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Prevalence and risk factors for disability in leprosy patients in Indonesia during the post-elimination era

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Abstract

Leprosy has been nationally eliminated in Indonesia, but it continues to be a public health problem, with disability contributing to the disease burden. Disability caused by leprosy often results in stigmatization, leading to decreased quality of life. This was a retrospective cross-sectional study using secondary data from primary healthcare centers in one of the districts in the region with the highest number of leprosy patients in Indonesia. All leprosy patients between 2016-2022 were included. Among 189 leprosy patients (mean age 46 years old, 65,6% male), 19% had grade 1 disability and 29.6% had grade 2 disability. Duration of disease, nerve enlargements, leprosy reactions, and symmetric lesions were identified as risk factors for both grade 1 and 2 disability. Being male and having a positive smear test was associated with a higher risk of only grade 2 disability. Disability due to leprosy is still prevalent in the post-elimination era despite the decline in new leprosy cases. Improvement in early case detection and prevention of disability are still needed in the post-elimination era.

Introduction

Leprosy is a neglected tropical disease (NTD) caused by *Mycobacterium leprae* that continues to be a health problem in Indonesia. This infection primarily damages peripheral nerves and mucocutaneous tissues, which manifests as a loss of skin sensation and the development of deformities and disabilities as the disease progresses.^{1,2} Indonesia ranked third globally in leprosy cases, with incidence reaching more than 13,000 new cases by 2022.¹⁻³ According to the Indonesian Ministry of Health, the prevalence rate of leprosy in Indonesia had decreased, but from 2001 to 2019 there had been an increasing trend of leprosy cases with grade 2 disabilities, with a proportion above 10%.⁴ Disability assessment in leprosy patients is a very important factor in the evaluation of the effectiveness of a leprosy elimination program. Gradual increases in grade 2 disability appear to be a sign of growing detection-detection delays, which itself is an indication of operational failure.^{5,6}

Leprosy that is not treated immediately causes this disease to develop in a progressive direction causing damage to the skin, nerves, limbs, and eyes.^{6,7} In the absence of verifiable data, it has been estimated that 3–4 million people are living with visible impairments or deformities as a consequence of the disease.¹ Disability in leprosy can cause broad problems and have an impact on education, and employment, and lead to social and economic problems.⁸ Disability caused by leprosy often results in stigmatization and discrimination, leading to decreased social participation and quality of life.⁹ Understanding the related risk factors would be helpful for preventing the physical disability associated with leprosy disease.¹⁰

East Java Province achieved elimination in 2016; however, East Java remains the province with the highest number of leprosy patients in the country.^{11,12} In 2021, a total of 1694 newly diagnosed leprosy cases were identified in East Java, and 9.76% of cases had been assessed with grade 2 disability (G2D) at the time of diagnosis. The proportion of G2D in East Java still needs attention because even though it has decreased every year, the value still has not reached the national target of less than 5%.¹¹ Previous studies in India discovered that the prevalence of G2D among new leprosy cases was detected higher in rural areas than in urban areas.^{13,14} Majority of the leprosy patients in Indonesia are spread in rural areas and managed in primary health care.¹¹

A number of studies had been conducted about disabilities in leprosy in referral hospitals,¹⁵⁻¹⁷ but very few from the primary care settings. Therefore, this study aims to describe the profile and explore the risk factors of disability in leprosy patients in primary healthcare settings.

Material and Methods

This cross-sectional retrospective study was conducted in Mojokerto District, one of the rural districts in the East Java province, Indonesia. Data on all leprosy patients between 2016 and 2022 were collected from the medical records of all primary public healthcare centers in the district. Exclusion criteria in this study were leprosy patients with missing data regarding the disability

status or who had prior physical disabilities that were not caused by leprosy. The assessment of the degree of disability was performed according to the current classification system of WHO, using the following criteria: grade 0 disability indicates no loss of sensitivity or visible deformity; grade 1 disability (G1D) is defined as loss of sensitivity without visible deformity; and grade 2 disability (G2D) is defined by as loss of sensitivity with the presence of visible deformity.[6] This study followed the declaration of Helsinki and was approved by the Department of Health of Mojokerto District and City (072/1453/416-206/2022).

Histogram and Quantile-Quantile plot were used to evaluate the data distribution. Data were presented as mean \pm standard deviation (SD) for normally distributed data and as frequency (valid percentage) for categorical data. Comparison between groups was tested with a chi-square test and independent t-test as appropriate. To identify the risk factors associated with disability, multinomial logistic regression models were used to estimate the odds ratios (ORs) and 95% confidence intervals (CIs). For all analyses, p-value <0.05 were considered statistically significant. All statistical analyses were done using SPSS for Windows version 24.0 (IBM Corp., Armonk, New York) and R version 4.2.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

There were 189 leprosy patients included in this study. Looking at the number of patients each year, there was a decreasing trend in the number of patients from 2016 to 2022 (**Figure 1**). The median age was 46 ± 15 years, and there were more male patients. The type of lepra in almost all of the patients was MB type. The majority of the patients were diagnosed in less than two years after developed the disease. Disability was presented in 92 (48.7%) patients. Stratified based on its grade, 36 (19%) had G1D, and 56 (29.6%) patients had G2D. From this study, almost the entire patients (86.8%) were discovered from passive case findings. More detailed baseline characteristics of the study population are presented in **Table 1**.

Stratified based on the disability grade, all patients in G1D and G2D groups had MB type of leprosy. There were significantly more male patients in the G2D group compared to G1D or non-disability group. Furthermore, the presence of leprosy reaction, longer disease duration, and history of relapse were more prevalent across the increasing grade of disability. In addition to that, the number of nerve enlargements also increased across the increasing grade of disability (**Table 2**).

