



Risk Factors Associated with Leprosy at Mataram University Hospital, West Nusa Tenggara, Indonesia

Alfira Safitri^{1*}, Metta Octora², Yunita Hapsari³, Raehanul Bahraen⁴

¹ Medical Study Program, Faculty of Medicine and Health Sciences, University of Mataram

² Master's Program in Public Health, Faculty of Medicine and Health Sciences, University of Mataram

³ Department of Dermatology, Venereology, and Aesthetic Medicine, Faculty of Medicine and Health Sciences, University of Mataram

⁴ Department of Clinical Pathology, Faculty of Medicine and Health Sciences, University of Mataram

DOI: <https://doi.org/10.29303/nsf0qs47>

Article Info

Received : 20 April 2026

Revised : 22 August 2026

Accepted : 28 September 2026

Abstract: Background: Although West Nusa Tenggara (NTB) has achieved the leprosy elimination target of less than 1 case per 10,000 population, the rate of grade 2 disability remains relatively high at 3.0 per 1,000,000 population, exceeding the national target of less than 1 per 1,000,000 population. This highlights the importance of identifying locally relevant risk factors for leprosy. **Objective:** To identify risk factors associated with leprosy among patients receiving healthcare services at Mataram University Hospital, West Nusa Tenggara, Indonesia. **Methods:** This analytical observational study used an unmatched case-control design. Cases were patients with clinically or laboratory-confirmed leprosy identified from medical records at Mataram University Hospital between August and December 2025. Due to the limited number of eligible cases, total sampling was used, resulting in 26 cases. Sixty controls were recruited from patients receiving healthcare services at Mataram University Hospital who met the eligibility criteria and came from the same geographical area as the cases. Exposure data were collected through face-to-face interviews using a structured questionnaire. Data were analyzed using Chi-square or Fisher's Exact Test, as appropriate, with odds ratios (ORs) and 95% confidence intervals (CIs). **Results:** Bivariate analysis showed significant associations between leprosy and sex, healthy housing status, personal hygiene, history of contact with leprosy patients, and BCG vaccination history. Age was not significantly associated with leprosy. **Conclusion:** Several demographic, environmental, behavioral, and contact-related factors were associated with leprosy. These findings support the importance of strengthening locally relevant prevention and early detection strategies.

Keywords: leprosy, risk factors, case-control, history of contact with patients, and personal hygiene.

Citation: Safitri, A., Octora, M., Hapsari, Y., Bahraen, R. (2026). Risk Factors Associated with Leprosy at Mataram University Hospital, West Nusa Tenggara, Indonesia. *Lombok Medical Journal*, 5(3), 219-225. <https://doi.org/10.29303/nsf0qs47>

Introduction

Leprosy (Hansen's disease) is a chronic infectious disease caused by *Mycobacterium leprae* (*M. leprae*), an obligate intracellular, acid-fast, Gram-positive bacillus (Chen et al., 2022). The disease primarily affects the skin,

peripheral nerves, upper respiratory tract mucosa, and eyes, with clinical manifestations ranging from localized hypopigmented skin lesions accompanied by sensory loss to diffuse skin involvement with peripheral neuropathy (Chen et al., 2022). Delayed diagnosis and

Email: alfirasafitri31@gmail.com (*Corresponding author)

treatment may result in irreversible nerve damage, permanent physical disability, deformity, visual impairment, and social stigma, making leprosy a persistent public health concern despite the availability of effective multidrug therapy (MDT) (Chen et al., 2022; World Health Organization, 2023).

According to the World Health Organization (2023), Indonesia ranks third worldwide in the number of leprosy cases after India and Brazil, with a prevalence of 0.63 per 10,000 population and a new case detection rate of 5.2 per 100,000 population. This represents an increase compared with the previous year's incidence of 4.5 per 100,000 population (Kemenkes, 2023). Although Indonesia has achieved the World Health Organization's elimination target at the national level, defined as a prevalence of less than one case per 10,000 population, leprosy remains unevenly distributed across the country. Eleven of the 38 provinces have not yet achieved elimination status, indicating that transmission continues in several endemic areas (Kemenkes, 2023).

