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Household Health Behaviors as Modifiable Risk Factors for Pneumonia Symptoms in Toddlers

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Abstract

Pneumonia remains a leading cause of morbidity and mortality among children under five years of age. Parental health-related behaviors, including smoking, handwashing with soap, and household ventilation, are potential modifiable risk factors. This cross-sectional study, conducted in 2024, examined the association between these behaviors and pneumonia incidence among children under five. Data were collected from children with and without pneumonia, and bivariate analysis was performed using Chi-square tests and Odds Ratio (OR) estimation. Results showed that parental smoking had an OR of 4.889 (p = 0.100), handwashing with soap before feeding an OR of 2.471 (p = 0.193), handwashing before eating an OR of 1.843 (p = 0.452), and handwashing after defecation or urination an OR of 3.159 (p = 0.297). Window opening and closing habits showed a protective tendency with an OR of 0.328 (p = 0.273). Although all p-values were >0.05, indicating no statistically significant associations, the OR magnitudes suggest a potential increased risk of pneumonia linked to unfavorable parental behaviors. These findings highlight the importance of promoting healthy household practices, including smoke-free environments, proper hand hygiene, and adequate ventilation, as essential strategies for preventing pneumonia in children.

Introduction

Pneumonia is an infection of the respiratory tract, primarily caused by viruses and bacteria, and is one of the most common infections. It has a varied spectrum of severity, ranging from mild infections to life-threatening conditions at all ages. However, the most significant burden of the disease is still in children under five years of age, where, to date, pneumonia is the leading cause of death from infectious diseases in this age group (World Health Organization (WHO), 2017). Pneumonia is the leading cause of death in children under five years of age, even exceeding the total deaths from AIDS, measles, and malaria. Of all deaths in children under five years of age, about 19% were caused by pneumonia and 17% by diarrhoea. It is estimated that each year, more than 2 million children die from pneumonia, equivalent to one death every 20 seconds out of about 9 million deaths of children under five globally. Despite its enormous contribution, pneumonia is still often referred to as "the forgotten killer of children" because it has not received proportionate attention in disease control efforts (World Health Organization (WHO), 2017). Based on the 2022 health profile, the number of pneumonia cases among toddlers in Indonesia was 386,724, equivalent to 38.78% of all toddlers nationwide. The coverage of pneumonia discoveries in toddlers over the last ten years, from 2012 to 2022,

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showed significant fluctuations, with a 7.38% increase in 2022 compared to the previous year and a 15.38% increase compared to 2012. Central Java Province ranks third nationally, after West Java and East Java, with 101,967 and 92,118 cases, respectively. In Central Java province, the number of pneumonia cases among toddlers reached 38,348. The rate of discovery and management of pneumonia cases among toddlers in Central Java in 2022 was 43.5%, a decrease from the 2021 achievement of 49.5% (Ministry of Health of the Republic of Indonesia, 2022).

Tegal City is the next to last with the highest number of pneumonia cases after Kudus Regency, with a total of 34 cases, while Tegal City recorded 42 cases. However, the number of cough cases not caused by pneumonia in Tegal City is relatively high, totaling 51,585 (Central Java Health Office, 2022). Although Tegal City has a relatively low number of pneumonia cases compared to other areas, such as Kudus Regency, the high number of cough cases (51,585) indicates significant respiratory health problems in this city. This also shows an excellent potential for the development of more severe respiratory diseases, including pneumonia. Conducting a study of pneumonia in Tegal City can help identify factors related to the increase in cough cases. It could also help prevent future outbreaks of pneumonia. In addition, this research can help design more effective measures to address respiratory health problems in the city and to improve the community's overall quality of life. At the East Tegal Health Center, 2 cases in toddler were identified and treated in 2021. In 2022, the number reached 35 out of 194 targeted pneumonia cases. This percentage represents an increase from 2021, when it was only 18%. However, it is far from the National SPM target set at 100% (East Tegal Health Center, 2023). Indoor environmental factors, including exposure to environmental tobacco smoke, have been shown to contribute to respiratory problems in children. Evidence indicates that children exposed to indoor pollutants such as tobacco smoke, household molds, and other environmental factors have a higher risk of developing persistent cough and respiratory symptoms. This suggests that the indoor environment plays a significant role in affecting respiratory health, where continuous exposure may increase susceptibility to conditions such as pneumonia, particularly among children with vulnerable respiratory and immune systems (Xu *et al*., 2024).

