Association Between Home Physical Environment, Individual Characteristics and Personal Hygiene and the Incidence of Leprosy in Cirebon Regency

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Abstract

Leprosy is a contagious disease caused by the bacterium Mycobacterium leprae, which attacks the peripheral nerves and skin. This study aims to analyze whether household ventilation, housing density, window availability, wall and floor conditions, room separation, and personal hygiene behaviors are significantly associated with leprosy incidence in Cirebon regency. This research is an analytical observational study with a case-control design, involving 77 case respondents and 77 controls randomly selected. Data were collected through observation and interviews regarding home conditions and personal habits, and then analyzed using the chi-square test. The results show that the variables of ventilation size (p-value < 0.001 and OR = 5.361), window condition (p-value < 0.001 and OR = 3.640), room separation (p-value < 0.001 and OR = 6.249), and occupancy density (p-value = 0.014 and OR = 2.387) were significantly associated with the incidence of leprosy, while floor type (p-value = 0.297 and OR = 1.539) and wall type (p-value = 0.250 and OR = 1.543) were not associated with leprosy incidence. Regarding personal hygiene factors, knowledge (p-value < 0.001 and OR = 7.125), attitude (p-value < 0.001 and OR = 6.818), shared towel use (p-value < 0.001 and OR = 5.2), and nail-cutting habits (p-value < 0.001 and OR = 3.433) had a significant effect on leprosy, while bathing frequency (p-value = 0.294 and OR = 1.539) did not show a significant relationship. The findings indicate that the physical housing environment and personal hygiene are associated with leprosy occurrence in Cirebon Regency, suggesting that control efforts should prioritize housing improvements and the promotion of proper hygiene practices

Keyword: Leprosy, Physical Home Environment, Knowledge, Attitude, Personal hygiene

INTRODUCTION

Leprosy is a chronic infectious disease caused by Mycobacterium leprae that primarily affects the peripheral nerves and skin and may also involve the eyes and upper respiratory tract. Leprosy is classified into paucibacillary (PB) and multibacillary (MB) types, with MB cases serving as the main source of transmission due to higher bacterial loads (Peraturan Menteri Kesehatan Republik Indonesia Nomor 11 Tahun 2019 Tentang Penanggulangan Kusta, 2019). Leprosy is usually treated through multidrug therapy; however, it remains a persistent public health problem in several endemic regions worldwide.

Leprosy is often seen in low- and middle-income countries. According to the World Health Organization (WHO), 174,087 new leprosy cases were reported globally in 2022, with more than 95% of cases occurring in 23 countries, predominantly in South and Southeast Asia, sub-Saharan Africa, and Latin America (World Health Organitation, 2022). In South Asia,

India contributes to being a country with the most new cases of Leprosyfollowed by Brazil and several African countries, (World Health Organiation, 2020). The uneven global spreading of Leprosy is influenced bysocioeconomic, environmental, and living conditions.

Indonesia is one of the highest leprosy-burden countries worldwide. National surveillance data indicate an increase in leprosy reported cases from 12,288 in 2021 to 15,052 in 2022, with Banten, West Java, and Papua consistently reporting the highest number (Kementerian Kesehatan, 2024). Actually, efforts to eliminate leprosy in provincial level have been made, but its transmission persists at the sub-district and village levels. In West Java Province, leprosy prevalence increased from 0.32 per 10,000 population in 2021 to 0.45 per 10,000 population in 2022, accompanied by a new case detection rate of 2.62 per 10,000 population. At the local level, Cirebon Regency remains a high-endemic area, ranking fourth in West Java in 2023, with 187 newly detected cases, predominantly multibacillary, and showing a persistent upward trend in recent years (Badan Pusat Statistik, 2022).

How does leprosy transmit from one person to another? There are many factors contributing to the transmission of leprosy. Contact intensity, duration of exposure, and environmental conditions such as household crowding, ventilation, and sanitation have been identified as significant contributors to transmission risk. Besides, poor personal hygiene and high residential density are strongly associated with increased leprosy risk, reflecting the interaction between host behavior and the physical environment in disease spread (Pertiwi & Syahrul, 2024)

Environment has been acknowledged as a determinant of leprosy cases, for examples, stigma and health-seeking behavior (e.g., Sierra Leone qualitative research), and ventilation and house structure (e.g., Indonesia and coastal community reviews) (Asboeck et al., 2025). These findings suggest that the contribution of environmental and behavioral factors of leprosy cases may vary across settings, and evidence is particularly limited for localized Indonesian contexts such as Cirebon Regency.