West Nusa Tenggara (NTB) Province has officially achieved elimination with a prevalence of 0.55 per 10,000 population. Nevertheless, NTB still ranks nineteenth nationally in the number of reported leprosy cases (Kemenkes, 2023). More importantly, the province reports a grade 2 disability rate of 3.0 per 1,000,000 population, which exceeds the national target of less than 1 per 1,000,000 population. This high disability rate suggests delayed diagnosis and treatment, reflecting ongoing transmission and inadequate early case detection. Within NTB, Mataram City has demonstrated an increasing trend in leprosy incidence, rising from 1.90 per 100,000 population in 2022 to 2.79 per 100,000 population in 2023 (BPS, 2023). These epidemiological findings highlight the need to identify locally relevant factors associated with leprosy occurrence.

Leprosy is a multifactorial disease resulting from complex interactions among host susceptibility, environmental conditions, and behavioral factors. Previous studies have identified older age and male sex as demographic factors associated with an increased risk of leprosy (Gao et al., 2021). Prolonged close contact with untreated patients remains the principal route of transmission, particularly among household contacts and individuals living in overcrowded settings (Ploemacher et al., 2020). Environmental factors, including poor ventilation, inadequate lighting, overcrowding, high humidity, poor sanitation, and unhealthy housing conditions, have also been associated with an increased risk of leprosy (Wahyuni et al., 2021; Rini et al., 2023). Furthermore, previous studies have shown that BCG vaccination provides partial protection against leprosy, whereas individuals without BCG vaccination have a higher risk of developing the disease (Susanti et al., 2016; Pertiwi et al., 2024). Personal

hygiene is another modifiable risk factor, and poor hygiene practices have consistently been associated with an increased likelihood of leprosy (Bestari et al., 2023; Novita et al., 2023).

Previous studies have identified several risk factors associated with leprosy. However, evidence regarding these risk factors in West Nusa Tenggara remains limited, particularly among patients treated at referral hospitals that receive cases from multiple districts. Identifying locally relevant risk factors is therefore essential to support evidence-based prevention strategies, improve early case detection, and reduce disability among affected communities.

This study was conducted at Mataram University Hospital, a referral hospital that receives leprosy patients from various districts across West Nusa Tenggara, particularly West Lombok, where leprosy remains endemic. The hospital therefore provides a representative population for evaluating factors associated with leprosy in the province. Therefore, this study aimed to identify risk factors associated with leprosy among patients at Mataram University Hospital, including age, sex, history of close contact, housing conditions, BCG vaccination status, and personal hygiene.

Materials and Methods

This analytical observational study employed an unmatched case-control design and was conducted at Mataram University Hospital, West Nusa Tenggara, Indonesia, between August and December 2025. The minimum sample size was calculated using Dahlan's formula for unmatched categorical studies. Based on the exposure proportions reported in previous studies ($P_1 = 0.161$ and $P_2 = 0.018$), with a 95% confidence level ($Z\alpha = 1.96$) and 80% statistical power ($Z\beta = 0.84$), the minimum required sample size was 62 participants in each group. However, because leprosy is a relatively low-prevalence disease and only a limited number of eligible patients were identified during the study period, all available cases were included using a total sampling approach.

Cases were identified from the medical records of Mataram University Hospital between August and December 2025. Eligible cases were patients with a clinically or laboratory-confirmed diagnosis of leprosy who agreed to participate and were available for interview. Patients with incomplete medical records or those who were unable to communicate were excluded. A total of 26 patients met the eligibility criteria and were included in the study.

To improve statistical precision despite the limited number of cases, controls were recruited using consecutive sampling with an approximate case-to-control ratio of 1:2, as recommended by Steven et al. (2014). A total of 60 controls were selected from

individuals attending Mataram University Hospital and Sesela Public Health Center (Puskesmas Sesela). Controls were recruited from the same geographical area as the cases, had no previous history or clinical evidence of leprosy, and had a comparable age and sex distribution. The final analytical sample comprised 86 participants, including 26 cases and 60 controls, resulting in a case-to-control ratio of approximately 1:2.3.

Primary data were collected through face-to-face interviews using a structured questionnaire administered by trained researchers. The diagnosis of leprosy among cases was confirmed using hospital medical records. The dependent variable was leprosy occurrence, while the independent variables included age, sex, healthy housing status, personal hygiene, history of contact with patients with leprosy, and BCG vaccination status.

