



Parental Smoking Behavior Inside the Home and Pneumonia Incidence Among Under-Five Children

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ABSTRACT

Pneumonia is an acute lower respiratory tract infection that remains a major health problem among infants and young children worldwide, including in Indonesia. Globally, pneumonia poses a serious health threat, with more than 700,000 deaths occurring among infants and young children each year. This situation is also evident in Gorontalo Province, where reported cases of pneumonia have increased annually from 2021 to 2024, with the highest number of cases in Gorontalo City recorded at the Dungi Community Health Center. Exposure to secondhand smoke indoors is a modifiable risk factor for pneumonia; however, local evidence regarding the association between parental smoking behavior and the incidence of pneumonia among infants in Gorontalo City remains limited. This study aims to analyze the association between parental smoking behavior indoors and the incidence of pneumonia among toddlers in the service area of the Dungi Community Health Center in Gorontalo City. The study employed an analytical observational design with a cross-sectional approach involving 95 respondents selected using accidental sampling. Data on smoking behavior were collected via a structured questionnaire, while data on pneumonia incidence were obtained from medical records. Analyses were conducted using univariate and bivariate methods, including the Kolmogorov-Smirnov test. The results showed that the majority of respondents exhibited moderate smoking behavior (80.0%), followed by high (15.8%) and low (4.2%) levels, and 18.9% of toddlers were diagnosed with pneumonia. Bivariate analysis revealed a significant association between parental smoking behavior indoors and the incidence of pneumonia in toddlers ($p=0.011$). These findings suggest that exposure to secondhand smoke in the home environment is associated with an increased incidence of pneumonia in toddlers. The study results can serve as a basis for strengthening education on smoke-free homes as part of pneumonia prevention efforts at the family level and in primary health care.

1. INTRODUCTION

Pneumonia is an acute lower respiratory tract infection that remains a leading cause of death among infants worldwide. The World Health Organization (WHO) reports that approximately 740,000 infants die from pneumonia each year, accounting for about 18% of all infant deaths due to infectious diseases. In Indonesia, pneumonia remains one of the leading causes of death among children under five, with a prevalence of 4.5% and the highest incidence in the 1-4 year old age group, according to the 2023 Indonesia Health Survey. Although the government has implemented various efforts through immunization programs and improved early detection, these figures have not shown a significant decline over the past five years. This situation indicates that pneumonia remains a public health issue requiring comprehensive prevention efforts, including through the control of modifiable risk factors (WHO, 2025).

An increase in pneumonia cases has also been observed in Gorontalo Province. Data from the Gorontalo Provincial Health Office show that the number of pneumonia cases among toddlers rose from 1,787 cases in 2022 to 2,634 cases in 2023, and then increased further to 3,199 cases in 2024. In Gorontalo City, the service area of the Dungi Community Health Center has consistently recorded the highest number of cases compared to other community health centers,

with 125 cases in 2023, rising to 149 cases in 2024, and reaching 157 cases as of November 2025. This high case burden makes the Dungi Community Health Center's service area a key for the study, as it represents the area with the highest burden of pneumonia among toddlers in Gorontalo City (Gorontalo City Health Department, 2025).

One modifiable environmental risk factor is exposure to secondhand smoke indoors. Gorontalo City has a high proportion of active smokers, approximately 30.72%. This high proportion of smokers indicates a potential for secondhand smoke exposure within the household environment, thereby increasing the likelihood that infants will be exposed to secondhand smoke within the family setting. Continuous exposure to secondhand smoke can disrupt the airway's defense mechanisms, impair mucociliary function, and increase infants' susceptibility to lower respiratory tract infections, including pneumonia. Therefore, parents' smoking behavior at home is a critical risk factor that must be addressed in efforts to prevent pneumonia in infants.

As a modifiable risk factor, this issue requires serious attention in efforts to prevent pneumonia in toddlers. From a public health perspective, high rates of pneumonia increase the burden on primary health care services while also increasing the need for referrals. In addition, families must bear the costs of examinations, treatment, transportation, and lost work time while caring for a sick child, which impacts the quality of life for both the infant and the family. Therefore, controlling parental smoking behavior at home is a key strategy that can support pneumonia prevention, alongside immunization, improved nutritional status, and early detection.