Hand hygiene practices are also an essential determinant in preventing respiratory infections. Recent epidemiological studies report that children from families with soap-free handwashing habits have a 2- to 3-fold higher risk of pneumonia than children from families who consistently use soap during handwashing. Contaminated hands serve as the primary transmission route for pathogens that cause respiratory tract infections through direct or indirect contact (Kifle *et al*., 2023). A study conducted in China found that children's bedrooms that are rarely ventilated, due to seldom-opened windows, are associated with an increased risk of pneumonia. Inadequate ventilation allows indoor pollutants to accumulate, increases humidity, and prolongs the persistence of pathogenic microorganisms in the air, thereby increasing children's susceptibility to lower respiratory tract infections (Qu *et al*., 2023). Based on the explanation above, this study will examine household health behaviors as modifiable risk factors for pneumonia symptoms among toddlers in the East Tegal Health Center area. This is very important because it can provide insight into the factors underlying the region's high incidence. As well as a basis for developing more effective policies and intervention programs to control pneumonia.

Method

This study employed an observational analytic design, with a cross-sectional approach to examine the relationship between household health behaviors and pneumonia symptoms among toddlers. The research was conducted within the working area of the East Tegal Health Center in Tegal City, Central Java, Indonesia, which covers three urban villages: Panggung, Mangkusuman, and Mintaragen. These areas collectively represent the entire health center service coverage, allowing a focused assessment of household health behaviors within the population. The study population consisted

of all toddlers residing in the East Tegal Health Center's service area. Based on data from the Tegal City Statistics Office in 2022, the toddler population was 3,888, including 2,389 in Panggung, 340 in Mangkusuman, and 1,159 in Mintaragen (East Tegal Health Center, 2023). The sample size was determined using the Isaac and Michael formula with a 10% error tolerance (90% confidence level).

$$s = \frac{\lambda^2 . N . P . Q}{d^2(N-1) + \lambda^2 . P . Q}$$

Where *s* is the required sample size, λ^2 is the chi-square value (2.706 for df = 1 at a 10% error level), *N* is the population size, *P* is the probability of success (0.5), *Q* is the probability of failure (0.5), and *d* is the margin of error (0.05). Based on this calculation, the minimum required sample size was 251 toddlers. However, due to practical constraints, only 155 respondents (61% of the required sample) were included in the study, which may affect the statistical power of the findings. The samples were selected using proportional random sampling based on the number of toddlers in each urban village to ensure representativeness.

The inclusion criteria were toddlers aged 0–59 months whose parents or caregivers were willing to participate and allow home observation, including both healthy and sick children who had received examination or treatment at a health facility within the last three months (January 1 to March 31, 2024). Exclusion criteria included those who declined participation or were unavailable during data collection. Data were collected through home visits using a structured questionnaire and observation checklist administered to caregivers. The instrument captured information on household health behaviors, including parental smoking habits, handwashing practices among mothers and toddlers. Also, household ventilation practices, such as window-opening frequency, and data on pneumonia symptoms in toddlers.

Prior to data collection, the instrument was tested for validity and reliability. Content and construct validity were assessed, with construct validity evaluated using the Pearson Product–Moment correlation test at a 5% significance level (Sabri & Hastono, 2006). The validity test involved 36 respondents, and all items demonstrated r-count values greater than the r-table value (>0.329), indicating acceptable validity. Internal consistency reliability was assessed using Cronbach's alpha, yielding a value of 0.627. This indicates an acceptable level of reliability, as values above 0.60 are considered adequate in exploratory research, although higher values are generally preferred for stronger internal consistency (Taber, 2018). The gathered data were analyzed using descriptive statistics and bivariate analysis, specifically the chi-square test, to explore the relationship between household health behaviors and pneumonia symptoms in toddlers, with a significance threshold set at $p<0.05$. Ethical clearance for this research was received from the appropriate health research ethics committee, and informed consent was secured from all participants before they took part in the study. Data analysis was conducted using descriptive statistics and bivariate analysis with the chi-square test to assess associations between variables, with a significance level set at $p<0.05$. Ethical approval was obtained from the relevant health research ethics committee, and informed consent was secured from all participants prior to data collection.

