SMOKE-FREE ZONE POLICIES AND PNEUMONIA INCIDENCE AMONG INFANTS IN INDONESIA (ANALYSIS OF SECONDARY DATA FROM THE 2023 INDONESIA HEALTH SURVEY)

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ABSTRACT

Indonesia remains one of the ASEAN countries that has not fully implemented a smoke-free zone policy (SFZ). SFZ policies can prevent air pollution that can cause pneumonia. The novelty of this study lies in its analysis of SFZ policies based on the level of regional regulations, namely Regional Regulations and Mayor/Regent Regulations, which are linked to pneumonia cases in infants, utilizing national data with a large sample size to provide empirical evidence as a basis for strengthening SFZ policy implementation in Indonesia. This study aims to determine the relationship between SFZ policies and pneumonia cases in infants in Indonesia. This study used a cross-sectional design. The study population consisted of 284,177 respondents, and the study sample consisted of 49,747 respondents. This study used the 2023 Indonesian Health Survey questionnaire as an instrument and used the chi-square test with JASP version 19 software for data analysis. The results of the study indicate that there is a significant relationship between the form of implementation of SFZ policies at the district/city level (p=0.045) and no significant relationship in the implementation of SFZ across provinces in Indonesia (p=0.162; PR=1.159), districts/cities that implemented SFZ (p=0.664; PR=1.059), the duration of SFZ implementation in districts/cities (p=0.269; PR=0.891), fathers' smoking behavior (p=0.867; PR=0.983), and mothers' smoking behavior (p=0.1; PR=1.938). It can be concluded that there is a significant relationship between the form of local regulations/mayor/regent regulations on SFZ and the incidence of pneumonia in infants in Indonesia with p=0.045. These findings emphasize the importance of the government's role in strengthening the implementation of SFZ policies through improved monitoring, enforcement, and integrated evaluation. Policy strengthening can be achieved through regulations accompanied by strict sanctions, data-based monitoring by the Ministry of Health, and continuous education on the dangers of thirdhand smoke for parents. In addition, the results also indicate that the gender of mothers as primary caregivers plays an important role in protecting infants from exposure to cigarette smoke. Therefore, empowering mothers through improved health literacy and social support is crucial to reducing the risk of pneumonia in toddlers. Districts/cities that do not yet have smoke-free policies are expected to formulate them immediately, while the wider community is expected to actively participate in supporting the implementation of smoke-free policies to protect toddlers from the dangers of smoking.

Keywords: Infants, Smoke-Free Zones, Policy, Pneumonia, Gender.

Introduction

According to a report published by UNICEF (United Nations Children's Fund), pneumonia is considered the leading infectious disease causing the highest mortality rate globally in 2021, affecting children under five years of age. This pneumonia has caused over 700,000 child deaths per year, equivalent to 2,000 deaths per day. This includes approximately

190.000 newborns (infants). Globally, the incidence of pneumonia in children exceeds 1.400 cases per 100,000, meaning approcimately 71 children, or one case per year. The highest case rates are observed in South Asis, with 2,500 cases per 100,000 children, followed by Central and West Africa, reporting 1,620 cases per 100,000 children. In this context, the 2024 State of Global Air report indicates that 15% of all global deaths are caused by children under the age of five (State of Global Air (SOGA), 2024).

Based on data from the Indonesian Ministry of Health in 2023, pneumonia cases in Indonesia have also become a major concern as the leading cause of death among infants, ranking first among diseases with the highest treatment costs in Indonesia at around Rp 8.7 trillion (Kementerian Kesehatan RI, 2024). The prevalence of pneumonia cases among infants has reached 3.5% in 2023. This indicates that nearly two million infants are affected by pneumonia each year. In this situation, the government is urged to take serious action as it will have significant implications for the healthcare system and quality of life in the future.

One of the main causes of pneumonia is air pollution caused by Environmental Tobacco Smoke (ETS). According to , exposure to cigarette smoke indoors contains many toxic substances that can irritate the respiratory tract in every individual, especially infants. This can lead to pneumonia in infants, triggering symptoms of breathing difficulties (shortness of breath) characterized by rapid breathing and chest retractions, as well as coughing (Anjaswanti et al., 2022; Asamal et al., 2022; Rahmawati et al., 2024).

