

## ORIGINAL RESEARCH

# EFFECTS OF HOUSING ENVIRONMENTAL CHARACTERISTICS ON PNEUMONIA OCCURRENCE IN UNDER-FIVE-YEAR-OLD CHILDREN IN SOUTH TANGERANG CITY

*Pengaruh Karakteristik Lingkungan Fisik Rumah dengan Kejadian Pneumonia Pada Balita Kota Tangerang Selatan*

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### ABSTRACT

**Background:** Pneumonia is an ongoing public health problem in Indonesia, ranking as the second most prevalent disease in South Tangerang. **Purpose:** This study aimed to examine the physical housing environment characteristics in relation to pneumonia occurrence rates among children under-five years of age in South Tangerang City. **Method:** This research was carried out as a quantitative study with a case-control study design. The population consisted of children under five who were diagnosed with pneumonia at Public Health Center (PHC) of Pamulang and PHC of Ciputat Timur between January 2017 and March 2018. The data were analyzed using the chi-square statistical test. **Results:** The following characteristics of the housing environment were shown to be associated with pneumonia are bad routines of opening windows ( $p = 0.00$ ; OR = 11; 95% CI = 2.59–46.78), location of the kitchen is in similar area with other rooms ( $p = 0.04$ ; OR = 4.03; 95% CI = 1.20–13.53), unqualified humidity in the house ( $p = 0.05$ ; OR = 3.86; 95% CI = 1.18–12.60), unqualified light intensity in the house ( $p = 0.01$ ; OR = 9.04; 95% CI = 1.74–46.89), unqualified ventilation area ( $p = 0.02$ ; OR = 4.50; 95% CI = 1.38–14.82), and unqualified occupancy ( $p = 0.03$ ; OR = 4.84; 95% CI = 1.29–18.26). **Conclusion:** The community needs to maintain the physical environment in their houses, such as by opening the windows in the morning so that light comes in and the house does not get damp.

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## ABSTRAK

**Latar Belakang:** *Pneumonia* masih menjadi permasalahan kesehatan masyarakat di Indonesia. *Pneumonia* menempati urutan kedua penyakit tertinggi di Tangerang Selatan. **Tujuan:** Penelitian ini bertujuan untuk menganalisis pengaruh karakteristik lingkungan fisik rumah dengan kejadian penyakit *pneumonia* pada anak balita di Kota Tangerang Selatan. **Metode:** Penelitian ini merupakan penelitian kuantitatif dengan desain studi kasus kontrol. Populasi dalam penelitian ini adalah seluruh balita yang didiagnosis *pneumonia* di Pusat kesehatan masyarakat (Puskesmas) Pamulang dan Puskesmas Ciputat Timur. Data dianalisis dengan uji statistik *chi-square*. **Hasil:** Karakteristik lingkungan rumah yang berhubungan dengan kejadian *pneumonia* antara lain kebiasaan membuka jendela yang buruk ( $p = 0,00$ ;  $OR = 11$ ;  $95\%CI = 2,59-46,78$ ); letak dapur berada di area yang sama dengan yang lain ( $p = 0,04$ ;  $OR = 4,03$ ;  $95\%CI = (1,20 - 13,53)$ ); kelembaban tidak memenuhi syarat dalam rumah ( $p = 0,05$ ;  $OR = 3,86$ ;  $95\%CI = 1,18-12,60$ ); intensitas cahaya tidak memenuhi syarat dalam rumah ( $p = 0,01$ ;  $OR = 9,04$ ;  $95\%CI = 1,74- 46,89$ ); luas ventilasi yang tidak memenuhi syarat ( $p = 0,02$ ;  $OR = 4,50$ ;  $95\%CI = 1,38-14,82$ ) dan kepadatan rumah tidak memenuhi syarat ( $p = 0,03$ ;  $OR = 4,84$ ;  $95\% CI = 1,29 - 18,26$ ). **Kesimpulan:** Masyarakat perlu menjaga lingkungan fisik rumah seperti membuka jendela pada pagi hari agar cahaya dapat masuk dan tidak lembab.