Result and Discussion

The East Tegal Health Center is located at Jalan Flores No. 35, Tegal, East Tegal District, Tegal City, with the telephone number (0283) 356059 and postal code 52122. The working area of the East Tegal Health Center is bordered by the Slerok Health Center area in East Tegal District to the south, the West Tegal Health Center area to the west, the Tegal Regency area to the east, and the Java Sea to the north. The working area of the East Tegal Health Center includes three sub-districts, namely Panggung Village, Mintaragen Village, and Mangkukusuman Village. The East Tegal Health Center, located in East Tegal District, is in a coastal area at an altitude of 2.5 meters above sea level, in the eastern part of Tegal City. Panggung Village, which is divided into 14 neighborhood units (RWs), is the

administrative center of Tegal City. This area is located in the middle of the city, with relatively high and evenly distributed residential density, government buildings, and public facilities. In certain areas near the center of government, houses tend to be more spacious, and some have courtyards. The northern part of Panggung Village is directly adjacent to the North Sea, where several factories and small industrial estates are located. In these areas, houses are generally more densely populated and adjacent to industries or factories. Mintaragen Village has 11 neighborhood units (RWs). It is a coastal area bordering the North Sea. The area is an industrial zone, dominated by many factories. Housing conditions in Mintaragen range from simple houses occupied by industrial workers to medium-sized dwellings near factory facilities, resulting in a densely populated area. Meanwhile, Mangku-kusuman Village, which is divided into 4 neighborhood units (RWs), is located in the city center. The area has a more dense and diverse residential area, with generally older houses and some modern buildings. The houses are generally more varied in architecture and conditions, reflecting the diversity of the people living in the middle of the city. This area does not have direct access to the sea and functions more as a residential area. In general, the East Tegal Health Center is strategically located. It serves areas with varying topography and residential characteristics, including government centers, coastal industrial areas, and residential areas downtown. According to East Tegal District Statistics, the total population in the East Tegal Health Center service area in 2023 will reach 54,407. The area with the largest population is Panggung Village, with 32,283 people, while the smallest is Mangkukusuman Village, with 5,483 people (East Tegal Health Center, 2023).

Based on the health service records from the East Tegal Health Center, pneumonia cases among toddlers were identified during the study period. Respondents included toddlers who had undergone a doctor's examination and were hospitalized with a diagnosis of pneumonia or bronchopneumonia between January 1 and March 31, 2024. Based on information obtained by researchers from the East Tegal Health Center on the number of toddlers with pneumonia across all hospitals in the city of Tegal, 29 toddlers have been treated for bronchopneumonia. However, when researchers checked in the field, they found only 12 toddlers with pneumonia symptoms, and among the hospitalized toddlers, as many as 7 still had symptoms. In contrast, the others had recovered and no longer experienced symptoms. There are several symptoms found in the field, which can be said to be symptoms of pneumonia, which can be said to be cases in toddlers, as follows:

TABLE 1. Symptoms of Pneumonia in the Working Area of the East Tegal Health Center in 2024

Symptoms	Categories	Case	Non Case
Cough	No	0	102
	Yes	12	41
Nausea/vomiting	No	7	135
	Yes	5	8
Fever	No	0	108
	Yes	12	35
Shortness of Breath	No	0	140
	Yes	12	3
Phlegm Test	No	10	143
	Yes	2	0
Blood Test	No	7	138
	Yes	5	5

Symptoms	Categories	Case	Non Case
Rongen Test	No	4	138
	Yes	8	5
Health Check-Up	No	0	2
	Yes	12	141
Chronic History	No	4	137
	Yes	8	6

Source: Primary data, 2024.