Various countries have attempted to control diseases caused by cigarette smoke, including pneumonia, through the WHO Framework Convention on Tobacco Control (FCTC), which has been established as a global framework for tobacco control and has been in effect since 2005. In this context, the WHO developed a technical package called MPOWER in 2008 to assist countries in implementing effective interventions related to tobacco demand. This is also in line with the WHO FCTC.

In this case, Indonesia still faces significant challenges that prevent it from optimally implementing MPOWER policies. This is due to high tobacco consumption rates in Indonesia and the strong influence of the tobacco industry in policy-making . Although Indonesia is not yet a signatory to the WHO FCTC, it continues to strive to control tobacco use, one of which is by SFZ.

According to research Martayani et al (2020), smoking inside the home is a very strong risk factor for pneumonia in toddlers,

causing 9,327 cases, while research Novitry & Permatasari (2020) and Stefani & Setiawan (2021) also shows that children who live in homes with family members who smoke indoors are 2-6 times more at risk than children whose family members smoke outdoors. In this context, it is evident that the implementation of smoke-free zones has not been enforced rigorously, which will inevitably impact the health of infants (Marita & Amelia, 2023).

In this case, the father's smoking behavior towards pneumonia in toddlers has a significant correlation with a p-value of 0.000. This phenomenon may occur due to the father's smoking habits inside the home (Permatasari et al., 2023). Additionally, previous studies have not specifically addressed the relationship between maternal smoking behavior and pneumonia in infants. However, maternal smoking behavior is significantly associated with an increased incidence of chronic respiratory infections (ARIs) in infants, with a 1.24-fold increased risk (Rahaman et al., 2023).

This is also related to thirdhand smoke, which is cigarette smoke residue that sticks to surfaces in the home environment, such as walls, clothing, furniture, and dust. These residues contain harmful chemicals that can be inhaled, ingested, or absorbed through the skin of infants, thereby increasing the risk of respiratory infections, particularly pneumonia. Children are particularly vulnerable to this due to their play activities on the floor and their underdeveloped immune systems (Anonym, 2025). Exposure to thirdhand smoke persists even in the absence of direct cigarette smoke, making smoke-free zones crucial for minimizing this risk. This aligns with research Riestiyowati et al (2020) indicating that Environmental Tobacco Smoke (ETS) includes both secondhand and thirdhand smoke, which significantly increases the risk of pneumonia in infants with an OR ranging from 1.66 to 2.15 ($p < 0.001$). Exposure to smoking parents or family members at home is a primary risk factor for pneumonia in infants (Riestiyowati et al., 2020).

The implementation of Smoke-Free Zones (SFZ) began in 2012, with only 22 districts/cities having local regulations on SFZs. This prompted the Indonesian government to set a target of achieving 100% SFZ coverage by 2023. However, in reality, SFZ coverage in 2023 reached only 86%, meaning the government has not yet achieved this target. Therefore, further analysis is needed regarding the implementation of smoke-free zone policies in each region of Indonesia, particularly in relation to pneumonia cases among infants, as there are currently limited studies examining the relationship between

the implementation of smoke-free zones and pneumonia cases among infants at the national level.

Based on the above issues, there are several problems that make researchers interested in analyzing the relationship between the No Smoking Zone policy and pneumonia cases in Indonesian toddlers based on secondary data from the 2023 Indonesian Health Survey, including the following.

