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The Relationship of Physical House Conditions and Individual Characteristics on Leprosy Incidence in Singgahan Primary Health Care Area: A Case-Control

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ABSTRACT Leprosy remains a significant public health challenge in Indonesia, particularly in rural areas like Singgahan, Tuban District, where the Case Detection Rate (CDR) reached 6.87 per 100,000 population in 2023 exceeding the national target of <5 per 100,000. Environmental conditions and individual characteristics are believed to influence the persistence of leprosy. This study aims to analyze the relationship between the physical conditions of housing and individual characteristics with the incidence of leprosy in the Singgahan Primary Health Care area. A case-control study design was applied involving 30 respondents (15 cases and 15 controls). Data collection included questionnaires and direct observations on variables such as temperature, humidity, lighting, ventilation, occupancy density, age, gender, occupation, education, knowledge, and contact history. Chi-square statistical tests were used to analyze the relationships. The results showed that household factors significantly associated with leprosy incidence were humidity ($p = 0.014$), ventilation area ($p = 0.014$), and occupancy density ($p = 0.009$), while temperature ($p = 0.130$) and lighting ($p = 0.264$) were not significant. Individual characteristics significantly associated with leprosy were gender ($p = 0.023$), occupation ($p = 0.001$), education level ($p = 0.003$), knowledge ($p = 0.027$), and contact history ($p = 0.000$); age showed no significant relationship ($p = 0.598$). These findings highlight the need for integrated interventions targeting housing improvements and health education to reduce transmission risks. Future efforts should focus on raising awareness, reducing stigma, and encouraging behavioral changes, particularly in high-risk occupational and low-education groups.

INDEX TERMS Household Physical Conditions, Leprosy Incidence, Individual Characteristics, Case-Control, Environmental Health

I. INTRODUCTION

Leprosy is a chronic infectious disease caused by *Mycobacterium leprae*, which primarily affects the skin and peripheral nerves. The bacterium thrives in warm, humid environments and can be transmitted through prolonged close contact via respiratory droplets or skin lesions [1], [2]. Despite global efforts, Indonesia continues to rank among the top three countries with the highest leprosy burden, following India and Brazil. In 2022, Indonesia reported 12,441 new leprosy cases, with East Java contributing 2,244 cases and a prevalence rate of 0.55 per 10,000 population [3], [4]. Tuban District, particularly the Singgahan Primary Health Care area, has consistently reported higher-than-targeted prevalence and CDR values. In 2023, the CDR was 6.87 per 100,000, exceeding the national threshold of 5 per 100,000 [5]. This ongoing trend indicates the need for urgent public health interventions. Prior studies have emphasized that the incidence of leprosy is influenced by both environmental and host-related factors [6]–[8].

From an environmental standpoint, housing conditions play a pivotal role. Unqualified ventilation, inadequate lighting, high humidity, and overcrowding may support the survival and transmission of *M. leprae* [9]–[12]. Fitriya et al. [13] showed that homes with poor structural conditions had up to 15.67 times greater risk for leprosy transmission. In parallel, individual characteristics such as age, gender, occupation, education level, knowledge, and contact history significantly impact disease susceptibility. Men, those with physically demanding jobs, and individuals with limited education are disproportionately affected [14]–[17]. Existing state-of-the-art approaches to leprosy control emphasize passive case detection, household contact tracing, and Bacillus Calmette–Guérin (BCG) vaccination. However, these strategies have been insufficient in many endemic regions due to social stigma, poor health literacy, and inadequate environmental conditions [18]–[20].

The research gap lies in the limited case-control studies that simultaneously examine physical house conditions alongside individual risk factors in high-burden settings. Most previous studies focus on one factor or are descriptive in nature, lacking robust epidemiological comparisons. Therefore, this study aims to analyze the relationship between household physical conditions and individual characteristics with leprosy incidence in the Singgahan Health Center area of Tuban District in 2024. This study offers three major contributions:

1. Provides a comprehensive evaluation of environmental and host-related determinants of leprosy using a case-control design.
2. Identifies statistically significant risk factors to inform targeted interventions.

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3. Supports health policymakers in developing integrated control strategies emphasizing both housing improvements and personal behavior change.