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## INTRODUCTION

Pneumonia is a respiratory disease that infects the lung tissues or alveoli. It may be caused by viruses, fungi, and bacteria, and it often occurs among children under five years of age. Pneumonia is an infectious disease that often cause high morbidity and mortality (Ministry of Health RI, 2018). Common symptoms of pneumonia in children and infants are very fast and labored breathing, coughing, fever, chills, headaches, loss of appetite, and a specific sound being produced while breathing (Juni, Nurjazuli, & Suhartono, 2016).

Pneumonia is the main cause of child mortality globally. In 2015, it caused 16% of deaths in children aged below five years. With figures of 920,136 deaths in children under five, it is estimated that two children under the age of five die every minute. In 2016, there were 568,146 cases of under-fives suffering from pneumonia, among which there were 589 deaths (case fatality rate [CFR] = 0.11%). In 2017, occurrences of pneumonia decreased to 511,434 cases, and the CFR was 0.34%. Based on data from Ministry of Health RI (2018), the rate of pneumonia cases in children under five in Banten Province reached

62.35%, while in South Tangerang City, the prevalence of identified and treated pneumonia cases in children under five only reached 40.10%.

One factor that plays an important role in the occurrence of pneumonia is the housing environment. A house is a physical structure that is used as a shelter and a facility that supports physical, spiritual, and social health. A healthy house is key to achieving optimal health quality (Ministry of Health RI, 2018). According to research conducted by Fataruba, Suhartono, & Sulistiyani (2019), the physical housing environment factors that affect pneumonia occurrence are the type of floor, wall conditions, ventilation, occupancy, humidity, and lighting intensity. Hayati, Suhartono, & Winarni (2017) also highlight that the housing environment such as lighting and humidity are risk factor for pneumonia in children under five years of age.

The rate of Indonesians occupying livable houses in 2016 was 93.93%, and in Banten, the rate was as high as 95.33% (Ministry of Health RI, 2018). These statistical data attracted the authors of the current study to conduct research regarding the characteristic effects of the physical housing environment in an area where children under five

suffered from pneumonia, located in South Tangerang City.

## METHOD

The research was conducted as an observational study with a case-control study design. The study population consisted of children under five years old who were diagnosed with pneumonia at Public Health Center (PHC) of Pamulang and East Ciputat. The sample calculation in this study used a ratio of 1:1. The case group comprised under-fives who were diagnosed with pneumonia and registered in the patient register between January 2017 and March 2018 ( $n = 25$ ), and the control group consisted of children under five who did not suffer from pneumonia and lived in the same neighborhoods as the 25 children in the case group. The technique used was purposive sampling.

The study independent variables were age ( $<$ mean [28.5 months or below] and  $\geq$ mean [28 months 14 days and above]), sex (male and female), occupancy ("unqualified" if house area was  $<9 \text{ m}^2$  per person and "qualified" if house area was  $\geq 9 \text{ m}^2$  per person) (Ramdan, Anggun, & Rahmat, 2018). The ventilation area was categorized as "unqualified" if the area with permanent ventilation was  $<10.00\%$  of the floor area and "qualified" if it was  $\geq 10.00\%$  of the floor area, humidity was classed as "unqualified" at  $<40.00\%$  or  $>70.00\%$  and "qualified" in the range  $40.00\%$ – $70.00\%$ , and temperature was categorized as "unqualified" if  $<180^\circ\text{C}$  or  $>300^\circ\text{C}$  or "qualified" if between  $180^\circ\text{C}$ – $300^\circ\text{C}$ . Lighting was categorized as "unqualified" if the lighting in the house was  $<60$  lux and "qualified" if it was  $\geq 60$  lux, and the location of the kitchen was classed as "unqualified" if the kitchen area was integrated with other rooms in the house and "qualified" if it was separated from or partitioned from other rooms. For floor type, a house was categorized as "unqualified" if some part of the floors was soil and "qualified" if the entire floor was made of ceramic, sealed wood, tiles, or water-proof cement, and for type of wall, a house was "unqualified" if the walls of the bedroom and living room were not equipped with ventilation and were not made of plastered walls or boards (Ministry of Health RI, 2011). The habit of opening the windows was categorized as "good" if the residents opened the windows every day and "bad" if they did not do so (Darmawati, Sunarsih, & Trisnaini, 2016).