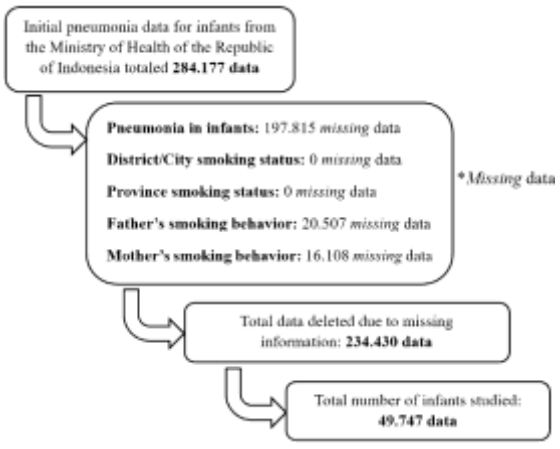
1. Is there a relationship between provincial smoke-free zone policies and pneumonia cases among infants in Indonesia?
2. Is there a relationship between the duration of smoke-free zone implementation and pneumonia cases among infants in Indonesia?
3. Is there a relationship between the form of smoke-free zone policies implemented by districts/cities and pneumonia cases among infants in Indonesia?
4. Is there a relationship between district/city smoke-free zone policies and the incidence of pneumonia among infants in Indonesia?
5. Is there a relationship between fathers' smoking behavior and the incidence of pneumonia among infants in Indonesia?
6. Is there a relationship between fathers' smoking behavior and the incidence of pneumonia among infants in Indonesia?

Method

This study is quantitative in nature with a cross-sectional design using national-level secondary data from the 2023 Indonesian Health Survey (SKI) published by the Indonesian Ministry of Health. The use of secondary data has been approved under document number FRM/SMKI-PUSDATIN/70/0023/2025 and has been encrypted and stripped of personal identifiers. The population in this study consists of 284,177 respondents with infants from 38 provinces across Indonesia. However, only 49,747 respondents were included in the sample due to missing data in the variables required by the researcher.

The following explanation of the data found in this study can be illustrated in the data table below.

Figure 1. Data Collection Diagram



Based on the data collection chart above, it was found that the initial data based on the 2023 Indonesian Health Survey amounted to 284,177 data points.

However, there were 197,815 incomplete data points related to pneumonia cases in infants, resulting in a total of 86,362 complete data points for pneumonia in infants. However, this data has not been adjusted for incomplete data on smoking behavior, which amounts to 20,507 cases, and incomplete data on maternal smoking behavior, which amounts to 16,108 cases. As a result, the total number of complete pneumonia cases among infants accompanied by smoking behavior of both parents in Indonesia is 49,747 respondents. Additionally, the number of complete data on smoke-free zone policies available for each district/city in Indonesia is 42,618 districts/cities.

The dependent variable in this study is pneumonia in infants (Y). The independent variables used in this study include provincial SFZ policies (X_1), district/city SFZ policies (X_2), duration of district/city SFZ implementation (X_3), type of district/city SFZ policy implementation (X_4), father's smoking behavior (X_5), and mother's smoking behavior (X_6). Furthermore, to determine whether each district/city has implemented the Smoke-Free Zone (SFZ) policy, this can be seen based on the Smoke-Free Zone Dashboard website created by the Ministry of Health.

Data analysis in this study used univariate analysis in the form of descriptive statistics to determine the frequency and percentage of each variable studied. Next, bivariate analysis was used to determine the relationship between independent variables and dependent variables using the chi-square test. It should be noted that this study uses the chi-square test, which can only show the presence or absence of a relationship in categorical form and cannot be used to show cause and effect. In addition, this data cannot confirm the sequence of time between exposure and outcome, so the interpretation cannot be applied directly. Therefore, this researcher only used the chi-square test, which uses JASP version 19 software in the data analysis process.

Results

Univariate Analysis

Table 1. Frequency Distribution of Respondent Characteristics Based on Children's Gender

Characteristics of Research Respondents Based on Gender of Children	F	%
Male	25,813	51.9
Female	23,934	48.1
Total	**49,747**	**100**

Based on Table 1, it can be seen that the characteristics of the research respondents based on the gender of their children show that the majority are male at 51.9% and female at 40.7%.

Table 2. Frequency Distribution of Pneumonia Incidence in Infants

Incidence of Pneumonia in Infants	F	%
Yes	452	0.9
No	49,295	99.1
Total	**49,747**	**100**

Based on Table 2, it can be sseen that the majority of respondents did not experience pneumonia in infants 99.1%, while 0.9% experienced pneumonia in infants.