II. METHODS

This study employed an analytical observational research design with a retrospective case-control approach. The objective was to evaluate the association between physical housing conditions and individual characteristics with the incidence of leprosy in the Singgahan Primary Health Care area, Tuban District, East Java. A case-control study was chosen to facilitate comparison between individuals with the disease (cases) and those without (controls), allowing for identification of potential risk factors by tracing past exposures [26].

A. STUDY POPULATION AND SAMPLING TECHNIQUE

The study population included residents within the working area of Singgahan Health Center in 2024. The case group consisted of 15 individuals diagnosed with leprosy, obtained from secondary records at the health center. The control group also included 15 individuals who lived in proximity to the case respondents but had no history of leprosy. Both groups were matched based on residential location to ensure environmental exposure comparability. A total sampling technique was applied due to the limited number of leprosy cases in the area, which was fewer than 100. Thus, all eligible individuals meeting the inclusion criteria were selected, resulting in 30 total respondents with a 1:1 case-to-control ratio.

B. INCLUSION AND EXCLUSION CRITERIA

The inclusion criteria for both groups in this study were carefully established to ensure the selection of appropriate and representative participants. Eligible individuals were required to be residents aged 15 years or older, demonstrate a willingness to participate by providing informed consent, and have lived in the study area for at least the past two years to ensure familiarity with the local environment and consistent exposure to relevant conditions. Conversely, exclusion criteria were applied to individuals with incomplete data or those who declined to participate after being informed about the study. Additionally, residents who had recently moved into the area or were living there temporarily were excluded to maintain consistency in exposure and minimize variability that could affect the validity of the findings.

C. DATA COLLECTION TOOLS AND VARIABLES

The dependent variable was the incidence of leprosy, categorized as present or absent.Temperature and humidity were measured using thermohygrometers, and lighting was measured using a lux meter. Ventilation adequacy was assessed by calculating the ratio of ventilation area to floor area, and residential density was determined by dividing the number of occupants by room size. All environmental parameters were evaluated against national health standards set by the Indonesian Ministry of Health [27]. Data collection was conducted using a structured questionnaire and direct observation checklist. The questionnaire was used to gather demographic and personal information, while physical house condition data were recorded using a standardized measurement sheet. The independent variables in this study were:

1. Physical housing conditions, including: Temperature, Humidity, Lighting, Ventilation area, Residential density
2. Individual characteristics, including: Age, Gender, Type of occupation, Education level, Knowledge about leprosy, History of contact with leprosy patients

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D. DATA COLLECTION AND PROCEDURE

Data were collected during home visits from May to June 2024. Observations of physical house conditions were recorded on-site by trained data collectors. Respondents were then interviewed to complete the structured questionnaire. The knowledge variable was assessed through a series of 10 multiple-choice questions related to leprosy symptoms, transmission, prevention, and treatment. Scores were classified into “good” or “poor” based on a 60% cut-off point, consistent with similar studies [28].

Ethical approval for this research was granted by the Ethics Committee of the Surabaya Health Polytechnic under approval number EA/2791/KEPK-Poltekkes_Sby/V/2024. Informed consent was obtained from all participants, and confidentiality was strictly maintained throughout the study.

E. DATA ANALYSIS

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25. Univariate analysis was conducted to describe the distribution of each variable. Bivariate analysis was performed using the Chi-square test to determine the association between independent variables and the incidence of leprosy. A p-value of <0.05 was considered statistically significant. Odds ratios (OR) with 95% confidence intervals (CI) were calculated to measure the strength of associations between exposure variables and leprosy incidence. This approach allowed for the identification of multiple significant risk factors while accounting for possible confounding. The results of the bivariate analysis were summarized in contingency tables for both physical housing conditions and individual characteristics.

III. RESULTS

The distribution of respondents in this study includes 30 individuals, with an equal split between the case and control groups, resulting in 50% cases (15 respondents) and 50% controls (15 respondents). The bivariate analysis of the data from TABLE 1 revealed that the physical housing conditions had an odds ratio (OR) of 4.571 with a p-value of 0.130. The OR of 4.571 meant that respondents who lived in houses with temperatures that met the standards had a 4.571 times lower risk of contracting leprosy than those who lived in houses with temperatures that did not meet the standards. The p-value indicated that p-value > α (α = 0.05), indicating that there was no significant relationship between temperature and the incidence of leprosy in the area covered by Singgahan Health Center, Tuban Regency, in 2024.

