasites, and fungi, although bacterial and viral infections are the most common causes according to the Centers for Disease Control and Prevention.[1,2] Infection leads to inflammation and fluid accumulation in the lungs, causing breathing difficulties and potentially death, making pneumonia the leading infectious cause of mortality among children worldwide.[3]

Globally, pneumonia remains the leading cause of death among children compared to other infectious diseases. It is estimated that over 700,000 children under five die annually, or about 2,000 deaths per day, with around 610,000 deaths reported in 2023 based on the Global Burden of Disease study.[4] Reports from UNICEF and the International Vaccine Access Center (IVAC) in 2024 indicate that more than 70% of under-five deaths are due to pneumonia and diarrhea.[5] The decline in pneumonia-related mortality has been slower than that of other infectious diseases, highlighting its ongoing public health importance.

In Indonesia, the burden of under-five children's pneumonia has increased significantly over the past five years. Data from the Indonesian Health Profile 2020–2024 show a decline from 309,838 cases in 2020 to 278,261 cases in 2021, likely due to pandemic-related changes in healthcare access and mobility. However, cases rose again in 2022, reaching 386,724, 416,435 in 2023, and 530,641 in 2024.[6] Overall, this represents an increase of more than 70%, indicating that pneumonia remains a major challenge for the national health system.

Several studies have identified factors associated with under-five children's pneumonia, particularly environmental conditions such as crowded housing. High housing density increases the risk of droplet transmission due to poor ventilation and close contact. A study by Sa'diyah et al. (2022) in Semarang found a significant association between crowded housing and pneumonia (OR=3.889; p=0.014).[7] Additionally, residence classification (urban–rural) also plays a role, with a study by Dharel et al. (2023) in Nepal reporting higher pneumonia risk among children in urban areas (p<0.001).[8]

Other contributing factors include sex, nutritional status, and type of cooking fuel. Ananda & Budyanra (2024) found that male children had a 1.14 times higher risk of pneumonia, while undernourished children had 1.23 times higher odds.[9] Furthermore, Kurniawati and Wulandari (2025) reported that the use of unclean cooking fuel (firewood) increased the risk of pneumonia by 6.61 times (p=0.019).[10]

Based on this background, this study utilizes data from the 2024 Indonesian Nutritional Status Survey (SSGI), the most recent nationally representative dataset. The novelty of this study lies in examining key risk factors, especially crowded housing and residence classification, along with supporting factors such as sex, nutritional status, and cooking fuel type. Therefore, this study aims to analyze their association with the incidence of under-five children's pneumonia in Indonesia in 2024.

METHOD

This study employed a cross-sectional design using secondary data from the 2024 Indonesian Nutritional Status Survey (SSGI). The target population was all children aged 12–59 months living in Indonesia in 2024. The study sample included 201,017 children who met the following inclusion criteria: (1) aged 12–59 months at the time of the SSGI 2024 survey; and (2) had complete data for all variables analyzed in this study. Children aged 0–11 months or those with missing data on any of the study variables were excluded from the analysis.

Pneumonia was defined based on maternal report of a healthcare worker's diagnosis. The child's sex was classified as male or female.[11] Nutritional status was determined using weight-for-age based on WHO standards (normal or undernutrition).[8] Crowded housing was defined as floor area <9 m² per person, per Ministry of Health Regulation No. 2/2023. Cooking fuel was classified as clean (LPG/electricity) or dirty (firewood/charcoal).[12] Place of residence was categorized as urban or rural.

Data analysis was performed using univariate and bivariate analyses. Univariate analysis was used to describe the frequency

distribution of each variable. Bivariate analysis was conducted using the chi-square test to examine the association between each independent variable and the incidence of under-five children's pneumonia. Ethical approval for this study was issued by the Faculty of Public Health, Andalas University, with ethical clearance number B/295/UN16.12.D/PP/2026 on 23 February 2026.

RESULT

A total of 201,017 children aged 12–59 months were included in this analysis. The prevalence of pneumonia among under-five children in Indonesia in 2024 is presented in Table 1.

Table 1. Frequency Distribution of Under-five children Pneumonia Incidence

Variable	f	%
Under-Five Children Pneumonia Incidence		
Yes	2,188	1.09
No	198,829	98.91

Based on Table 1 above, the frequency distribution of pneumonia incidence in under-five children in Indonesia in 2024 shows that out of a total of 201,017 children, 2,188 children (1.09%) had pneumonia.