Data were collected by measuring the variables of occupancy residency, area of

ventilation, humidity, temperature, and lighting. Observations were conducted on the variables of floor types, wall types, and kitchen location. The analysis was completed by using chi-square statistical testing and calculate odds ratio (OR). This research has received ethical approval (No. 043A / PE / KE / FKK-UMJ / VII / 2018).

## RESULTS

The study results regarding the respondents' characteristics show that this sample of under-five-year-old children who suffered from pneumonia was dominated by toddlers aged  $<28$  months 14 days ( $60.00\%$ ), while the gender of the majority of the patients was male ( $64.00\%$ ) (Table 1).

Table 1 also shows that the majority of those in the case groups did not have their windows open each day ( $88.00\%$ ), while more than half of the control group had a routine of opening the windows ( $60.00\%$ ). The statistical test results give a p-value of 0.01 (OR = 11.00; 95% CI = 2.59–46.78), indicating a significant relationship between the habit of opening the windows and the occurrence of pneumonia in children under the age of five.

Most of the respondents in the case group lived in houses where the kitchen was part of another room ( $56.00\%$ ), while the control group respondents were more likely to live in houses where the kitchen was a separate room ( $76.00\%$ ). The p-value is 0.04, meaning that there is a significant relationship between the location of the kitchen and the occurrence of pneumonia in children under five (Table 1).

Most of the case group respondents lived in houses with qualified wall types ( $80.00\%$ ), and most of the control group also lived in houses with qualified wall types ( $88.00\%$ ). The results of the statistical tests give a p-value of 0.70, meaning that there is no significant relationship between wall types and the occurrence of pneumonia in children under five (Table 1).

Table 1 shows that both the case group and the control group respondents mostly lived in houses with qualified floors. However, most of the case group respondents lived in houses with unqualified temperature ( $84.00\%$ ), as did  $68.00\%$  of the control group. The analysis results show that a p-value of 0.32, which indicates no significant relationship between the temperature in the house and the occurrence of pneumonia in children under five.

The findings regarding the humidity effect show that most of the case group respondents had

unqualified house humidity (60.00%), compared with only 28.00% of the control group. The statistical analysis shows that there is a significant relationship between humidity in the house and the occurrence of pneumonia in children under five ( $p = 0.05$ ). The OR value of 3.86 (95% CI = 1.18–12.60) means that respondents living in houses where the humidity was unqualified had a 3.86x greater likelihood of suffering from pneumonia than those living in houses where the humidity was qualified (Table 1).

The proportion of unqualified houses for light intensity in the case group was higher (92.00%) than in the control group (56%), with a  $p$ -value of 0.01. This indicates a significant relationship between lighting and the occurrence of pneumonia in children under five. The OR value of 9.04 means that the respondents living in houses with unqualified light intensity had a 9.04x greater chance of suffering from pneumonia than those living in houses with qualified light intensity (Table 1).

The proportion of houses with unqualified ventilation areas in the case group was higher (68.00%) than in the control group (32.00%), with a  $p$ -value of 0.02. This shows that there is a significant relationship between unqualified levels of ventilation and the occurrence of pneumonia in children under five.

The results regarding the effect of occupancy density on the occurrence of pneumonia show that pneumonia occurred more frequently in houses with unqualified occupancy density results (48.00%) than in houses with qualified occupancy density (16.00%). The statistical test results show a  $p$ -value of 0.03, meaning that there is a significant relationship between occupancy density and the occurrence of pneumonia in children under five (Table 1).