Therefore, this study addresses an important research gap by examining the combined effects of household physical environmental factors and personal hygiene on leprosy incidence in Cirebon Regency. By integrating multiple environmental and behavioral variables within a high-endemic local context, this study aims to clarify inconsistencies in previous findings and provide context-specific evidence to support targeted leprosy prevention and control strategies. Specifically, this study analyzes whether household ventilation, housing density, window availability, wall and floor conditions, room separation, and personal hygiene behaviors are significantly associated with leprosy incidence in an endemic setting.

METHODS

This is an observational analytical study with a case-control design. The participants are limited to registered leprosy patients from June 2024 to June 2025, diagnosed by medical personnel, with an unchanged home condition for ≥2 years, and willing to be a respondent. Control is a community member without leprosy based on a health worker's examination, living approximately 2 alleys away from the case's house, of the same age, and willing to be a respondent. This study was conducted in Cirebon Regency from July to September 2025, involving 154 respondents, consisting of 77 confirmed leprosy patients and 77 healthy individuals as controls, randomly selected by drawing lots in Cirebon Regency.

This study used questionnaires as its research instruments. The dependent variable is the occurrence of leprosy. Meanwhile, the independent variables include house physical factors and personal hygiene. House physical factors consist of lighting level, occupancy density, presence of windows, ventilation area, type of flooring, room partitioning, and type of walls. As for personal hygiene variables, they include knowledge, attitude, habits of sharing towels, frequency of bathing, and nail-cutting habits. This limitation has been made in accordance with the aims of this study.

Data processing was carried out through cross-tabulation and then presented in the form of tables and narrative explanations. Statistical analysis was conducted using the Chi-Square test with a significance threshold (p-value) of < 0.05. Data analysis using the chi-square test with stages, namely univariate, bivariate, and multivariate. The same test was also used to calculate the Odds Ratio (OR) to assess the strength of the relationship between the independent and dependent variables. An OR is considered significant if the 95% confidence interval (CI) from the lower to the upper limit does not cross the value of 1. An ethical approval from the Ethics Committee of the Faculty of Public Health, Diponegoro University, with number 344/EA/KEPK-FKM/2025 is obtained in accordance with the seven WHO 2011 Standards, namely social values, scientific values, equitable assessment and benefits, riks, persuasion/exploitation, confidentiality and privacy, informed concent.

RESULTS

Table 1 Assessment of the association between household environmental physical factors and leprosy incidence in Cirebon Regency in 2024

Physical Factors	Leprosy Cases				p value	OR	95% CI
	Case		Control				
	f	%	f	%			
Ventilation area							
Not Qualified (<10 %)	45	58,4	16	20,8	<0,001	5,361	2,628-10,938
Qualified (≥10%)	32	41,6	61	79,2			

	f	%	f	%	p value	OR	95% CI
The Presence of a Window							
Poor (any, not open)	49	63,6	25	32,5	<0,001	3,640	1,871 - 7,083
Good (any, open)	28	36,4	52	67,5			
Type of Floor							
Not Qualified (Cracked land and plaster)	34	44,2	26	33,8	0,247	1,551	0,808 - 2,978
Qualified (cement/tiles/ceramics)	43	55,8	51	66,2			
Room Separation							
Poor (not separate from leprosy patients)	51	66,2	18	23,4	<0,001	6,429	3,167 - 13,054
Good (separate from leprosy patients)	26	33,8	59	76,6			
Occupancy Density							
Poor (<9m²/people)	40	51,9	24	31,2	0,014	2,387	1,237 - 4,608
Good ((≥ 9 m²/people)	37	48,1	53	68,8			
Type of wall							
Poor	35	45,5	27	35,1	0,250	1,543	0,807 - 2,951
Good	42	54,5	50	64,9			

Ventilation size was classified as inadequate (<10% of floor area or no ventilation) and adequate (≥10% of floor area). The analysis demonstrated a significant association between ventilation size and leprosy incidence (p < 0.05). It means houses with inadequate ventilation showed a substantially higher risk of leprosy compared to houses with adequate ventilation, indicating ventilation as an important environmental risk factor in Cirebon Regency.