The bivariate analysis results, based on TABLE 1 data, showed that physical housing conditions had an odds ratio (OR) of 16.0 and a p-value of 0.014, indicating that there was a significant relationship between humidity and the incidence of leprosy (p-value < α). This means that the risk of leprosy was 16.0 times lower for respondents who lived in houses with acceptable humidity levels than for those who lived in houses with unqualified humidity levels.

Based on the data from TABLE 1, the results of the bivariate analysis showed that physical housing conditions had a p-value of 0.264 with an odds ratio (OR) of 3.143. The p-value indicated that p-value > α, meaning there was no significant relationship between lighting and the incidence of

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leprosy. The OR value of 3.143 indicates that respondents living in houses with qualified lighting have a 3.143 times lower risk of developing leprosy compared to respondents living in houses with unqualified lighting.

The bivariate analysis's results, based on TABLE 1's data, indicated that ventilation area had an odds ratio (OR) of 16.0 and a p-value of 0.014. There was a substantial correlation between the incidence of leprosy and the ventilation area, as evidenced by the p-value of less than α. According to the OR of 16.0, respondents who lived in homes with qualified ventilation were 16.0 times less likely to contract leprosy than those who lived in homes without adequate ventilation.

The bivariate analysis's results, based on TABLE 1 data, indicated that physical housing conditions had an odds ratio (OR) of 13.0 and a p-value of 0.009. There was a substantial correlation between the incidence of leprosy and occupancy density, as demonstrated by the p-value of less than α. The OR of 13.0 meant that respondents who lived in homes with acceptable occupancy densities were 13.0 times less likely to contract leprosy than those who lived in homes with inadequate occupancy densities.

Based on the data from TABLE 1, the results of the bivariate analysis showed that physical housing conditions had a p-value of 0.023 with an odds ratio (OR) of 9.750. The p-value indicated that p-value < 0.05, meaning there was a significant relationship between physical housing conditions and the incidence of leprosy. The OR of 9.750 indicated that respondents living in houses with acceptable physical conditions had a risk of leprosy that was 9.750 times lower compared to respondents living in houses with unqualified physical conditions.

TABLE 1
Results of Physical Housing of Leprosy in the Singgahan Health Center, Tuban Regency, East Java, 2024

Variable	Leprosy Incident				*p-value*	OR (95% CI)
	Control		Case			
	N	%	N	%		
Temperature						
Temperature 18^{0}C-30^{0}C	8	53,3	3	20	0,130	4.571 (0.903-23.137)
Temperature > 30^{0}C	7	46,7	12	80		
Humidity						
Humidity ≤60%	14	93.3	7	46.7	0.014	16.0 (1.656-154.595)
Humidity >60%	1	6.7	8	53.3		
Lighting						
Lighting >60 lux	11	73.3	7	46.7	0.264	3.143 (0.681-14.503)
Lighting ≤60 lux	4	26.7	8	53.3		
Ventilation Area						
Eligible	14	93.3	7	46.7	0.014	16.0 (1.656-154.595)
Not Eligible	1	6.7	8	53.3		
Residential Density						
Eligible	13	86.7	5	33.3	0.009	13.0 (2.074-81.479)
Not Eligible	2	13.3	10	66.7		
Physical Condition of House						
Eligible	13	86.7	6	40	0.023	9.750 (1.592-59.695)
Not Eligible	2	13.3	9	60		
Total	**15**	**100**	**15**	**100**		

The bivariate analysis utilizing the chi-square test revealed a p-value of 0.598 with an odds ratio (OR) of 3.50 based on the data from TABLE 2. In the Tuban Regency, where Singgahan Health Center is located, there was no significant correlation found between age and leprosy incidence in 2024, as evidenced by the p-value of > α. The odds ratio (OR) of 3.50 signified that the risk of leprosy was 3.50 times lower in respondents under the age of 15 than in those over the age of 15.