Age was categorized as <15 years and ≥15 years. Sex was classified as male or female. Healthy housing status was assessed using a questionnaire adapted from the Indonesian Ministry of Health Regulation No. 829/Menkes/SK/VII/1999, which evaluates housing structure, ventilation, natural lighting, occupancy density, and basic sanitation. Total scores of <70 were classified as unhealthy housing, whereas scores of ≥70 were classified as healthy housing.

Personal hygiene was assessed using a structured questionnaire that evaluated bathing frequency, handwashing practices, footwear use, and nail and clothing hygiene. Total scores of <70 indicated poor personal hygiene, whereas scores of ≥70 indicated good personal hygiene.

A history of contact with patients with leprosy was defined as living in the same household or having frequent close contact with a confirmed leprosy patient for at least six months before data collection. This variable was categorized as either "yes" or "no".

BCG vaccination status was determined by direct observation of the presence or absence of a BCG scar on the upper arm by trained researchers and was categorized as vaccinated or unvaccinated.

All completed questionnaires were checked for completeness and consistency before data entry. The data were coded and analyzed using IBM SPSS Statistics version 30. Descriptive statistics were used to summarize the characteristics of the study participants. Bivariate analysis was performed to examine the association between each independent variable and leprosy occurrence. Fisher's Exact Test was used when the expected frequency in any contingency table cell was <5; otherwise, the Chi-square test was applied. Odds ratios (ORs) and 95% confidence intervals (95% CIs) were calculated to estimate the strength of the

associations. A two-sided p -value of <0.05 was considered statistically significant.

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universitas Mataram (Approval No. UNRAM2751125). Written informed consent was obtained from all adult participants before data collection. For participants younger than 18 years, written informed consent was obtained from their parents or legal guardians.

Result and Discussion

The results of the univariate analysis for 26 respondents in the case group and 60 respondents in the control group are presented in Table 1.

Table 1. Distribution of Characteristics

Category	Case		Control	
	f	%	f	%
Age				
≤ 15 years	0	0	2	3,3
>15 years	26	100	58	96,7
Sex				
Female	12	46,2	49	81,7
Male	14	53,8	11	18,3
Healthy housing status				
Good	13	50	50	83,3
Poor	13	50	10	16,7
Personal hygiene				
Good	6	23,1	43	71,7
Poor	20	76,9	17	28,3
History of contact with leprosy patients				
No	11	42,3	55	91,7
Yes	15	57,7	5	8,3
History of BCG vaccination				
Yes	10	38,5	40	66,7
No	16	61,5	20	33,3

The majority of leprosy patients were in the age group >15 years, with 26 (100%) individuals, while in the control group, most were also aged >15 years, totaling 58 (96.7%) individuals. In the control group, females predominated with 49 (81.7%) individuals, whereas in the case group, males were more common, with 14 (53.8%) individuals.

In this study, healthy housing status categorized as good and poor had equal proportions. The control group more frequently had good housing status, with 50 (83.3%) individuals. Personal hygiene in the case group was predominantly categorized as poor, with 20 (76.9%) individuals, while in the control group, it was mostly categorized as good, with 43 (71.1%) individuals. A

history of contact with leprosy patients was more commonly found in the case group, with 15 (57.7%) individuals, whereas the majority of the control group had no history of contact, with 55 (91.7%) individuals. Regarding BCG vaccination history, most individuals in the case group had no history of vaccination, totaling 16 (61.5%), while the majority in the control group had received BCG vaccination, with 40 (66.7%) individuals.

Table 2. Bivariate Analysis of Risk Factors for Leprosy Occurrence

Variable	p-value	OR (95% CI)
Age	0,346	-
Sex	<0.001	5,20(1,89-14,28)
Healthy housing status	0,001	5(1,79-13,94)
Personal hygiene	<0.001	8,43(2,89-24,61)
History of contact with leprosy patients	<0.001	15(4,51-49,87)
History of BCG vaccination	0,015	3,2(1,23-8,32)

Bivariate analysis demonstrated significant associations between sex, healthy housing status, personal hygiene, history of contact with leprosy patients, BCG vaccination history, and leprosy occurrence (Table 2). Based on Fisher's Exact Test, male sex, poor personal hygiene, and a history of contact with leprosy patients were significantly associated with leprosy (all $p < 0.001$). Among these variables, a history of contact with leprosy patients showed the highest odds of leprosy (OR = 15.00; 95% CI: 4.51–49.87), followed by poor personal hygiene (OR = 8.43; 95% CI: 2.89–24.61) and male sex (OR = 5.20; 95% CI: 1.89–14.28).