Several previous studies have shown an association between exposure to household tobacco smoke and the incidence of pneumonia in toddlers. Juniantari *et al.* (2023) reported that children living with family members who smoke are approximately twice as likely to develop pneumonia. Prayogo and Zein (2025) also found an increased risk among toddlers exposed to secondhand smoke, while Sen *et al.* (2025) demonstrated that the risk of pneumonia increases in households with higher tobacco consumption. Nevertheless, the magnitude of the reported associations still varies. These differences are thought to be influenced by variations in population characteristics, the intensity of exposure to secondhand smoke, home ventilation conditions, nutritional status, immunization coverage, and the methods used to measure smoking behavior in each study.

As of the time this study was conducted, no research had specifically analyzed the association between parental smoking behavior indoors and the incidence of pneumonia among toddlers in the Gorontalo region. Furthermore, most previous studies have focused primarily on the presence of family members who smoke or the number of cigarettes consumed, without evaluating smoking behavior more comprehensively, such as frequency, duration, intensity, or the circumstances under which toddlers are around smokers. Consequently, there remains a knowledge gap regarding the relationship between parental smoking behavior and the incidence of pneumonia in populations with local characteristics, such as those in the service area of the Dungi Community Health Center.

Preliminary observations conducted in the Dungi Community Health Center's service area further underscore the urgency of this study. From January through September 2025, a total of 120 cases of pneumonia were recorded among toddlers. Interviews with seven parents of toddlers with pneumonia revealed that all of them smoked indoors, with some smoking more than three times a day, near their children, in the living room, or at night without opening the windows. These findings are preliminary, intended only to identify research issues, and are not meant to represent the overall population.

Based on these findings, the novelty of this study lies in its contribution to providing empirical evidence regarding the association between parents' indoor smoking behavior and the incidence of pneumonia among toddlers in the service area of the Dungi Community Health Center in Gorontalo City, a topic that has not been widely reported in the local population to date. Unlike previous studies, which generally focused only on the presence of family members who smoke or the amount of cigarette consumption, this study specifically examines parents' smoking behavior within the home as a form of environmental exposure, measured in terms of duration, frequency, and intensity of smoking. Thus, this study is expected to strengthen the scientific

evidence regarding household environmental risk factors for pneumonia in toddlers and serve as a basis for formulating family based prevention strategies in Gorontalo Province.

Based on the above, this study aims to analyze the relationship between parental smoking behavior inside the home and the incidence of pneumonia among infants in the service area of the Dungi Community Health Center in Gorontalo City. The study results are expected to provide a scientific basis for strengthening education on smoke free homes and to support promotive and preventive efforts in the prevention of pneumonia among infants at both the family level and in primary health care.

2. METHOD

This study is a quantitative study with an analytical observational design using a cross-sectional approach, aimed at analyzing the relationship between parental smoking behavior indoors and the incidence of pneumonia among toddlers. The study was conducted in the service area of the Dungi Community Health Center in Gorontalo City from October to November 2025. The study population consisted of all infants and toddlers aged 0-59 months registered in the service area of the Dungi Community Health Center as of September 2025, totaling 1,796 children. The sample size was determined using the Slovin formula with a margin of error of 10%, resulting in a minimum required sample size of 95 respondents.

Sampling was conducted using a non-probability sampling technique with an accidental sampling approach, whereby respondents meeting the inclusion criteria were selected as the researchers collected data at the study site. This technique was chosen because it made it easier for the researcher to identify respondents who met the criteria within the limited research timeframe. However, the use of this technique has the potential to introduce selection bias; therefore, the research results must be interpreted with caution and have limitations in representing the entire population of toddlers in the Dungi Community Health Center's service area.