The most common symptoms of pneumonia in toddlers include coughing, difficulty breathing, and fever. All toddlers diagnosed with pneumonia have a cough, but not all coughs indicate pneumonia, as this symptom can also occur in other respiratory disorders. Therefore, a follow-up clinical assessment is needed to confirm the diagnosis. Of the 155 toddlers observed, 53 had a cough, and 12 of them were confirmed to have pneumonia. Another symptom analyzed was nausea and vomiting, which were found in 13 toddlers, with 5 positive cases of pneumonia. Although it can accompany pneumonia, it is not the main symptom. Fever and chills were also found in 47 children under five, with 12 confirmed cases of pneumonia. These findings are consistent with clinical evidence indicating that pneumonia is primarily characterized by respiratory symptoms such as cough and fever, often accompanied by dyspnea, whereas gastrointestinal symptoms such as nausea and vomiting are not considered specific manifestations of the disease (Grief & Loza, 2018). Supporting examinations were also analyzed: 10 toddlers underwent blood tests (5 of which were positive for pneumonia), and 13 underwent X-rays (8 of which were positive for pneumonia). Overall, these results confirm that cough and fever are critical early indicators. At the same time, laboratory and radiological examinations are needed to confirm the diagnosis to support early detection and appropriate management in toddlers with pneumonia.

The results align with findings from multiple international studies. A systematic review by Shah *et al.* (2017) reported that the clinical signs most strongly associated with pneumonia in children include fever, tachypnea, and cough, indicating that respiratory symptoms play a central role in early clinical recognition. Similarly, recent clinical evidence shows that children presenting with cough or dyspnea are commonly classified as suspected pneumonia cases, reinforcing the importance of respiratory symptoms as primary criteria in clinical assessment (Wang, 2025). These findings support the present study, which identified cough and fever as the most prominent early symptoms. At the same time, additional examinations, such as radiography and laboratory tests, remain essential to confirm the diagnosis and guide appropriate management. Furthermore, Priya M. Kevat indicated that fever and cough were common in most pediatric pneumonia cases. At the same time, symptoms such as difficulty breathing and tachypnea were also frequently noted and played a crucial role in clinical diagnosis (Kevat *et al*., 2022). Other studies also emphasize that clinical symptoms alone are often insufficient to establish a definitive diagnosis; therefore, supporting examinations, such as chest radiography and laboratory tests, are necessary to confirm pneumonia in children and guide appropriate treatment (Smith *et al*., 2021).

Following the pneumonia's clinical symptoms description, the research also explored various health behaviors within households that could affect the prevalence of pneumonia symptoms in toddlers. These behaviors encompass parental smoking patterns, handwashing practices with soap by both mothers and toddlers, and the habit of opening and closing windows at home as indicators of ventilation. The distribution of these factors among respondents is illustrated in Tables 2, 3, and 6. Additionally, to assess the relationship between these household health

TABLE 2. Distribution Smoking Behavior of Parents of Toddlers (n = 155)

Smoking Behavior of Parents of Toddlers					
Univariate			Case		Total
			Case	Not the Case	
Smoking Behavior of Parents of Toddlers	Yes	Quantity	11	99	110
		% within Smoking Behavior of Parents of Toddlers	10%	90%	100%
		% within Cases	91.7%	69.2%	71.0%
	No	Quantity	1	44	45
		% within Smoking Behavior of Parents of Toddlers	2.2%	97.8%	100%
		% within Cases	8.3%	30.8%	29%
Total		Quantity	12	143	155
		% within Smoking Behavior of Parents of Toddlers	7.7%	92.3%	100%
		% Within Cases	100%	100%	100%

Source: Primary data, 2024.

TABLE 3. Distribution of Mothers' and Toddlers' Handwashing Behaviors (n = 155)

Variables	Categories	Case n (%)	Non-case n (%)	Total n (%)
Mother's handwashing with soap before feeding toddlers	No	3 (15.0)	17 (85.0)	20 (100)
	Yes	9 (6.7)	126 (93.3)	135 (100)
Toddler's handwashing with soap before meals	No	2 (12.5)	14 (87.5)	16 (100)
	Yes	10 (7.2)	129 (92.8)	139 (100)
Mother's and toddler's handwashing after urination and defecation	No	1 (20.0)	4 (80.0)	5 (100)
	Yes	11 (7.3)	139 (92.7)	150 (100)
Total respondents		12 (7.7)	143 (92.3)	155 (100)

Source: Primary data, 2024

TABLE 4. Distribution Habits of Opening and Closing Windows (n = 155)

Habits of Opening and Closing Windows					
Univariate			Case		Total
			Case	Not the Case	
Opening and closing windows	No	Count	1	31	32
		% within Opening and Closing Windows	3.1%	96.9%	100%
		% within Cases	8.3%	21.7%	20.6%
	Yes	Count	11	112	123
		% within Opening and Closing Windows	8.9%	91.1%	100%
		% within Cases	91.7%	78.3%	79.4%
Total		Count	12	143	155
		% within Opening and Closing Windows	7.7%	92.3%	100%
		% within Cases	100%	100%	100%

Source: Primary data, 2024.