Table 3. Frequency Distribution of Provinces with SFZ Regulations in Indonesia

Province with SFZ Regulations	F	%
No SFZ	12,137	24.4
With SFZ	37,610	75.6
Total	**49,747**	**100**

Based on Table 3, it can be seen that the majority of provinces in Indonesia have SFZ regulations at 75.6%, while 24.4% of provinces do not have SFZ regulations.

Table 4. Frequency Distribution of Regencies/Cities with Local Regulations and Mayoral/Regent Regulations on SFZ in Indonesia

Regencies/Cities with Local Regulations/Regulations of the Mayor/Regent	F	%
No Local Regulations/ Regulations of the Mayor/Regent	7,129	14.3
Having Local Regulation	32,344	65,0
Having Mayor/Regent Regulations	10,274	20,7
Total	**49,747**	**100**

Based on Table 4, it can be seen that the majority of districts/cities that have policies in the form of Regional Regulations on SFZ are 65%, districts/cities that have policies in the form of Mayor Regulations/Regent Regulations are 20.7%, and districts/cities that do not policies in the form of Regional Regulations/Mayor/Regent Regulations are 14.3%.

Table 5. Frequency Distribution of Regencies/Cities with SFZ in Indonesia

Regencies/Cities with SFZ Regulations	F	%
No SFZ	7,129	14.3
There is SFZ	42,618	85.7
Total	**49,747**	**100**

Based on Table 5, it can be seen that the majority of districts/cities in Indonesia have SFZ regulations 85.7%, while 14.3% of districts/cities do not have SFZ regulations.

Table 6. Frequency Distribution of Regencies/Cities Implementing SFZ in Indonesia by Year

Duration of SFZ Implementation in Indonesia by Year	F	%
Less than 7 years	26,149	61.4
More than 7 years	16,469	38.6
Total	**42,618**	**100**

Based on Table 6, it can be seen that the majority of SFZ implementation duration in Indonesia based on year is less than 7 years at 66.9% and more than 7 years at 33.1%.

Table 7. Frequency Distribution of Fathers' Smoking Behavior

Father's Smoking Behavior	F	%
Yes	33,641	67.6
No	16,106	32.4
Total	**49,747**	**100**

Based on Table 7, it can be seen that the majority of fathers smoke 67.6%, while the remaining 32.4% do not smoke.

Table 8. Frequency Distribution of Mothers' Smoking Behavior

Mothers' Smoking Behavior	F	%
Yes	343	0.7
No	49,404	99.3
Total	**49,747**	**100**

Based on Table 8, it can be seen that the majority of mothers do not smoke 99.3%, while 0.7% of mothers smoke.

Bivariate Analysis

Table 9. Relationship between the Existence of SFZ Regulations in Each Province in Indonesia and the Incidence of Pneumonia in Infants

SFZ Regulations in Each Province in Indonesia	Incidence of Pneumonia				Total		PR (95% Cl)	*P*
	Yes		No					
	n	%	n	%	N	%		
None	123	0.2	12,014	24.2	12,137	24.4	1.159 (0.943-1.424)	0.162
Present	329	0.7	37,281	74.9	3,761	75.6		
Total	**452**	**0.9**	**49,295**	**99.1**	**49,747**	**100,0**		

Based on Table 9, the cross-tabulation results show that 24.4% of provinces still do not have SFZ regulations, and only 0.2% of infants suffer from pneumonia, with the remaining 24.2% not suffering from pneumonia. The SFZ regulations in place in each province account for 75.6% with only 0.7% of infants suffering from pneumonia, and the remaining 74.9% not suffering from pneumonia. Based on the results of the chi-square test, it is proven that the p-value (0.162) ((>α 0.05) means that there is no significant relationship between the Governer/Provincial SFZ Regulations in Indonesia and the incidence of pneumonia in infants.