Inclusion criteria included toddlers aged 0-59 months who had resided for at least six months within the Dungi Community Health Center's service area, were registered in the center's toddler registry, had parents who smoked and lived in the same household, and whose parents agreed to participate by signing an informed consent form. Toddlers with congenital abnormalities, those who experienced other severe infections during the study period, or those with uncooperative parents were excluded from the study. Primary data were collected through face to face interviews conducted by the researchers using a structured questionnaire administered to the respondents' parents to obtain information on the respondents' characteristics and their parents' smoking behavior at home. Secondary data on pneumonia cases were obtained through a review of medical records of toddlers at the Dungi Community Health Center, verified based on diagnoses by health care providers.

The independent variable was parental smoking behavior at home, measured using a questionnaire containing 17 statements, consisting of two items on smoking duration, ten items on smoking frequency, and five items on smoking intensity. Each item used a four-point scale (0-3). The total score was then categorized as low (≤ 17), moderate (18-34), and high (≥ 34) based on the categorization established in a previous study. The dependent variable was the incidence of pneumonia in toddlers, determined based on healthcare provider diagnoses recorded in the Community Health Center's medical records. The smoking behavior instrument was adapted from one used in a previous study. Validity test results showed that all items had a calculated r-value greater than exceeding the table r-value (0.273), while the reliability test yielded a Cronbach's Alpha value of 0.914, indicating that the instrument has very good reliability.

Data analysis in this study was conducted using univariate and bivariate methods. Univariate analysis was used to describe the characteristics of the respondents, parental smoking behavior, and the incidence of pneumonia. The researcher first considered bivariate analysis using the chi-square test. However, because more than 20% of the cells had an expected count of less than five, which did not meet the assumptions of the Chi-square test in a 3x2 contingency table, and the standard requirements for a 3x2 table for the alternative Fisher's Exact Test were

not met, the researcher used the alternative Kolmogorov-Smirnov test in accordance with the analysis procedures applied in this study. A p-value < 0.05 was considered statistically significant. As a methodological note, for future studies, it is recommended to use multivariate analysis to better control for the effects of confounding factors.

This study adhered to research ethics principles by providing explanations regarding the study's objectives, benefits, procedures, data confidentiality, and respondents' rights to refuse or withdraw from participation at any time. Informed consent was obtained through the signing of a consent form prior to data collection. The analysis of the relationships between variables was conducted using the Kolmogorov-Smirnov test in accordance with the analytical procedures applied at the time the study was conducted. Therefore, the research results must be interpreted with caution. Future studies are advised to use alternative tests for comparison.

3. RESULT AND DISCUSSION

Result

Table 1. Characteristics of Parent Respondents by Age

No	Parent Age	Frequency (N)	Percentage (%)
1	Late Adolescence	27	28.4
2	Early Adulthood	54	56.8
3	Late Adulthood	14	14.8
	Total	95	100

Source: Primary Data 2026

Table 1 shows that the majority of respondents were in early adulthood, totaling 54 respondents (56.8%).

Table 2. Characteristics of Respondents by Gender of Toddlers

No	Parent Age	Frequency (N)	Percentage (%)
1	Male	42	44.2
2	Female	53	55.8
	Total	95	100

Source: Primary Data 2026

Based on Table 2, it was found that female toddlers constituted the largest group, with 53 respondents (55.8%).

Table 3. Respondent Characteristics by Toddler Age

No.	Parent Age	Frequency (N)	Percentage (%)
1	Newborn	13	13.7
2	Infant	44	46.3
3	Toddler	38	40
	Total	95	100

Source: Primary Data 2026

Based on Table 3, respondents in the infant age category were the most numerous, totaling 44 respondents (46.3%).

Table 4. Parental Smoking Behavior Inside the Home Among Families with Toddlers

No.	Smoking Behavior	Frequency (N)	Percentage (%)
1	Low	4	4.2
2	Moderate	76	80
3	High	15	15.8
	Total	95	100

Source: Primary Data 2026

Based on Table 4, regarding parental smoking behavior inside the home in families with toddlers, the majority of respondents 76 respondents (80%), exhibited moderate smoking behavior.