Chi-square analysis further demonstrated significant associations between healthy housing status ($p = 0.001$) and BCG vaccination history ($p = 0.015$) and leprosy occurrence. Participants living in unhealthy housing had higher odds of leprosy than those living in healthy housing (OR = 5.00; 95% CI: 1.79–13.94). Likewise, participants without a history of BCG vaccination had higher odds of leprosy than those who had received BCG vaccination (OR = 3.20; 95% CI: 1.23–8.32). No significant association was observed between age and leprosy occurrence ($p = 0.346$).

Age was not significantly associated with leprosy occurrence in the present study, although most patients were aged >15 years. This finding is consistent with studies by Tutuop et al. (2022) and Zhang et al. (2025), which reported that age is not an independent determinant of leprosy but is more closely related to the duration of exposure, contact patterns, and environmental conditions. The absence of a significant

association may be explained by the relatively homogeneous age distribution among respondents, with nearly all participants belonging to the productive age group. In contrast, male sex was significantly associated with leprosy occurrence, consistent with previous studies by Yang et al. (2022), Sari et al. (2021), and Nugroho et al. (2020). Men generally have greater occupational and social exposure outside the household, increasing the likelihood of contact with infectious sources. In addition, lower health-seeking behavior and poorer personal hygiene practices among men may further contribute to the higher risk of leprosy (Salsabila et al., 2023).

Healthy housing status and personal hygiene were also significantly associated with leprosy occurrence. Similar findings have been reported by Rohmah et al. (2020), Dewi et al. (2022), Wahyuni et al. (2021), and Rini et al. (2023), who demonstrated that poor housing conditions increase the risk of leprosy transmission. Inadequate ventilation, poor natural lighting, overcrowding, and poor sanitation may facilitate prolonged exposure to *Mycobacterium leprae*, particularly among household members living with untreated patients (Ploemacher et al., 2020). Likewise, respondents with poor personal hygiene had a significantly higher risk of leprosy than those with good personal hygiene. This finding is consistent with studies by Dewi et al. (2021), Aisah et al. (2020), Sitorus et al. (2020), Bestari et al. (2023), and Novita et al. (2023). Poor hygiene practices may increase exposure to pathogenic microorganisms and facilitate the transmission of *M. leprae*, particularly in environments with inadequate sanitation.

A history of close contact with leprosy patients was identified as the strongest risk factor in this study, consistent with its high odds ratio. Similar findings have been reported by Bestari et al. (2023) and Karani et al. (2025), who found that household contacts have a substantially higher risk of developing leprosy than individuals without such exposure. Because *M. leprae* is primarily transmitted through respiratory droplets, prolonged and repeated contact with untreated multibacillary patients increases the likelihood of infection, especially in overcrowded households with poor ventilation (Ploemacher et al., 2020). In addition, the absence of BCG vaccination was significantly associated with leprosy occurrence. This finding agrees with previous studies by Susanti et al. (2016), Cuevas et al. (2021), and Pertiwi et al. (2024), which demonstrated that BCG vaccination provides partial protection against leprosy through cross-immunity between *Mycobacterium tuberculosis* and *M. leprae*. These findings highlight the importance of strengthening contact investigation and maintaining high BCG vaccination coverage in endemic areas.

This study has several strengths. It was conducted in a referral hospital that receives leprosy patients from multiple districts across West Nusa Tenggara, providing a representative population for evaluating factors associated with leprosy in the province. Nevertheless, several limitations should be acknowledged. The case-control design cannot establish causal relationships, recall bias may have influenced participants' responses regarding previous exposures, and the study was conducted at a single referral hospital with a relatively small sample size, which may limit the generalizability of the findings.