Table 10. Relationship Between Districts/Cities Implementing SFZ and Pneumonia Incidence in Infants

District/City Implementing SFZ	Incidence of Pneumonia				Total		PR (95% Cl)	*P*
	Yes		No					
	n	%	n	%	N	%		
Not SFZ	68	0.1	7,061	14.2	7,129	14.3	1.159 (0.819-1.368)	0.664
Present	384	0.8	42,234	84.9	42,618	85.7		
Total	**452**	**0.9**	**49,295**	**99.1**	**49,747**	**100,0**		

Based on Table 10, the cross-tabulation results show that 14.3% of districts/cities did not implement SFZ, 0.1% of infants suffered from pneumonia, and the remaining 14.2% did not suffer from pneumonia. The districts/cities that implemented SFZ account for 85.7%, with 0.8% of infants suffering from pneumonia, and the remaining 84.9% not suffering from pneumonia. Based on the results of the chi-square test, it is proven that the p-value (0.664) (>α 0.05) indicates that there is no

significant relationship between districts/cities that implement SFZ and the incidence of pneumonia in infants.

Table 11. Relationship Between Districts/Cities Implementing SFZ and Pneumonia Incidence in Infants

District/City Having SFZ Policies	Incidence of Pneumonia				Total		*P*
	Yes		No				
	n	%	n	%	N	%	
None	68	0.1	7,061	14.2	7,129	14.3	0.045
Local Regulation	312	0.6	32,032	64.4	32,344	65.0	
Regulations of the Mayor/Regent	72	0.1	10,202	20.5	10,274	20.7	
Total	**452**	**0.9**	**49,295**	**99.1**	**49,747**	**100,0**	

Based on Table 11, the cross-tabulation results show that districts/cities without SFZ regulations in the form of local regulations or mayor/regent regulations had a pneumonia incidence rate among infants of 14.3%, with 0.1% o finfants suffering from pneumonia and the rest not suffering from pneumonia. The study also shows that districts/cities implementing SFZ in the form local regulations have a pneumonia incidence rate among infants of 65%, with 0.6% of infants suffering from pneumonia and the remainder not suffering from pneumonia. In addition, this study also showed that districts/cities that implemented SFZ in the form of mayor regulations/regent regulations had a pneumonia incidence rate of 20.7%, with 0.1% of infants suffering from pneumonia and the rest not suffering from pneumonia.

Based on the results of the chi-square test between districts/cities that have SFZ policies in the form of regional regulations/regulations of the mayor/regent and the incidence of pneumonia in infants, a p-value of 0.045 (<α 0.05), indicating a significant association between districts/cities with SFZ policies in the form of regional regulations/regulations of the mayor/regent and the incidence of pneumonia among infants in Indonesia.

Table 12. Relationship Between the Duration of SFZ Implementation by Year in Regencies/Cities and the Incidence of Penumonia in Infants

Duration of Implementation	Incidence of Pneumonia				Total		PR (95%Cl)	*P*
	Yes		No					
	n	%	n	%	N	%		
Less than 7 years	225	0.5	25,924	60.8	26,149	61.4	0.891 (0.728-1.091)	0.144
More than 7 years	159	0.4	16,310	38.3	16,469	38.6		
Total	**384**	**0.9**	**42,234**	**99.1**	**42,618**	**100,0**		

Based on Table 12, the cross-tabulation results prove that the majority of toddlers did not suffer from pneumonia (99.1%), while 0.9% of toddlers suffered

from pneumonia. Based on the duration (years) of SFZ implementation, it was found that in areas where SFZ was implemented for less than 7 years, there were 225 cases of pneumonia (0.5%) out of a total of 26,149 children (61.9%), while 25,924 children (60.8%) did not experience pneumonia. Additionally, in areas where SFZ has been implemented for more than 7 years, there were 159 cases of pneumonia (0.4%) out of a total of 16,469 children (38.6%). A total of 16,310 children (38.3%) did not experience pneumonia.

In this case, the proportion of pneumonia cases appears to be slightly lower in districts/cities that have implemented SFZ for more than 7 years (0.4%) compared to districts/cities that have implemented SFZ for less than 7 years (0.5%). However, based on the results of the chi-square test, the p-value of 0.144 (>α 0.05) indicates that there is no significant association between the duration of SFZ implementation and the incidence of pneumonia among infants.