## DISCUSSION

Based on the analytical results regarding the respondents' characteristics, most of the respondents who suffered from pneumonia were aged <28 months and 14 days (60.00%) and were male (64.00%). This is in line with research conducted by Nurnajiah, Rusdi, & Desmawati (2016), which reports that most children suffering from pneumonia are aged 13–28 months. Research conducted by Ceria (2016) show the similar finding that most children suffering from pneumonia are aged 12–35 months. With regard to gender, other studies also show similar results that male children under five years have a greater risk

than female children of developing pneumonia (Fikri, 2017).

Our analysis shows that the respondents whose households did not have a habit of opening the windows were at 11x higher risk of suffering from pneumonia compared to those whose households did have such a habit. These results are in line with the research conducted by Pratiwi, Yunus, & Gayatri (2018), which also shows a relationship between a habit of opening windows and the occurrence of pneumonia in children under five ( $p = 0.01$ ). A habit of opening the windows every morning, especially the bedroom windows, and keeping them open during the day makes it easier for sunlight to enter the house, primarily for air exchange. If the bedroom windows are never opened, the bedrooms will become damp and stuffy, enabling pathogenic microorganisms to make pneumonia grow and spread easily. *Streptococcus haemolyticus* bacteria are very sensitive to sunlight, so they cannot grow and spread in rooms that have high-quality sunlight. This is what underlies the importance of having a routine of opening the windows every morning and afternoon (Darmawati et al., 2016).

The data analysis results of the current study indicate that the respondents who lived in houses where the kitchen area was shared with another room had a 4.03x greater risk of suffering from pneumonia than those living in houses where the kitchen was in a separate room. This finding is in line with the research conducted by Suryati, Natasha, & Id'ys (2018), where most of the respondents (91.40%) had their kitchen in the same area as the family room and lacked a chimney. Research conducted by PrayGod, Mukerebe, Magawa, Jeremiah, & Török (2016) have also reported that the location of the kitchen in the house is related to pneumonia occurrence ( $p = 0.02$ ). A kitchen area that is not separated from other rooms is likely to cause pneumonia in family members because the kitchen space is a source of air pollution in the house. During cooking, there are emissions of various pollutants from incomplete combustion when cooking activities are carried out continuously (every day), and when this happens over quite a long time, the smoke from the kitchen will pollute the entire room (Suryati, Natasha, & Id'ys, 2018). The research results of Nirmolia et al (2018) also show that indoor air pollution affects the occurrence of pneumonia.

Our results indicate no significant effect of wall types on the occurrence of pneumonia. This finding is in line with research conducted by

Kurniasih, Suhartono, & Nurjazuli (2015), which also states that there is no significant effect between wall types and the occurrence of pneumonia in children under five ( $p > 0.05$ ). This is in contrast, however, to a study conducted by Khasanah, Suhartono, & Dharminto (2016), which reports that house wall types do have an effect on the occurrence of pneumonia in children under five ( $p = 0.01$ ) with an OR of 3.75 (CI 95% = 1.42–9.88). Their findings suggest that children under five who live in houses with unqualified wall types have a higher risk (3.70x) of suffering from pneumonia than do children under five who live in houses with qualified wall types. Dewiningsih research (2018) also shows a relationship between wall types and the occurrence of pneumonia ( $p = 0.01$ ). The conditions of house walls can also indirectly affect the incidence of pneumonia. The walls function as supports for the roof and protect a house from rain, wind, and heat. Construction of temporary and bamboo-woven house walls can contribute to health problems, one of which is pneumonia. Temporary walls will also affect the temperature inside a house (Nilandita, 2018).

The current study's results show no significant effect of floor type on the occurrence of pneumonia in children under five in South Tangerang City. This is because both groups had high proportions of qualified floor types. This research is in line with a study by Kurniasih, Suhartono, & Nurjazuli (2015), which found no significant effect of floor types on the occurrence of pneumonia in children under five at PHC of Candi Lama, Semarang City ( $p = 0.31$ ). This is because some of the respondents already lived in houses with qualified floors, i.e., permanent floors that are dustless in the dry season and waterproof during the rainy season. This is contrary, however, to Fataruba, Suhartono, & Sulistiyani (2019) finding of a relationship between floor types and the occurrence of pneumonia ( $p = 0.01$ ). Houses with untiled floors are more humid than those with tiled floors, and the materials for house floors should be waterproof and not untiled because rain will make the soil damp, a condition that may cause disturbances or diseases. In the dry season, soil floors will make the interior of the house dusty. Dusty conditions in a house can be a medium of indoor air pollution (Sari, Rahardjo, & Joko, 2018).