The findings of this study have important public health implications. Strengthening early case detection, household contact tracing, health education to improve personal hygiene, promotion of healthy housing conditions, and maintaining high BCG vaccination coverage should be prioritized to reduce leprosy transmission and disability in endemic areas. Future multicenter studies with larger sample sizes are recommended to further validate these findings and provide stronger evidence for leprosy control programs in Indonesia.

Conclusion

Based on the results of the study on the analysis of leprosy risk factors at Mataram University Hospital, it can be concluded that male sex, poor healthy housing status, poor personal hygiene, a history of contact with leprosy patients, and the lack of a BCG vaccination history are significant risk factors for the occurrence of leprosy. Conversely, an age of more than 15 years is not a risk factor for the occurrence of leprosy at Mataram University Hospital.

Acknowledgements

The authors would like to express their gratitude to all parties who contributed to the preparation of this scientific paper.

References

- Abubakar, I., Pimpin, L., Ariti, C., et al. (2013). Systematic review and meta-analysis of the current evidence on the duration of protection by bacillus Calmette-Guérin vaccination against tuberculosis. Southampton (UK): NIHR Journals Library; (Health Technology Assessment, No. 17.37.) Chapter 6, Conclusions. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK260961/>
- Aisah, S., Bubakar, A. H. A., & Setiasih, N. (2019). Correlation between personal hygiene and the incidence of leprosy in Central Jakarta area in 2017. *International Journal of Advances in Medicine*, 7(1), 93. <https://doi.org/10.18203/2349-3933.ijam20195652>
- Alrehaili, J. (2023). Leprosy classification, clinical features, epidemiology, and host immunological responses: Failure of eradication in 2023. *Cureus*, 15(9), 1–19. <https://doi.org/10.7759/cureus.44767>
- Arunraghav, P., & Herakal, K. (2021). Leprosy in elderly and children among new cases - A 3-year retrospective study. *Indian Dermatology Online Journal*, 12(2), 294–297. https://doi.org/10.4103/idoj.IDOJ_177_18
- Bestari, R. A. D., Maulana, J., Fitriyani, N. L., & Akbar, H. (2023). Faktor risiko kejadian lepra di Indonesia: Literature review. *Promotif: Jurnal Kesehatan Masyarakat*, 13(2), 57–65. <https://doi.org/10.56338/promotif.v13i2.4492>
- Bangun, R. S., Hutabarat, P. B. A., Napitupulu, D. S., & Simbolon, P. (2023). Analisis morfologi *Mycobacterium leprae* dan pendekatan daya kasih Kristus pada penderita morbus Hansen di Panti Rehabilitasi Lepra Gemakasih Galang Desa Jaharun. *Mahesa: Malahayati Health Student Journal*, 3(5), 1200–1211. <https://doi.org/10.33024/mahesa.v3i5.10269>
- Carvalho, de, J. C., Araújo, M. G., Reis, J. G., Magalhães, V. P., Alvares, C. C., Moreira, M. L., Carvalho, A. T., Filho, O. A. M., & Araújo, M. S. S. (2018). Phenotypic and functional features of innate and adaptive immunity as putative biomarkers for clinical status and leprosy reactions. *Microbial Pathogenesis*, 125, 230–239. <https://doi.org/10.1016/j.micpath.2018.09.011>
- Chelsea, E., Yolanda, S., & Irawan, Y. (2024). Lepra multibasiler dengan reaksi eritema nodosum leprosum: Sebuah kasus terabaikan dari daerah terpencil. *Multibacillary Leprosy with Erythema Nodosum Leprosum: An Abandoned Case from A Remote Area*, 12(3).
- Chen, Lin, C. Y., Su, S. B., & Chen, K. T. (2022). Leprosy: A review of epidemiology, clinical diagnosis, and management. *Journal of Tropical Medicine*, 2022. <https://doi.org/10.1155/2022/8652062>
- Cuevas, N. C., & Cardenas, V. M. (2021). Bacillus of Calmette and Guérin (BCG) and the risk of leprosy in Ciudad del Este, Paraguay, 2016–2017. *Epidemiology and Health*, 43, e2021060. <https://doi.org/10.4178/epih.e2021060>
- Darmawan, H., & Rusmawardiana. (2020). Sumber dan cara penularan *Mycobacterium leprae*. *Tarumanagara Medical Journal*, 2(1), 186–97. <https://doi.org/10.24912/tmj.v2i2.7860>