TABLE 5. Bivariate Analysis

Variables	OR	95% CI	p-value	Analysis Results
Smoking Behavior of Parents of Toddlers	4.889	0.612 – 39.043	0.1	No Connection
Mothers' Handwashing with Soap Behavior Before Feeding Toddlers	2.471	0.68 - 1,032	0.193	No Connection
Toddlers' Handwashing with Soap Behavior Before Meals	1.843	0.366 – 9.268	0.452	No Connection
Mothers' and Toddlers' After Urination and Defecation	3.159	0.325 – 30.752	0.297	No Connection
Opening and Closing Windows	0.328	0.041 – 2.643	0.273	No Connection

Source: Primary data, 2024.

behaviors and the occurrence of pneumonia symptoms in toddlers, a bivariate statistical analysis was performed.

Smoking behavior is one of the critical factors that affects health, especially in children under five. The habit of smoking can be interpreted as the routine act of smoking cigarettes by individuals, in this case, parents of toddlers. This habit not only has a detrimental impact on the health of the smoker himself, but also on other family members who are passively exposed to cigarette smoke, especially children who are still very vulnerable. The World Health Organization (WHO) states that exposure to secondhand smoke is one of the main risks of respiratory diseases in children, including pneumonia, bronchitis, and asthma. Children who live with smokers have a greater risk of developing lower respiratory tract infections (World Health Organization, 2025). Correspondingly, environmental tobacco smoke exposure has been widely recognized as harmful to children's respiratory health, as even early or continuous exposure can negatively affect lung development and increase the risk of respiratory infections, indicating that there is no safe level of exposure (Vanker *et al*., 2017).

Based on the data contained in Table 2, of the 12 cases of toddlers who experienced pneumonia, 11 of them came from families with smoking parents, while only one toddler had parents who did not smoke. On the other hand, of the 143 toddlers who did not have pneumonia, as many as 99 toddlers came from families with smoking parents. This data shows that the proportion of toddlers with smoking parents who do not have pneumonia is 90%, while the proportion of toddlers with parents who do not smoke reaches 2.2%. This shows that although many toddlers who are exposed to secondhand smoke do not develop pneumonia, there is a significant relationship between parents' smoking habits and the incidence of pneumonia in toddlers.

Some studies report that exposure to secondhand smoke from parents significantly increases the risk of pneumonia and lower respiratory tract infections in children under five years of age. An epidemiological meta-analysis showed that children who lived in homes with smokers had a higher chance of developing pneumonia than children without exposure to environmental cigarette smoke (Riestiyowati *et al*., 2020). Recent evidence from a Mendelian randomization study indicates a causal relationship between smoking behavior and the risk of bacterial pneumonia, with higher cigarette consumption and smoking initiation significantly associated with increased pneumonia risk. This finding reinforces the role of smoking as an important modifiable risk factor influencing respiratory health outcomes (He *et al*., 2024). A more in-depth analysis through bivariate tables showed that the Odds Ratio (OR) for the occurrence of pneumonia in young children whose parents smoke is 4,889. This indicates that young children with parents who have a smoking habit are 4,889 times more likely to develop pneumonia compared to young children whose parents do not smoke. This figure confirms that exposure to cigarette smoke in the home is a significant risk factor for children's respiratory health. Although the data showed an important pattern, the Chi-

Square test for 2,705 with p=0.1 indicated that this relationship was not significant (p>0.05). In other words, although there is a bias in the data, there is not enough evidence to claim that parental smoking directly increases the risk of pneumonia in toddlers in this study.