Table 13. Relationship Between Fathers' Smoking Behavior and the Incidence of Penumonia in Infants

Father's Smoking Behavior	Incidence of Pneumonia				Total		PR (95%Cl)	*P*
	Yes		No					
	n	%	n	%	N	%		
Yes	304	0.6	33.337	67	33,641	67,6	0.983 (0.809-1.196)	0.867
No	148	0.3	15,958	32.1	16,106	32.4		
Total	**452**	**0.9**	**49,295**	**99.1**	**49,747**	**100,0**		

Based on Table 13, the cross-tabulation results show that 67.6% of fathers who smoke have children with pneumonia, with 0.6% of children suffering from pneumonia and the remaining 67% not suffering from pneumonia. The incidence of pneumonia among infants whose fathers did not smoke was 32.4%, with 0.3% of infants suffering from pneumonia and the remaining 32.1% not suffering from pneumonia. The results of the chi-square test also indicate that there is no association between fathers' smoking behavior and the incidence of pneumonia among infants, with a p-value of 0.867.

Table 14. Relationship Between Mothers' Smoking Behavior and the Incidence of Penumonia in Infants

Mother's Smoking Behavior	Incidence of Pneumonia				Total		PR (95%Cl)	*P*
	Yes		No					
	n	%	n	%	N	%		
Yes	6	0.0	337	0.7	343	0.7	1.938 (0.872-4.306)	0.1
No	446	0.9	48,958	98,4	49,404	99.3		
Total	**452**	**0.9**	**49,295**	**99.1**	**49,747**	**100,0**		

Based on Table 14, the cross-tabulation results show that 0.7% of mothers who smoke have infants with pneumonia, of which 0.0% of infants suffer from pneumonia and 0.7% do not suffer from pneumonia. Mothers who do not smoke have a 99.3% incidence of pneumonia in their infants, with 0.9% of infants suffering from pneumonia and the remaining 99.1% not suffering from pneumonia. Based on the results of the chi-square test, there is no significant association between maternal smoking behavior and the incidence of pneumonia in infants (p-value = 0.1).

However, mothers who smoke and have infants have a 1.938 times higher risk of having children with pneumonia compared to infants whose mothers do not smoke compared to infants whose mothers do not smoke.

Discussion

Forms of Smoke-Free Zone (SFZ) Policies

Local regulations or mayor/regent regulations are policy forms designed to address various issues and achieve the objectives set by a government. In this case, local regulations are the lowest level of policy in the hierarchy of legislation in Indonesia, as stipulated in Undang-Undang Nomor 11 Tahun 2011 Tentang Pembentukan Peraturan Perundang-Undangan.

Regulations of the mayor/regent are policies of equal standing. However, the distinction between the two lies solely in their scope of application, and these regulations are subordinate to local regulations. Based on these two regulations, it tirns out that they have different levels of legal force, where the regulatory framework is hierarchical. In this case, regulations of a lower level do not conflict with regulations of a higher level. In terms of sanctions, regional regulations have criminal and administrative sanctions, while mayor/regent regulations only have administrative sanctions.

The implementation of regional regulations includes a socialization phase, which is often considered ineffective due to its broad scope, resulting in insufficient focus on local communities and leading to low public awareness of the Smoke-Free Zone (SFZ) regulations, there by reducing compliance rates (Despariyenita et al., 2024; Lestari et al., 2025).

The dissemination of this regional regulations is typically conducted through semianrs, mass media, and public campaigns, meaning not all segments of society receive it (Haristia & Chalik Sjaaf, 2023). When compared to regulations issued by mayors or regents, these

regulations are more focused on the local community and involve the surrounding community in the dissemination process (Dinas Kesehatan Kapuas Hulu, 2022; Rahim et al., 2024). Usually, this dissemination is carried out through various media such as notice boards, mass media, and seminars, and involves the active participation of the local community to monitor the implementation of the SFZ (Dinas Kesehatan Kapuas Hulu, 2022; Rahim et al., 2024).