- Dewi, S., et al. (2022). Kualitas rumah dan risiko transmisi lepra: Studi kasus di wilayah pedesaan. *Media Kesehatan Masyarakat Indonesia*, 8(3), 201-209.
- Gao, Y. S., Liu, J., Li, Q., & Zhang, Z. Q. (2021). Clinical and pathological features of different types of leprosy. *Vojnosanitetski Pregled*, 69(1), 1050-59. <https://doi.org/10.5937/vojtehg69-28844>
- Ghifari, H. A., Haqq, Y. M. B., & Ilma, A. (2025). Effectiveness of Bacillus Calmette-Guérin (BCG) Vaccine as post-exposure prophylaxis against leprosy among household contacts: A systematic review. *Jurnal Ilmiah Mahasiswa Kedokteran Indonesia*, 12. <https://doi.org/10.53366/jimki.vi.964>
- H.R, Amaliah, R., Yuniati, L., Roem, N. R., Vitayani, S., & Setiawati, S. (2022). Karakteristik penderita lepra (lepra) yang menjalani pengobatan rawat jalan di Puskesmas Tamalate Makassar Periode 2018-2021. *Fakumi Medical Journal: Jurnal Mahasiswa Kedokteran*, 3(5), 357-65.
- Ilyas, A. M., Abdi, D. A., Safei, I., Royani, I., & Yuniati, L. (2024). Analisis faktor risiko usia, jenis kelamin dan indeks massa tubuh terhadap kejadian lepra di Rumah Sakit Tadjuddin Chalid Makassar Tahun 2023. *Jurnal Kesehatan Tambusai*, 5, 12353-58.
- Karani, V., Dierro, L., Rono, A., Githiomi, M., Nkirote, W. R., Pola, R., Olubulyera, S. J., Maragia, J. M., Ongaki, D., Odhiambo, F., Owiny, M., Onyango, D., & Ahmed, A. (2025). Associated factors of *Mycobacterium leprae* infection among people with leprosy in Kwale County. *PLoS Neglected Tropical Diseases*, 19(11), e0012901. <https://doi.org/10.1371/journal.pntd.0012901>
- Le, P. H., Philippeaux, S., Mccollins, T., Besong, C., Kellar, A., Klapper, V., Witt, A. S. D., et al. (2023). Pathogenesis, clinical considerations, and treatments: A narrative review on leprosy. *Cureus*, 15(12). <https://doi.org/10.7759/cureus.49954>
- Mayangsari, R., Zulkarnain, I., & Setyaningrum, T. (2016). Profil interferon- γ dan skar BCG sebagai gambaran respons imun pada pasien kusta anak. *Berkala Ilmu Kesehatan Kulit dan Kelamin – Periodical of Dermatology and Venereology*, 28(3).
- Muharry, A. (2014). Faktor risiko kejadian lepra. *Jurnal Kesehatan Masyarakat*, 9(2), 174-82.
- Novita, L., Widiarini, R., & Sakufa, A. (2023). Relationship between personal hygiene with leprosy at Manghuharjo and Ngegong Health Center. *Jurnal Ilmu Kesehatan*, 11(2), 6. <https://doi.org/10.32831/jik.v11i2.464>
- Palmeirim, M. S., Geluk, A., C de Jong, B., M Braet, S., R Macaluso, K., M Tufariello, J., Lavania, M., Singh, I., Sharma, R., Singh, P., & Steinmann, P. (2025). Advancing *Mycobacterium leprae* transmission research: Insights from the R2STOP fund. *PLoS Neglected Tropical Diseases*, 19(8), e0013370. <https://doi.org/10.1371/journal.pntd.0013370>
- Pertiwi, A. N. A. M., Martini, S., & Nasr, N. M. G. (2024). Relationship between BCG vaccination history and the incidence of leprosy. *Jurnal Berkala Epidemiologi*, 12(1), 1-8. <https://doi.org/10.20473/jbe.v12i12024.1>
- Pertiwi, M., Madani, A. N. A., & Syahrul, F. (2024). Risk factors for leprosy: A systematic review. *Indonesian Journal of Public Health*, 19(3), 575-89. <https://doi.org/10.20473/ijph.v19i3.2024.575-589>
- Ploemacher, T., Faber, W. R., Menke, H., Rutten, V., & Pieters, T. (2020). Reservoirs and transmission routes of leprosy; A systematic review. *PLoS Neglected Tropical Diseases*, 14(4), 1-27. <https://doi.org/10.1371/journal.pntd.0008276>
- Rini, E. W. N., Lesmana, O., & Pitoyo. (2023). Faktor-faktor yang berhubungan dengan risiko kejadian lepra di wilayah kerja Puskesmas Muara Sabak Timur Kabupaten Tanjung Jabung Timur. *Jambi Medical Journal*, 11(1), 41-57.
- Rohmah, N., et al. (2020). Pengaruh sanitasi lingkungan terhadap kejadian kusta di daerah endemik Indonesia. *Jurnal Kesehatan Masyarakat Nasional*, 15(2), 112-120.
- Sadhu, S., & Mitra, D. M. (2018). Emerging concepts of adaptive immunity in leprosy. *Frontiers in Immunology*, 9, 1-7. <https://doi.org/10.3389/fimmu.2018.00604>
- Salsabila, I., Khairunnisa, C., & Mellaratna, W. P. (2023). Gambaran karakteristik sosiodemografi penderita lepra di Kabupaten Aceh Utara Tahun 2017-2021. *Mahesa: Malahayati Health Student Journal*, 3(11), 3689-3700. <https://doi.org/10.33024/mahesa.v3i11.11481>
- Sitorus, E., et al. (2019). Hubungan faktor lingkungan rumah tangga dengan kejadian leprosy di Indonesia. *Jurnal Kesehatan Masyarakat Nasional*, 13(4), 245-252.
- Susanti, N. K., & Azam, M. (2016). Hubungan status vaksinasi BCG, riwayat kontak dan personal hygiene dengan lepra di Kota Pekalongan. *Unnes Journal of Public Health*, 5(2), 130. <https://doi.org/10.15294/ujph.v5i2.10121>
- Tuturop, K. L., Adimuntja, N. P., & Borlyin. (2022). Faktor risiko kejadian kusta di Puskesmas Kotaraja. *Jambura Journal of Epidemiology*, 1(1).
- Wahyuni, N. I., Haidah, N., & Winarko. (2021). Hubungan kondisi fisik rumah dan riwayat kontak dengan kejadian lepra. *Sulolipu: Media*