The current study's results indicate no significant relationship between the temperature in a house and the occurrence of pneumonia in

children under five in South Tangerang City. This is because both the case and control groups had unqualified temperature levels. These results are in accordance with the research of Sari, Rahardjo, & Joko (2018), which states that there is no significant effect between house temperature variables and the occurrence of pneumonia in children under five ( $p = 0.66$ ). These variables had no effect because the data collection was conducted in the rainy season, which brings conditions of lower air temperature.

Our results show that humidity affected the occurrence of pneumonia, with a 3.86x higher risk among under-five children living in unqualified conditions than among those living in houses with qualified humidity. This is in line with Darmawati, Sunarsih, & Trisnaini (2016) finding of a statistically significant effect of humidity in a house and the occurrence of pneumonia in under-five-year-olds ( $p = 0.01$ ). Their results showed that under-fives living in houses with unqualified humidity were 5.90x more likely to suffer from pneumonia than those living in houses with qualified humidity.

The range for good humidity in houses is 40%–70%. High humidity (>80.00%) is an ideal condition for Pneumonia bacteria to grow and spread quickly. The humidity levels inside houses are affected by temperature, lighting intensity, ventilation, and the type of flooring. House structures that are of poor quality, such as leaking rooves and walls that are not waterproof, are also risk factors for indoor humidity levels (Ramdan, Anggun, & Rahmat, 2018).

Our findings show a relationship between light intensity in the house and the occurrence of pneumonia in children under five. The OR was 9.04, which means that children under five years old living in houses with unqualified light intensity had a 9.04x greater risk of suffering from pneumonia than those living in houses with qualified light intensity. Research by Nuretza, Suhartono, & Winarni (2017) also shows that there is a relationship between lighting intensity and the occurrence of pneumonia in under-fives ( $p = 0.02$ ). Darmawati, Sunarsih, & Trisnaini (2016) findings similarly show that light intensity has a significant effect on the occurrence of pneumonia in children under five ( $p = 0.000$ ), as do Wulandari, Suhartono, & Dharminto (2016), which show that children under five years who live in houses with unqualified light intensity are at 3.85x greater risk than those who living in houses with qualified light intensity.

**Table 1**

Frequency Distribution of Characteristics of Housing Environments in South Tangerang City

Characteristics of Housing Environment	Case		Control		OR 95% CI	p
	n	%	n	%		
<b>Habit of Opening the Windows</b>						
Bad	22	88,00	10	40.00	11.00	0.01
Good	3	12.00	15	60.00	(2.59–46.78)	
<b>Kitchen Location</b>						
In similar area with other rooms	14	56.00	6	24.00	4.03	0.04
Separated with other rooms	11	44.00	19	76.00	(1.20–13.53)	
<b>Wall Type</b>						
Unqualified	5	20.00	3	12.00	1.83	0.70
Qualified	20	80.00	22	88.00	(1.53–2.72)	
<b>Floor Types</b>						
Unqualified	1	4.00	0	0.00	-	1.00
Qualified	24	96.00	25	100.00		
<b>Temperature in the House</b>						
Unqualified	21	84.00	17	68.00	2.47	0.32
Qualified	4	16.00	8	32.00	(0.63–9.63)	
<b>Humidity in the House</b>						
Unqualified	15	60.00	7	28.00	3.86	0.05
Qualified	10	40.00	18	72.00	(1.18–12.60)	
<b>Light Intensity in the House</b>						
Unqualified	23	92.00	14	56.00	9.04	0.01
Qualified	2	8.00	11	44.00	(1.741–46.89)	
<b>Ventilation Area</b>						
Unqualified	17	68.00	8	32.00	4.52	0.02
Qualified	8	32.00	17	68.00	(1.38–14.82)	
<b>Occupancy</b>						
Unqualified	12	48.00	4	16.00	4.85	0.03
Qualified	13	52.00	21	84.00	(1.29–18.26)	
Total	25	100.00	25	100.00		