The implementation of regional regulations often faces a lack of resources and effective structures to conduct consistent monitoring, resulting in many violators of the Smoke-Free Zone not being punished. Supervision of the implementation of Regional Regulations is carried out by Satpol PP and related agencies, while Mayors/Regents' Regulations are more intensively supervised at the local level. The government has also formed special monitoring teams to monitor the implementation of Smoke-Free Zones on a regular basis and involve the community in the monitoring process to improve compliance.

Based on the above research results, it was found that out of 32,344 respondents (65%), 312 respondents (0.6%) had pneumonia in infants, while 32,032 respondents (64.4%) did not have pneumonia in infants. The study also revealed that local regulations in districts/cities in Indonesia with pneumonia cases among infants totaled 10,247 respondents (20.7%), with 72 respondents (0.1%) suffering from pneumonia and 10,202 respondents (20.5%) not suffering from pneumonia. Additionally, this study also showed that districts/cities that did not have Regional Regulations or Mayor/Regent Regulations with pneumonia incidence among infants in Indonesia were 7,129 respondents (14.3%), with 68 respondents (0.1%) suffering from pneumonia and 7,061 infants (14.2%) not suffering from pneumonia.

Based on the results of the chi-square test, it was found that the p-value was $0.045 < 0.05$, indicating that there is a relationship between districts/cities with local regulations/mayor/regent regulations on smoke-free zones and the incidence of pneumonia in infants in Indonesia. This indicates that cigarette smoke can suppress the immune system in the respiratory tract, thereby potentially increasing the risk of infection (Anjaswanti et al., 2022). Based on the results of Stefani & Setiawan (2021) study, a statistically significant relationship was found between the presence of smokers and the incidence of severe pneumonia in infants, with a p-value of 0.001. This may occur due to exposure to cigarette smoke in the home.

According to another study by Imanian, cited in the research by Kusumawardani et al (2020), the location of smoking (inside the home and outside the home) had a p-value of 0.048. This highlights the importance of smoking location as a key determinant, as it can serve as an indicator of exposure to cigarette smoke. Therefore, exposure to cigarette smoke both inside the home and in smoke-free environments is crucial to monitor. In this context, the Indonesian government has made efforts to create smoke-free environments and reduce the negative impacts on passive smokers through the Smoke-Free Zone (SFZ) policy.

The implementation of the Smoke-Free Zone (SFZ) policy is considered ineffective due to several factors, such as insufficient resources for monitoring, resulting in a limited number of personnel responsible for monitoring, unclear sanctions, suboptimal internal communication, and/or a lack of understanding among some members of the community regarding the objectives and functions of the Smoke-Free Zone policy (Lestari et al., 2025; Ridhayati et al., 2024; Wulandari et al., 2024).

In the implementation of smoke-free policies, it appears that the duration of policy implementation has no significant relationship with the incidence of pneumonia in toddlers, with a p-value of 0.144. This may be because the crucial factor is not the duration of implementation but rather the crucial factors that support policy implementation, such as implementation and support resources, compliance levels, supervision levels, and suboptimal socialization and communication. In this context, the implementation of the policy is more dependent on consistency, which can improve the quality of its implementation compared to the duration of the policy's implementation (Alindra et al., 2024).

Parental Smoking Behavior

Parental smoking behavior has been identified as a significant factor contributing to the increased risk of pneumonia in infants. This relationship is attributed to the presence of various toxic chemicals in cigarette smoke emitted by smokers. The harmful substances contained in cigarettes pose significant risks, not only for active smokers but also for passive smokers.

Father's Smoking Behavior

According to previous studies, family smoking behavior has a significant association with pneumonia incidence in infants, with a p-value of 0.023 ($p < 0.05$). Additionally, according to another study, the smoking behavior of fathers is associated with the severity of pneumonia

with a p-value <0.05. However, this contradicts the results obtained using the chi-square test, where the smoking behavior of fathers was not associated with the incidence of pneumonia in infants with a p-value of 0.875. This aligns with the study by Widiastuti et al (2024) which found that the father's smoking status is not associated with the incidence of pneumonia in infants. This may occur due to other dominant factors influencing the incidence of pneumonia in infants.