Table 2. Descriptive Analysis of Independent Variables

Variables	f	%
Crowded Housing		
Not Crowded	165,179	82.2
Crowded	35,838	17.8
Cooking Fuel Type		
Clean	186,232	92.6
Unclean	14,785	7.4
Nutritional Status		
Normal	168,815	84
Undernutrition	32,202	16
Sex		
Female	98,267	48.9
Male	102,750	51.1
Classification of Residence		
Rural	78,120	38.9
Urban	122,897	61.1

Table 2 presents the distribution of the five independent variables. In crowded housing, 165,179 children (82.2%) lived in non-crowded housing, whereas 35,838 children (17.8%) lived in crowded housing. In terms of cooking fuel type, the majority of households used clean cooking fuel (186,232 children; 92.6%), while only 14,785 children (7.4%) lived in households that still used unclean cooking fuel such as wood or charcoal. Regarding nutritional status, 168,815 children (84.0%) had normal nutritional status, while 32,202 children (16.0%) were classified as undernourished. In terms of sex, 102,750 children (51.1%) were male, and 98,267 children (48.9%) were female. Finally, for classification of residence, 78,120 children (38.9%) lived in rural areas, and 122,897 children (61.1%) lived in urban areas.

Table 3. Relationship Between the Independent Variable and Under-five Children's Pneumonia

Variables	Pneumonia				Total		POR (95% CI)	p-value
	Yes		No					
	f	%	f	%	f	%		
Crowded Housing								
Crowded	472	1.32	35,366	98.68	35,838	100	1.273 (1.063 – 1.524)	0.008
Not Crowded	1,715	1.04	163,463	98.96	165,179	100		
Cooking Fuel Type								
Unclean	136	0.92	14,649	99.08	14,785	100	0.833 (0.594 -1.169)	0.290
Clean	2,052	1.10	184,180	98.90	186,232	100		
Nutritional Status								
Under Nutrition	384	1.19	31,818	98.81	32,202	100	1.118 (0.937 – 1.335)	0.216
Normal	1,803	1.07	167,011	98.93	168,815	100		
Sex								
Male	1,153	1.12	101,597	98.88	102,750	100	1.066 (0.915- 1.242)	0.412
Female	1,035	1.05	97,232	98.95	98,267	100		
Classification of Residence								
Urban	1,641	1.33	121,257	98.67	122,897	100	1.918 (1.493-2.463)	<0.001
Rural	547	0.7	77,572	99.3	78,120	100		

Based on Table 3, the bivariate analysis using the chi-square test identified several factors associated with under-five children's pneumonia. Crowded housing and residence classification were significantly associated with the outcome. Children living in crowded housing and those residing in urban areas showed higher odds of pneumonia compared to their counterparts. In contrast, cooking fuel type, nutritional status, and sex were not significantly associated with pneumonia among under-five children. These findings highlight that environmental and residential factors play a more prominent role than individual characteristics in this analysis.

DISCUSSION

This study aimed to analyze the association between crowded housing, cooking fuel type, nutritional status, sex, and residence classification with the incidence of under-five children's pneumonia in Indonesia using the 2024 SSGI data. The main findings of this study are that crowded housing and urban residence are significant risk factors, while sex, nutritional status, and cooking fuel type did not show statistically significant associations.

Crowded Housing

Crowded housing was proven to be a significant risk factor for under-five children's pneumonia, with children in crowded housing having 1.27 times higher odds of pneumonia compared to those in non-crowded housing. Biologically, crowded housing increases close contact and limits air circulation, facilitating the spread of infectious droplets containing pathogens such as *Streptococcus pneumoniae* from an infected person to a susceptible child.[7] A systematic scoping review by Lorentzen et al. confirmed that overcrowding increases the risk of pneumonia in children under five through droplet transmission and limited air circulation, creating an environment where respiratory pathogens such as Streptococcus pneumoniae spread more easily among household members.[13] Furthermore, Holden et al. reported that poor indoor air quality due to housing density significantly contributes to under-five children's pneumonia morbidity, with ventilation adequacy being a key modifying factor.[14]

The association between crowded housing and childhood pneumonia has been consistently demonstrated across different geographical settings. Sa'diyah et al. in Semarang found that children living in crowded

housing had 3.889 times higher odds of pneumonia (OR=3.889), while Islam et al. in Bangladesh reported that crowded housing significantly increased the risk of respiratory hospitalization among children under five.[7,15] The strength of this association varies by regional characteristics and environmental conditions. Syakbanah et al. in Bojonegoro, Indonesia, further revealed that inadequate ventilation in rural areas carried an even higher risk for under-five children pneumonia, with a prevalence ratio of 25.00 (PR=25.00; p=0.03), indicating that rural settings with poor housing quality may face unique challenges in pneumonia prevention despite having lower population density compared to urban areas.[16]