The ideal light intensity is at least 60 lux (Ministry of Health RI, 2011). Natural lighting has functions to kill bacteria that live in houses, such as the *Streptococcus pneumoniae* bacteria, which can last for several days under ordinary lighting and will be killed by direct sunlight. This is because sunlight contains ultraviolet rays which can cause cell ionization, which inhibits growth or causes death (Nilandita, 2018).

Our analysis results show that children under five living in houses with unqualified ventilation areas had a 4.52x greater risk of suffering from pneumonia than those living in houses with qualified ventilation areas. This is in agreement with Wulandari, Suhartono, & Dharminto (2016), who state that the area of ventilation has a significant effect between on the occurrence of pneumonia in children under five ( $p = 0.01$ ). Fikri (2017) also reports that the area of ventilation is a risk factor for pneumonia in children under five, with an OR of 13.50, meaning that children living

in houses with unqualified ventilation areas have a 13.50x greater risk of suffering from pneumonia than those living in houses with qualified areas of ventilation.

To be qualified, the ventilation area must be  $\geq 10\%$  of the floor area (Ministry of Health RI, 2011). Ventilation functions as a means of circulating or moving air into the house and maintaining the indoor humidity. An unqualified ventilation area will cause air circulation in a house to be low. Good air quality is needed because poor air quality can affect the physiology of the respiratory system, especially in infants and the under-fives. An unqualified ventilation area will affect air exchange and can thus become the cause of a proliferation of microorganisms that can interfere with human health. Dust and vapor act as a medium for bacteria to enter human bodies. A gram of street dust contains  $\pm 50$  million bacteria, while dust in an indoor room contains  $\pm 5$  million bacteria/gram. Pneumonia and TB are

highly likely to be transmitted in houses with unqualified ventilation conditions (Darmawati, Sunarsih, & Trisnaini, 2016).

The current results show a significant effect of residential density on the occurrence of pneumonia in children under the age of five living in unqualified density conditions, with these children having a 4.85x greater risk of suffering from pneumonia than those living in houses with qualified levels of occupancy density. This is in line with Korelia's (2017) research, which also reports an effect of occupancy density on the occurrence of pneumonia in children under five (OR = 13.00). Adaji, Ekezie, Clifford, & Phalkey (2019) also find that occupancy density is significantly associated with the occurrence of pneumonia in children under five.

A house being too densely populated can cause the temperature to increase so that the house becomes hot and disease transfer becomes easier and faster, especially for diseases that are transmitted through the air (Darmawati, Sunarsih, & Trisnaini, 2016). More residents living in a house can increase air pollutants such as gas and bacteria. This can cause the O<sub>2</sub> level in the house to drop drastically, which will be followed by an increase in CO<sub>2</sub>. Increasing CO<sub>2</sub> levels can reduce the quality of indoor air and allow bacteria to reproduce very quickly, facilitating disease transmission through droplets and direct contact (Maulana, Rahmatun Handari, Dwi Jatmika, & Sunarti, 2018).

## CONCLUSION

The physical environmental factors of houses that are related to the occurrence of pneumonia in children under five years old in South Tangerang City include a habit of opening windows, occupancy density, area of ventilation, lighting, humidity, and location of the kitchen. There is a need for campaigns to increase public awareness about maintaining the physical environment of houses to avoid pneumonia occurrence, especially in the form of counseling.

## CONFLICT OF INTEREST

The authors state that there is no conflict of interest in this study.

## AUTHORS' CONTRIBUTION

Each author had an active contribution in writing this article. TF was in charge of the

content of the writing, covering the introduction, method, analysis, and discussion. AL contributed to the introduction, discussion, analysis, and conclusions. MF contributed and provided inputs regarding the writing concept, methods, design, and analysis.

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