While these results do not show a statistically significant relationship, it is essential to be aware of the potential risks indicated by the data. Parents' smoking habits can have a variety of negative impacts on children, such as an increased risk of respiratory infections, asthma, and lung development problems. Therefore, initiatives to reduce smoking habits among parents are a crucial step in preventing diseases in children. Educational programs on the dangers of secondhand smoke and the implementation of smoke-free policies at home can be very effective in reducing children's exposure to secondhand smoke and improving their overall health. In addition, it is crucial to increase understanding of the adverse effects of smoking on families through public health campaigns (Hidayah *et al*., 2019). Counseling and smoking cessation support programs can also be components of a more comprehensive public health strategy to reduce smoking rates. In this way, the risk of diseases associated with cigarette smoke in children can be reduced.

Handwashing with soap is a method of washing hands using clean running water and soap to remove dirt and harmful microorganisms. Handwashing with soap is one of the most effective ways to prevent the spread of infectious diseases, including diarrhea and respiratory tract infections such as pneumonia. This is supported by the results of a systematic review and meta-analysis published in The Lancet Global Health, which showed that the promotion and practice of washing hands with soap can reduce the incidence of acute respiratory infections by up to 17% (RR 0.83; 95% CI 0.76–0.90) in low- and middle-income countries (Ross *et al*., 2023). These findings suggest that handwashing with soap protects against lower respiratory infections, which are the leading cause of pneumonia in children.

Correct handwashing with soap behavior includes washing hands before feeding the child, before eating, and after urinating and defecating. Epidemiological research in Ethiopia shows that mothers who only use soapy water before feeding children have a higher risk of pneumonia in toddlers compared to mothers who use soap and water. Thus, the use of soap is considered protective against pneumonia (Girma *et al*., 2023). The results of this study showed that of 20 toddlers whose mothers did not wash their hands with soap before feeding, 3 (15%) developed pneumonia, whereas of 135 toddlers whose mothers did wash their hands with soap before feeding, only 9 (6.7%) developed pneumonia. The OR of 2.471 indicated that toddlers whose mothers did not wash their hands with soap before feeding had a 2.471 times greater risk of developing pneumonia than those whose mothers did. Although the p-value of 0.193 (p>0.05) indicates that the association is not statistically significant, the direction and magnitude of the OR still indicate epidemiologically relevant risk trends and are consistent with international findings.

In addition, handwashing with soap before eating is also very important for toddlers. Data show that 12.5% of toddlers who do not wash their hands before eating experience an adverse health outcome, compared with only 7.2% of those who do. An OR value of 1.843 indicates that toddlers who do not wash their hands before eating have nearly twice the risk of developing pneumonia than those who do. These results are in line with global evidence that suboptimal hand hygiene practices contribute to higher respiratory infections in children (Ross *et al*., 2023). Although the p-value of 0.452 (p>0.05) indicates no statistically significant relationship, the tendency toward increased risk is still worth considering.

Hand washing behavior after defecation also showed a similar pattern. The results showed that 20% of mothers and toddlers who did not wash their hands after defecation experienced adverse health outcomes, compared with only 7.3% among those who washed their hands with soap. With an OR value of 3.159, the risk of pneumonia in toddlers who did not do handwashing with soap after bowel movements and BAK more than tripled compared to those who did. International studies also confirm that hand hygiene practices after contact with fecal contaminants are an important factor

in breaking the transmission of pathogens that cause respiratory infections and diarrhea in children (Ross *et al*., 2023). Bivariate analysis showed p=0.297 (p>0.05); the trend of increasing risk remained consistent with the global literature. A prior study found that environmental hygiene, such as domestic liquid waste management and water microbiological quality, is related to diarrhoea incidents (Siwiendrayanti & Maulidah, 2022). These findings are also supported by previous studies in Indonesia. (Jannah *et al*., 2021) reported that family health behaviors, including hygiene practices within the household, are important determinants of pneumonia incidence among toddlers. Similarly, (Wati *et al*., 2021) emphasized that family health behavior and environmental sanitation play an important role in increasing or reducing the risk of pneumonia in children under five.

Overall, good handwashing with soap behavior is a practical preventive step for maintaining toddlers' health and preventing infectious diseases. Recent scientific evidence suggests that handwashing with soap-promoting interventions has a significant impact in reducing the incidence of acute respiratory infections and preventing pneumonia in children (Ross *et al*., 2023). Therefore, the practice of washing hands with soap before eating, before feeding children, and after defecation and bathing needs to be socialized and encouraged in daily life. Increasing awareness and compliance with handwashing with soap behavior can significantly reduce the incidence of infectious diseases in toddlers.