Based on TABLE 2, the results of the bivariate analysis using the chi-square test showed a p-value of 0.023 with an odds ratio (OR) of 0.103. The p-value indicated that p-value < α, meaning there was a significant relationship between gender and the incidence of leprosy. The OR of 0.103 (OR < 1) suggested that gender is not a risk factor for the occurrence of leprosy.

Based on TABLE 2, The bivariate analysis with the chi-square test yielded an odds ratio (OR) of 26.0 and a p-value of 0.001. There was a substantial correlation between the incidence of leprosy and occupation, as evidenced by the p-value of less than α. The odds ratio (OR) of 26.0 indicated that the probability of contracting leprosy was 26.0 times lower for respondents in occupations not at risk for the disease than for those in occupations where leprosy is a possibility.

Based on TABLE 2, the results of the bivariate analysis using the chi-square test showed a p-value of 0.003 with an odds ratio (OR) of 17.0. The p-value indicated that p-value < α, meaning there was a significant relationship between education level and the incidence of leprosy. The OR of 17.0 suggested that respondents with secondary education had a risk of leprosy that was 17.0 times lower compared to respondents with basic education.

TABLE 2
Results of Individual Characteristics and the Incidence of Leprosy

Variable	Leprosy Incident				*p-value*	OR (95% CI LO-LU)
	Control		Case			
	N	%	N	%		
Age						
< 15 tahun	3	20	1	6.7	0.598	3.50 (0.320-38.232)
≥ 15 tahun	12	80	14	93.3		
Gender						
Man	2	13.3	9	60	0.023	0.103 (0.017-0.628)
Woman	13	86.7	6	40		
Type of Work						
Not Risk Work	12	80	2	13.3	0.001	26.0 (3.686-183.418)
Risky Work	3	20	13	86.7		
Level of Education						
Secondary Education	13	86.7	4	26.7	0.003	17.0 (2.734-116.877)
Basic Education	2	23.3	11	73.3		
Level of Knowledge						
Good	12	80	5	33.3	0.027	8.00 (1.522-42.042)
Not Good	3	20	10	66.7		
Contact History						
Not Contact	13	86.7	1	6.7	0.00	91.0 (7.349-1126.895)
Contact	2	13,3	14	93,3		

Based on TABLE 2, the results of the bivariate analysis using the chi-square test showed a p-value of 0.027 with an odds ratio (OR) of 8.00. The p-value indicated that p-value < α, meaning there was a significant relationship between knowledge level and the incidence of leprosy. The OR of 8.00 suggested that respondents with good knowledge had a risk of leprosy that was 8.00 times lower compared to respondents with poor knowledge. Based on Table 2, the results of the bivariate analysis using the chi-square test showed a p-value of 0.00 with an odds ratio (OR) of 91.0. The p-value indicated that p-value < α, meaning there was a significant relationship between contact history and the incidence of leprosy. The OR of 91.0 suggested that respondents who had never had contact with leprosy patients had a risk of leprosy that was 91.0 times lower compared to respondents had contact with leprosy patients.

IV. DISCUSSION

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A. RELANTIONSHIP BETWEEN PHYSICAL HOUSING CODITIONS AND LEPROSY INCIDENCE

The results of this study revealed a significant association between several physical housing conditions and the incidence of leprosy. Specifically, variables such as humidity ($p = 0.014$), ventilation area ($p = 0.014$), and residential density ($p = 0.009$) demonstrated statistically significant relationships with the presence of leprosy. These findings align with Fitriya et al. [33], who reported that inadequate physical housing conditions increase the risk of leprosy by up to 15.67 times. Furthermore, Lathifah and Adriyani [34] highlighted that substandard-homes may serve as reservoirs for *M. leprae*, particularly when coupled with poor air quality and lack of sunlight exposure. While temperature ($p = 0.130$) and lighting ($p = 0.264$) did not show statistically significant relationships in this study, Amsikan et al. [35] previously suggested that elevated temperatures and low light exposure could create environments conducive to bacterial survival. These conflicting findings may be attributed to regional differences in architectural design and ventilation strategies. Government regulations, such as Indonesia's Ministry of Health Regulation No. 2 of 2023, recommend optimal indoor air temperatures of 18°C to 30°C to support occupant health [36]. Ventilation was found to be critical in mitigating airborne transmission. Inadequate ventilation reduces air exchange, thereby increasing moisture and bacterial concentration, as also confirmed by Cendaki [37], who identified the presence of *M. leprae* DNA in poorly ventilated air samples. Furthermore, high occupancy density increases interpersonal contact, which facilitates transmission. This observation supports findings by Fadlila et al. [38], who linked overcrowded housing with greater disease spread due to poor hygiene and limited air movement.