When considering environmental factors such as housing density, poor ventilation in homes can also increase the incidence of pneumonia in infants (Anjaswanti et al., 2022; Yuliniar et al., 2021). When considering nutritional factors, exclusive breastfeeding history, low birth weight (LBW), immunization status, and nutritional status also influence the incidence of pneumonia in infants (Anjaswanti et al., 2022; Yuliniar et al., 2021). Additionally, behavioral factors such as the presence of family members who smoke, exposure to secondhand smoke indoors, smoking locations within the home, the number of cigarettes consumed by family members, and the toddler's interaction with smokers also influence the incidence of pneumonia in infants (Anjaswanti et al., 2022; Dita et al., 2023; Widiastuti et al., 2024; Yuliniar et al., 2021).

Mother's Smoking Behavior

According to the findings of a study conducted using the chi-square test, there is no significant relationship between maternal smoking behavior and the incidence of pneumonia in toddlers, as evidenced by a p-value of 0.1. However, based on the results of the study, maternal smoking behavior is 1.938 times more likely to cause pneumonia in mothers with toddlers than in mothers with toddlers who do not smoke.

This can happen because mothers have a double burden in their lives, where they interact more intensely with their children, so mothers who have dual roles will certainly have limited time to focus on caring for their children, leading to a decline in the quality of their care. In addition, if mothers smoke, this will have a direct impact on their children, causing respiratory disorders such as ARI, influenza, and may even lead to pneumonia in children, especially when combined with high levels of air pollution and humid, colder weather conditions (Mayaswari et al., 2024).

In addition, the negative stigma attached to mothers who smoke is caused by a lack of family support for mothers who smoke, which further exacerbates the situation. This may also occur due to a lack of education received by mothers

(Wildayanti & Pratiwi, 2023). Based on previous studies, no specific research has been found that specifically addresses the relationship between maternal smoking behavior and pneumonia in infants. However, according to research (Rahaman et al., 2023), maternal smoking behavior is significantly associated with acute respiratory infections (ARIs) in infants, with a 1.24 times higher incidence.

This is related to thirdhand smoke, which is cigarette smoke residue that sticks to surfaces in the home environment, such as walls, clothing, furniture, and dust. This residue contains harmful chemicals that can be inhaled, ingested, or absorbed through the skin of toddlers, increasing the risk of respiratory infections, including pneumonia. In this context, children are more vulnerable to pneumonia due to their play activities on the floor and their underdeveloped immune systems (Anonym, 2025).

Exposure to thirdhand smoke will still occur even if there is no direct cigarette smoke, so the implementation of smoke-free zones (SFZs) is very important to help minimize this risk. This aligns with research Riestiyowati et al (2020) showing that exposure to environmental tobacco smoke (ETS), which includes secondhand and thirdhand smoke, significantly increases the risk of pneumonia in infants with an odds ratio (OR) ranging from 1.66 to 2.15 ($p < 0.001$). Exposure to smoking parents or family members at home is a primary risk factor for pneumonia in infants (Riestiyowati et al., 2020). In this context, mothers play a central role in their children's health, as they have a dominant role in caring for their children.

Conclusions

Based on the results of the chi-square test, this study shows that there is a significant relationship between the form of policy in the form of Regional Regulations/Mayor/Regent Regulations on Smoke-Free Zones (SFZs) and the incidence of pneumonia in toddlers in Indonesia with a p-value of 0.045. This finding emphasizes the importance of the government's role in strengthening the implementation of SFZ policies through improved monitoring, enforcement, and integrated evaluation. Policy strengthening can be achieved through regulations accompanied by strict sanctions, data-based monitoring by the Ministry of Health, and continuous education on the dangers of thirdhand smoke for parents. In addition, the results also show that the gender of the mother as the primary caregiver of infants plays an important role in protecting them from exposure to cigarette smoke. Therefore, empowering mothers through

improved health literacy and social support is crucial to reducing the risk of pneumonia in infants. For districts/cities that do not yet have smoke-free zone policies, it is hoped that they will formulate them immediately, while the general public is encouraged to actively participate in supporting the implementation of smoke-free zones to protect infants from the dangers of tobacco.

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