Occupancy density was categorized as inadequate (<9 m² per person) and adequate (≥9 m² per person). A statistically significant relationship was observed between occupancy density and leprosy incidence (p < 0.05). Households with inadequate living space per person were more likely to experience leprosy cases than those meeting the recommended standard.

Floor type was classified into non-waterproof and waterproof categories. Statistical analysis showed no significant association between floor type and leprosy incidence (p > 0.05). This finding suggests that floor material alone may not contribute to leprosy transmission. Wall type was categorized as non-permanent/semi-permanent and permanent waterproof walls. The results indicated no significant relationship between wall type and leprosy incidence (p > 0.05). This suggests that wall construction material was not a determining factor for leprosy occurrence.

Table 2. Analysis Of Behavior Regarding Leprosy Incidence In Cirebon Regency In 2024

Behavioral Factors	Leprosy Cases				p value	OR	95% CI
	Case		Control				
	f	%	f	%			
Level of knowledge							
Poor (score<10)	57	74,0	22	28,6	<0,001	7,125	3,053-14,490
Good (score ≥10)	20	26,0	55	71,4			

Attitude							
Poor (score < median)	52	67,5	18	23,4	<0,001	6,818	3,347-13,886
Good (score ≥ median)	25	32,5	59	76,6			
Bathing frequency							
Not Qualified (< 2 times a day)	27	35,1	20	26,0	0,297	1,539	0,771 – 3,074
Qualified (≥ 2 times a day)	50	64,9	57	74,0			
Towel Use							
Not Qualified	52	67,5	22	28,6	<0,001	5,200	2,616 -10,336
Qualified	25	32,5	55	71,4			
Frequency of cutting nails	48	62,3	25	32,5	<0,001	3,443	1,773 – 6,683
Not Qualified	29	37,7	52	67,5			
Qualified							

Among personal hygiene and behavioral factors, shared towel use, nail-cutting frequency, knowledge level, and attitude showed significant associations with leprosy incidence in Cirebon Regency (p < 0.05). Individuals who shared towels, cut their nails less frequently, had poor knowledge, and held negative attitudes toward leprosy were more likely to be associated with leprosy cases, indicating that inadequate hygiene practices and low awareness play an important role in disease occurrence. In contrast, bathing frequency, such as bathing twice or more per day using soap, was not significantly associated with leprosy incidence (p > 0.05). These findings suggest that while general bathing habits alone may not be sufficient to reduce leprosy risk, specific hygiene behaviors and psychosocial factors are more strongly related to leprosy.

Table 3. Analysis Of Multivariat

Variabel	B	p-value	OR	95% CI
Room Separation	2,032	0,000	7,631	2,611 – 22,302
Ventilation Area	1,213	0,023	3,363	1,181 – 9,577
Knowledge	1,496	0,003	4,464	1,647 – 12,099
Respondent's Attitude	1,883	0,000	6,,572	2,314 – 18,666
Towel Usage	1,883	0,000	6,572	2,307 – 18,753
Nail Cutting Frequency	1,762	0,000	5,825	2,048 – 16,567
Constant	-4,700	0,000	0,009	

The results of the multivariate analysis showed that all variables were significantly associated with the occurrence of leprosy (p < 0.05). The absence of room separation was the most dominant factor, with a risk 7.6 times higher. An inadequate ventilation area can increase the risk of leprosy by about 3.4 times. Respondents with low knowledge and negative attitudes had 4.5 times and 6.6 times higher. Sharing towels can also increase the risk by 6.6 times, while rarely cutting nails increased the risk by about 5.8 times. The constant value indicates that, without these risk factors, the likelihood of developing leprosy is relatively low.

DISCUSSION

After analyzing the data, we found that leprosy transmission in Cirebon Regency is caused by physical housing conditions and individual behaviors. In line with the socio-ecological model, environmental exposure at the household level creates structural vulnerability, while personal hygiene practices and knowledge mediate individual susceptibility to infection.

Among environmental determinants, inadequate household ventilation and high residential density emerged as the most influential risk factors, as reflected by their high odds ratios and consistency across studies. Houses with poor ventilation were five times more likely to be associated with leprosy cases (Adellya et al., 2024). Insufficient air exchange may increase indoor humidity and reduce air circulation, creating conditions that support the persistence of Mycobacterium leprae (Dyfe Alisya Putri, Yuri Widia, Medhi Denisa Alinda, 2024). Similar findings have been reported in Indonesia, where permanently closed or poorly functioning ventilation systems were common in households of leprosy patients, resulting in stagnant and contaminated indoor air environments (Maulianti et al., 2021).