Classification of Residence

Residence classification showed the strongest association, with children in urban areas having 1.92 times the odds of pneumonia compared with those in rural areas. This finding aligns with that of Zhuge et al. in China, who reported a higher risk of urban pneumonia associated with population density and air pollution.[17] Islam et al. in urban Dhaka reported that overcrowded households increased the odds of childhood acute respiratory infections (including pneumonia) by 2.66 times (AOR = 2.66; 95% CI: 1.52–4.71; $p < 0.001$).[18] Similarly, Alfarisi & Syavera in metropolitan Jakarta reported that carbon monoxide (CO) levels were significantly associated with pneumonia case distribution, where each unit increase in CO corresponded to an increase in pneumonia cases.[19] Purnama et al. specifically in Indonesia confirmed that poor local environment combined with undernutrition plays a significant role in acute respiratory infections among children under five.[20]

The finding that urban residence increases pneumonia risk differs from studies in Nepal and Pakistan, where rural areas had a higher risk due to limited healthcare access.[8,21] This difference reflects Indonesia's unique context of rapid urbanization, leading to dense slum settlements, high air pollution from vehicles and industry, and potentially better case detection in urban areas.[22] Unlike South Asian countries where rural healthcare infrastructure remains a major challenge, Indonesia's urban areas face distinct pressures from overcrowded housing and concentrated population density, all of which contribute to the heightened risk of pneumonia among under-five children living in citie.

Cooking Fuel Type

Cooking fuel type did not show a significant association with under-five children's pneumonia. Interestingly, children using unclean fuel (wood/charcoal) had a lower pneumonia rate (0.92%) than those using clean fuel (1.10%). This unexpected finding is explained by the high proportion of clean fuel use in Indonesia (92.6%), following the successful national kerosene-to-LPG conversion program, which limits statistical power to detect an association. Additionally, households still using unclean fuel may have other protective factors, such as better ventilation or outdoor cooking practices. This finding does not negate established evidence that biomass smoke increases pneumonia risk, but rather reflects the success of Indonesia's clean fuel program.[10,23]

Nutritional Status

Nutritional status also did not show a significant association with under-five children pneumonia. Although undernourished children had a slightly higher pneumonia rate (1.19% vs 1.07%), the difference was not statistically significant. This finding differs from previous studies by Nurnajiah et al. in Padang and Ananda & Budyanra nationally, who reported significant associations between undernutrition and pneumonia[16–21]. The non-significant finding in this study may be explained by the lack of control for confounders such as immunization status, breastfeeding, and socioeconomic status, as well as the relatively small proportion of undernourished children (16%), limiting statistical power.

Sex

Sex was not found to be significantly associated with under-five children's pneumonia. Male children had a slightly higher proportion (1.12% vs 1.05%), but this difference was not statistically significant. This finding differs from previous studies by Fadl et al. in Egypt and Sakiguna et al. in Lombok, which reported that male children had a higher risk of pneumonia.[24,25] Although biologically male children are more susceptible due to narrower airways and slower immune maturation, the non-significant finding in this national study is likely due to the dominant effect of stronger environmental risk factors,

such as crowded housing and urban residence, which overshadow the influence of sex.[26]

Based on these findings, pneumonia prevention interventions should prioritize improving crowded housing conditions in urban areas, including promoting adequate ventilation and reducing household crowding. Pneumonia prevention programs must be specifically targeted to urban areas, where the risk is nearly twice that of rural areas. Furthermore, Indonesia's clean cooking fuel program needs to be sustained and expanded to reach households that still use unclean fuels.

Strengths and Limitations

This study has notable strengths, including a large nationally representative sample (n=201,017) from the 2024 SSGI, which provides robust statistical power and generalizability across all 38 provinces in Indonesia. However, several limitations should be considered. The cross-sectional design prevents causal inference, as exposure and outcome were measured simultaneously. Additionally, potential reporting bias may exist because pneumonia diagnoses relied on maternal recall of healthcare workers' diagnoses rather than direct medical verification, potentially leading to underreporting or misclassification of cases.

CONCLUSION

This study concludes that crowded housing and urban residence are significant risk factors for under-five pneumonia in Indonesia, while sex, nutritional status, and cooking fuel type show no significant associations. These findings provide evidence that environmental factors dominate over individual biological characteristics. Crowded housing facilitates droplet transmission, while urban areas concentrate high density, air pollution, and slums. The non-significant finding for cooking fuel reflects the success of Indonesia's clean fuel program. Practical applications include targeting pneumonia prevention to urban areas, improving housing and ventilation in crowded settlements, and maintaining the clean fuel program. Future research should use multilevel analyses to control for confounders and longitudinal studies to establish causality.

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