B. RELANTIONSHIP BETWEEN INDIVIDUAL CHARACTERISTICS AND LEPROSY INCIDENCE

In terms of individual characteristics, this study found significant associations between gender ($p = 0.023$), occupation ($p = 0.001$), education level ($p = 0.003$), knowledge level ($p = 0.027$), and contact history ($p = 0.000$) with leprosy incidence. Gender differences may be explained by behavioral factors; men are more likely to engage in outdoor and labor-intensive activities, exposing them to unsanitary environments, as reported by Porong et al. [39] and Lima et al. [40]. A strong association was observed between occupation type and leprosy, where respondents in high-risk jobs were significantly more likely to contract the disease. These findings are consistent with Salju et al. [41], who reported that labor-intensive work may impair immunity due to fatigue and increased pathogen exposure. Similarly, education level was a key determinant of disease risk. Individuals with lower educational attainment had reduced understanding of transmission pathways and prevention strategies, as noted in previous studies by Hidayatun et al. [42] and Ni'mah et al. [43]. Knowledge was also identified as a protective factor. Respondents with higher levels of leprosy-related knowledge demonstrated significantly lower incidence rates, underscoring the importance of targeted health education programs. Lastly, contact history emerged as the most influential variable, with a p-value of 0.000 and OR of 91.0, consistent with Wahyuni et al. [44], who emphasized the critical role of prolonged exposure in household settings.

C. STUDY LIMITATIONS AND IMPLICATIONS

Despite the strength of these findings, this study was limited by its relatively small sample size (n=30), which restricts generalizability. Future research should involve larger, more diverse populations to increase external validity. Additionally, variables such as immune status, nutritional factors, behavioral practices, and healthcare accessibility were not explored. These findings have several practical implications. First, health authorities should enhance environmental interventions by promoting better housing design, adequate ventilation, and reduced crowding. Second, educational campaigns targeting low-literacy populations can improve disease knowledge and reduce stigma. Third, routine screening for households with leprosy history is essential for early detection. Future longitudinal studies are recommended to establish causal relationships and evaluate the effectiveness of integrated control strategies.

V. CONCLUSION

This study aimed to investigate the association between physical housing conditions and individual characteristics with the incidence of leprosy in the Singgahan Primary Health Care area. The results showed that environmental factors such as humidity ($p = 0.014$), ventilation area ($p = 0.014$), and occupancy density ($p = 0.009$) significantly influenced leprosy transmission. Among individual characteristics, gender ($p = 0.023$), occupation ($p = 0.001$), education level ($p = 0.003$), knowledge ($p = 0.027$), and contact history ($p = 0.000$) were also significantly associated with leprosy incidence. Conversely, temperature, lighting, and age did not demonstrate statistically significant associations. These findings underscore the importance of integrated prevention strategies that address both environmental modifications and health education. Future research with larger samples and broader variables including immunity, behavior, and healthcare access is recommended to provide a more comprehensive understanding and support more effective interventions.

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DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTION

Dhea Vara Adellya designed the research and led data collection. Narwati contributed to methodology and supervised the study. Sri Angraeni performed data analysis and interpretation. Imam Thohari supported manuscript writing and critical review. All authors reviewed and approved the final manuscript.

DECLARATIONS

ETHICAL APPROVAL

This study was approved by the Health Research Ethics Committee of Surabaya Health Polytechnic (Approval No. EA/2791/KEPK-Poltekkes_Sby/V/2024).

CONSENT FOR PUBLICATION PARTICIPANTS.

Consent for publication was given by all participants

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COMPETING INTERESTS

The authors declare no competing interests.

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