Residential overcrowding further amplifies this risk by increasing the frequency and duration of close contact among household members. High occupancy density was significantly associated with leprosy occurrence, with studies reporting substantially higher risks in overcrowded households (Masrizal et al., 2020). Similar associations have been reported in endemic regions such as Brazil and India, where household crowding facilitates prolonged exposure to untreated or subclinical cases (Effendy et al., 2024). These findings indicate that environmental factors primarily influence leprosy transmission by enabling sustained interpersonal contact.

Environmental risks are amplified by behavioral and personal hygiene factors, particularly practices involving direct or indirect skin contact. Strong associations have been observed between leprosy and behaviors such as towel sharing, infrequent nail cutting, low knowledge levels, and unfavorable attitudes, with odds ratios exceeding three in several studies (Umagapi, 2025). Sharing towels, in particular, has been associated with substantially increased risk (OR = 6.7), suggesting that contaminated fomites may play a role in indirect transmission in humid household environments (Evi et al., 2022).

Conversely, several environmental and behavioral variablessuch as floor type, wall material, and bathing frequencywere not significantly associated with leprosy in this setting. This may be explained by contextual factors. Most households in the study area already had plastered brick walls and finished floors that met basic health standards, limiting variability

and reducing their discriminatory power. Additionally, while bathing frequency was self-reported, the quality of bathing practices (e.g., soap use, towel sharing) may be more relevant than frequency alone, potentially explaining discrepancies with other studies (Romdhani & Sulistyorini, 2020). Differences across studies may also reflect ecological variation, behavioral norms, or pathogen–environment interactions, as environmental contamination with M. leprae RNA has been detected in soil and water in some endemic areas but not uniformly across settings (Wahyuni et al., 2024).

From a public health perspective, these findings support integrated intervention strategies that simultaneously address housing conditions and behavioral change. Improvements in ventilation, reduction of household crowding, and housing renovation programs should be complemented by hygiene promotion, health education, and stigma-sensitive communication to enhance knowledge and attitudes toward leprosy prevention (Fastenau et al., 2024). Such integrated approaches align with global leprosy control strategies that emphasize environmental improvement alongside early detection and treatment (Masala et al., 2025).

After carrying out this study, we realize that there are still limitations. Behavioral variables were self-reported, which may introduce recall and social desirability bias. Our study design also did not include multivariable analysis, limiting the ability to control for potential confounders such as socioeconomic status, nutritional factors, or vaccination history. Consequently, unmeasured confounding may have influenced the observed associations. These limitations suggest that the results should be interpreted cautiously and highlight the need for future studies using longitudinal designs and multivariate modeling to better clarify causal pathways.

CONCLUSIONS

This study aims to analyze whether household ventilation, housing density, window availability, wall and floor conditions, room separation, and personal hygiene behaviors are significantly associated with leprosy incidence in an endemic setting. After analyzing the data, we found that physical housing environment factors, such as ventilation size, window availability, bedroom separation, and residential densityare significant factors of leprosy cases in Cirebon Regency. Households with inadequate ventilation, absence of functional windows, high occupancy density, and lack of bedroom separation between leprosy patients and healthy family members showed higher odds of leprosy. These findings are derived from bivariate

statistical analysis using odds ratios, and therefore should be interpreted as associations rather than predicted probabilities or model-based risk estimations.

In addition, besides environmental conditions, personal hygiene and behavioral factors also play an important role in leprosy occurrence. Lower levels of knowledge, unfavorable attitudes toward leprosy, shared towel use, and infrequent nail trimming were associated with increased odds of disease. These results suggest that behavioral practices and psychosocial factors may influence both exposure and transmission risk within households. From a public health perspective, leprosy prevention efforts should integrate housing improvement programs with targeted health education. Actionable strategies for the Indonesian health system include incorporating housing and hygiene assessments into routine Puskesmas activities, strengthening community-based leprosy education to improve knowledge and attitudes, promoting exclusive personal hygiene practices, and aligning these interventions with national leprosy elimination programs and WHO global strategies to interrupt transmission in endemic areas.

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