Table 5. Incidence of Pneumonia Among Toddlers

No	Smoking Behavior	Frequency (N)	Percentage (%)
1	Not Diagnosed with Pneumonia	77	81.1
2	Diagnosed with Pneumonia	18	18.9
	Total	95	100

Source: Primary Data 2026

Based on Table 5, it was found that among cases of pneumonia in toddlers in the Dungigi Community Health Center area, the majority of respondents 77 respondents (81.1%), were not diagnosed with pneumonia.

Table 6. Association Between Parents' Smoking Behavior Inside the Home and the Incidence of Pneumonia Among Toddlers in the Dungigi Community Health Center Area, Gorontalo City

Table 6. Association Between Parents' Smoking Behavior Inside the Home and the Incidence of Pneumonia

Parental Smoking Behavior Inside the Home	Pneumonia Incidence				Total		P-value
	Not diagnosed		Diagnosed				
	N	%	N	%	N	%	
Low	4	4.2	0	0	4	4.2	0.011
Moderate	67	70.5	9	9.5	76	80	
High	6	6.3	9	9.5	15	15.8	
Total	77	81	18	19	95	100	

Source: Primary Data 2026

Table 6 shows that moderate parental smoking behavior at home was associated with the highest prevalence of undiagnosed pneumonia among toddlers, with 67 respondents (70.5%) reporting this behavior and 9 (9.5%) toddlers with undiagnosed pneumonia. Furthermore, in the high smoking behavior category, there were 6 respondents (6.3%) with undiagnosed pneumonia and 9 respondents (9.5%) with diagnosed pneumonia, in the low smoking behavior category, there were 4 respondents (4.2%) with undiagnosed pneumonia and no toddlers diagnosed with pneumonia. Statistical analysis using the Kolmogorov-Smirnov test yielded a p-value of 0.011 < 0.05, indicating a significant association between parental smoking behavior at home and the incidence of pneumonia among toddlers in the Dungingi Community Health Center area of Gorontalo City.

Discussion

The study results indicate that the majority of respondents were parents with moderate smoking behavior indoors, totaling 76 respondents (80%), 15 respondents (15.8%) fell into the high category, and 4 respondents (4.2%) were in the low category. This distribution pattern indicates that smoking inside the home remains a common practice among families with toddlers, furthermore, the majority of parents in the moderate smoking behavior category smoke inside the home quite frequently, even after dinner. This behavior suggests that smoking has become a routine habit for parents, performed repeatedly at specific times. This habit aligns with the results of the researchers' interviews with parents, who stated that smoking provides them with greater pleasure compared to not smoking. These findings suggest that the home, as the primary setting where toddlers spend their time, can become a significant source of secondhand smoke exposure when smoking habits are repeated frequently, over long durations, or with high intensity.

Biologically, this relationship can be explained by the effects of chronic exposure to cigarette smoke on the respiratory tract's defenses. Substances such as nicotine, carbon monoxide, formaldehyde, fine particulate matter, and various oxidizing compounds in cigarette smoke can irritate the respiratory tract epithelium and trigger mucosal inflammation (Nursal *et al.*, 2024). Repeated exposure damages the structure and movement of cilia, increases mucus production, and reduces the effectiveness of mucociliary clearance. As a result, secretions and microorganisms cannot be cleared optimally, making it easier for bacteria and viruses to colonize and reach the lower respiratory tract. Cigarette smoke can also disrupt the function of alveolar macrophages and the local immune response in the lungs, thereby reducing the ability to phagocytose and eliminate pathogens. The combination of mucociliary dysfunction, reduced local immunity, and increased microbial colonization makes toddlers more susceptible to pneumonia. This susceptibility is greater in toddlers because their immune systems and pulmonary defense mechanisms have not yet fully developed (Helmi, 2021).

The results of this study are consistent with those of Juniantari *et al.* (2023), who reported that children living with family members who smoke are more likely to develop pneumonia. Prayogo and Zein (2025) also found a 1.73-fold higher risk of pneumonia among toddlers exposed to secondhand smoke, while Sen *et al.* (2025) reported a 2.8 fold higher risk in households where more than five cigarettes are smoked per day. The consistency of these findings reinforces the hypothesis that the frequency, duration, intensity, and location of smoking determine the extent of exposure experienced by toddlers.