- Komunikasi Sivitas Akademika dan Masyarakat*, 21(1), 97.
<https://doi.org/10.32382/sulolipu.v21i1.2107>
- WHO. (2017). SAGE evidence to recommendations framework. Table 2. BCG vaccination against leprosy.
- Widhiati, S., Widyastuti, Z., & Fiqnasyani, S. E. (2023). Morbus Hansen pausibasiler tipe borderline-borderline dengan lesi tunggal pada seorang anak laki-laki: Satu laporan kasus jarang. *Jurnal Cahaya Mandalika*, 4(2), 624–39.
- Yang, J., Li, X., Sun, Y., Zhang, L., Jin, G., Li, G., Zhang, S., Hou, K., & Li, Y. (2022). Global epidemiology of leprosy from 2010 to 2020: A systematic review and meta-analysis of the proportion of sex, type, grade 2 deformity and age. *Pathogens and Global Health*, 116(8), 467–476.
<https://doi.org/10.1080/20477724.2022.2057722>
- Yasmin, H., Varghese, P. M., Bhakta, S., & Kishore, U. (2021). Pathogenesis and host immune response in leprosy. *Advances in Experimental Medicine and Biology*, 1313, 155–77.
https://doi.org/10.1007/978-3-030-67452-6_8
- Zhang, K., Zhang, W., & Lu, H. (2025). Global trends in the incidence, prevalence and disability-adjusted life years of leprosy from 1990 to 2019: An age-period-cohort analysis using the Global Burden of Disease Study 2019. *Clinical, Cosmetic and Investigational Dermatology*, 18, 883–898.
<https://doi.org/10.2147/CCID.S508600>