Opening and closing windows can affect health, especially by preventing diseases such as pneumonia in toddlers. Opening windows allows for good air circulation, which can reduce the concentration of pathogens in the room. This is in line with research published in Environment International, which states that poor home ventilation and low air exchange are associated with an increased risk of respiratory infections in children. So window opening can lower that risk (Shao *et al*., 2020). On the other hand, closing windows under certain conditions, such as at night or when air quality is poor, can protect residents from exposure to cold air, dust, and pollution that can worsen respiratory conditions. Research published in BMC Public Health found that inadequate home ventilation is a significant risk factor for pneumonia in children under 5 years of age, as it increases exposure to pathogens and indoor pollutants (Temsesgen *et al*., 2023). These findings are further supported by a recent systematic review and meta-analysis, which demonstrated that effective infection prevention requires integrating multiple environmental and hygiene-related interventions rather than relying on a single measure. The study highlighted that controlling pathogen transmission through environmental management and hygienic practices is crucial in reducing pneumonia incidence, as these components work synergistically to limit microbial exposure and infection risk (Lim *et al*., 2026).

Based on the results of this study, the habit of opening and closing windows was analyzed in relation to pneumonia in toddlers. The findings showed that 1 out of 12 toddlers without the habit experienced pneumonia, while 11 out of 12 cases occurred among those with the habit. In the non-case group, 31 toddlers did not habitually open and close windows, while 112 did. Overall, the proportion of toddlers who habitually opened and closed windows was higher in both groups. Statistical analysis showed a p-value greater than 0.05, indicating no significant association between window opening habits and pneumonia incidence. The Odds Ratio value of 0.328 suggests a lower observed risk among toddlers who did not habitually open and close windows. However, this finding should be interpreted with caution, as it may be influenced by confounding factors such as housing conditions, crowding, or other dominant exposures. From a theoretical perspective, adequate ventilation plays an important role in reducing indoor air pollution and airborne pathogens. Previous studies have shown that good air circulation can reduce the risk of respiratory tract infections in children (Shao *et al*., 2020; Temsesgen *et al*., 2023). Therefore, maintaining proper ventilation remains an important recommendation, despite the absence of statistical significance in this study.

More broadly, household health

behaviors are interrelated and may collectively influence the risk of respiratory infections in children. Individual exposures such as parental smoking may increase the risk by approximately 30-60%, while poor ventilation and indoor air pollution may increase the risk up to two times. The World Health Organization also reports that household air pollution contributes to nearly 50% of pneumonia-related deaths among children under five, highlighting the important role of the home environment in child health outcomes (Adaji *et al*., 2019; World Health Organization (WHO), 2025). When these risk factors occur simultaneously, their combined impact becomes greater, indicating that pneumonia risk is influenced by the accumulation of multiple unfavorable household conditions rather than a single dominant factor. In line with this concept, although this study did not find statistically significant associations, the Odds Ratio values showed a tendency toward increased risk among toddlers exposed to unhealthy behaviors. This suggests that pneumonia may be influenced by the interaction of several moderate risk factors. Therefore, efforts to prevent pneumonia in toddlers should address multiple household health behaviors simultaneously, including reducing exposure to cigarette smoke, improving ventilation, and strengthening hygiene practices, as the absence of statistical significance does not diminish the practical importance of these cumulative risk factors.

Conclusion

The study concluded that there was no statistically significant association between parental behaviors, including smoking habits, handwashing with soap practices, and window opening and closing habits, and the incidence of pneumonia in toddlers ($p > 0.05$). However, the Odds Ratio (OR) values indicate a tendency toward increased risk of pneumonia in toddlers exposed to unhealthy parental behaviors, particularly parental smoking and suboptimal handwashing with soap practices. These findings suggest that, although not statistically significant in this study, parental behavioral factors still have the potential to act as important risk factors affecting respiratory health in toddlers, both clinically and epidemiologically. Therefore, promoting smoke-free environments, proper hand hygiene, and adequate household ventilation remains crucial as preventive strategies to reduce the risk of pneumonia in toddlers.

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