However, exposure to secondhand smoke does not always lead to pneumonia in every toddler. Jones (2022) and Juniantari *et al.* (2023) indicate that restricting smoking near children, smoking outdoors, better ventilation, and the child's immune status can reduce direct exposure and prevent infections from progressing to pneumonia. Differences in findings across studies may be influenced by population characteristics, sample size, definitions of exposure, methods for diagnosing pneumonia, and whether the study merely recorded the presence of smokers or also assessed the number of cigarettes smoked, duration, frequency, location, and the presence of the toddler when the parent was smoking. Differences in study design and the quality of exposure measurements may also result in varying strengths of association.

Pneumonia in toddlers is a multifactorial disease; therefore, the observed associations cannot be separated from the potential influence of confounding variables. Immunization status can reduce the risk of severe infection, while nutritional status affects the immune system's ability to fight microorganisms. Exclusive breastfeeding provides protection through antibodies and immunological components, while home ventilation determines the concentration of cigarette smoke and indoor pollutants. Housing density increases the likelihood of infection transmission, and socioeconomic status affects housing quality, nutritional adequacy, access to immunization, and affordability of health care. These factors may be associated with both smoking behavior and the incidence of pneumonia, thereby potentially strengthening or weakening the observed association (Tadjoedin, 2024).

Clinically, the findings of this study are significant because indoor smoking is a modifiable risk factor. Efforts to protect toddlers are insufficient if they merely involve reducing the number of cigarettes smoked or moving a few meters away from the child, as smoke can spread to other rooms and its residue can cling to clothing, walls, furniture, and other household surfaces. A more effective intervention is to implement smoke free homes and family vehicles. The presence of smokers in the household, smoking locations, the number of cigarettes smoked per day, and the presence of toddlers while smoking should also be part of the assessment for toddlers with recurrent cough, respiratory tract infections, or a history of pneumonia.

At the primary health care level, the results of this study support strengthening education on smoke free homes through community health posts, classes for mothers of toddlers, Integrated Management of Sick Toddlers, home visits, and family counseling. The Dungi Community Health Center can identify families with toddlers living with smokers, provide smoking cessation counseling, monitor behavioral changes, and prioritize families with a history of pneumonia or recurrent respiratory tract infections. Collaboration with community health workers, village

officials, community leaders, the Department of Health, and local government is also necessary to expand the smoke-free home campaign and build social support for smoking cessation.

Overall, this study provides local evidence that parental smoking behavior at home is associated with the incidence of pneumonia among toddlers in the Duingi Community Health Center's service area. The study's contribution lies in measuring smoking behavior across the dimensions of duration, frequency, and intensity in an area with a high burden of pneumonia among toddlers. These findings reinforce the importance of controlling household tobacco smoke as part of pneumonia prevention, alongside improvements in nutritional status, immunization coverage, exclusive breastfeeding, and home environmental conditions. The implementation of smoke free homes, smoking cessation counseling, and family interventions through primary health care services are the key implications that can be developed from this study.

4. CONCLUSION

This study demonstrates an association between parental smoking behavior indoors and the incidence of pneumonia among infants in the service area of the Duingi Community Health Center in Gorontalo City. These findings indicate that the higher the level of parental smoking behavior at home, the greater the exposure to secondhand smoke experienced by infants, which has the potential to increase the incidence of pneumonia. Thus, smoking behavior in the home environment is a risk factor that requires attention in efforts to prevent pneumonia in infants.

The results of this study imply that efforts to prevent pneumonia in toddlers should focus on controlling exposure to secondhand smoke in the home environment through family education, smoking cessation counseling, and the implementation of smoke-free homes as part of promotive and preventive programs in primary health care, particularly at Community Health Centers. Future research is recommended to use a research design and multivariate analysis that takes into account other factors that may influence the incidence of pneumonia, such as the nutritional status, immunization status, exclusive breastfeeding, home ventilation, housing density, and socioeconomic status, so that the relationships between variables can be explained more comprehensively. These recommendations align with the suggestions in this thesis, which emphasize strengthening parental education and implementing smoke free homes as part of pneumonia prevention in toddlers.

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