Zooming in to patients only with disability, the majority of the patients had disability at the time of diagnosis, whereas 8 (8.7%) patients and 4 (4.3%) patients had disability during treatment and after treatment, respectively. There was no significant difference in the time of disability between patients with G1D and G2D ($p = 0.7$). The most common site of disabilities was on the feet 66 (71.7%) in both patients with G1D and G2D (**Table 3**). Hypoesthesia/anesthesia was the most common type of G1D found. The most frequent visible disability in the G2D group was foot ulcer. More detailed types of disabilities in the study population are presented in **Table 4**.

Nerve enlargements, regardless of whether it was 1 nerve or 2 nerves, were the strongest risk factors for developing G1D (OR = 12.41, $p < 0.001$ for 1 nerve and OR = 98.0, $p < 0.001$ for 2 nerves) or G2D (OR = 31.36, $p = 0.001$ for 1 nerve and OR = 906.50, $p < 0.001$ for 2 nerves). Furthermore, those with leprosy reaction, suffered from leprae for more than 2 years, and had symmetric lesion distribution were also associated with a higher risk of having G1D and G2D. In addition to that, being male and had positive smear result were associated with a higher risk of having G2D (**Table 5**).

Discussion

Our study showed that in the post-elimination era, new patients were still discovered every year, albeit the trend of the discovery of new patients declined every year. This study revealed that 48.7% of the leprosy patients studied had disability. G1D and G2D accounted for 19% and 29.6% of the total sample of patients, respectively. The logistic regression analysis revealed that the risk factors associated with G1D and G2D were found to be nerve enlargements, leprosy reactions, duration of disease for more than 2 years, and symmetric lesion distribution. Being male and having a positive

smear result was associated with a higher risk of having G2D. The disability was not significantly related to the type of leprosy, education level, history of relapse, history of defaulters, case detection mode, contact history, or type of lesion.

frequently lifelong negative impact on the patient's quality of life, including social exclusion, stigma, and discrimination.^{7,9} The most frequent visible disability (G2D) was foot ulcer and followed by claw hand. This is similar to studies in tertiary medical centers that discovered foot ulcers to be the most common deformity.^{16,17} Claw hand was found to be the most common deformity in the upper limb.¹⁸ Leprosy patients are more likely to develop neuropathic ulcers due to delayed diagnosis, inadequate therapy, and failure to manage leprosy reactions.¹⁹ A higher frequency of the posterior tibial and fibular nerve involvement in leprosy is also associated with an increased prevalence of foot ulcer deformities.²⁰ Grade 2 disabilities do not occur spontaneously; early diagnosis of grade 1 disability is necessary for disability control and mitigation.¹⁸

The majority of the patients had developed disability before the treatment started, with the duration of disease being less than 2 years. This is similar to previous studies in Bangladesh and Western India, that also found a higher amount of G2D, reflecting a failure of the leprosy case detection^{14,18} Besides as indicator of delayed leprosy detection, G2D indirectly provides information on factors that affect case detection, such as community awareness about leprosy, the capacity of health staff to recognize early signs and symptoms, and, to some extent, the quality of the leprosy health services themselves.^{global1,21} After the completion of leprosy-elimination programs, numerous investigations found that delays had been caused by health care workers' lack of practical expertise, as well as their lack of interest and commitment to leprosy.⁷ In addition, patients with leprosy frequently delay seeking treatment because they attempt to conceal their lesions due to the social stigma attached to leprosy.⁷⁻⁹ These findings suggest the need for improvement in early case detection in the post-elimination era to prevent leprosy burden in the future.

Most of our leprosy patients were discovered from passive case findings, in line with other studies conducted in post-elimination areas.^{18,22} In our analysis, statistically significant differences were not found between the active and passive detection modes with regard to the presence of disabilities, but further efforts focusing on active case findings are crucial for improving leprosy control programs. Increasing active case detection succeeded in improving the early detection of leprosy cases and resulted in a declining trend of annual proportion of G2D among new cases in Shandong province, China.²³ Another study about active case-finding had verified that there were a large number of undetected cases in the community which revealed the real burden of leprosy.^{14,23}

According to our study, men significantly raise the risk of G2D. This study is comparable to one in India that revealed a higher rate of disability to be related to male sex. It can be explained by the fact that males are more likely to sustain trauma as a result of strenuous physical activity.¹⁹ Our study also found that positive smear results were associated with a higher risk of having G2D. A cohort study by Quilter et al found slit skin smear positivity as a dominant risk factor for leprosy development but not directly associated with disability in leprosy.²⁴

Higher educational level has been considered as a protective factor for the development of disability in leprosy as well as a determining factor for disease improvement.²⁵ However, our study discovered that education level was not associated with disability in leprosy. The correlation between the type of leprosy and disability in this study was not significant, similar to a study conducted in a tertiary hospital in Indonesia.¹⁴ While another study conducted in India showed that disability in MB patients was more significant than in PB patients.²⁶

In line with previous studies,^{22,27,28} the presence of a leprosy reaction was associated with G1D and G2D in leprosy. Leprosy reactions can occur prior to, during, and *after treatment with multi-drug therapy*, therefore disability assessment needs to be continued after completion of the treatment to early detect and prevent the progression of disabilities in individuals exposed to the risk of disabilities.^{6,18} Our analysis showed that nerve enlargements were the strongest risk factors for developing physical disability. Other studies carried out in Brazil also found that the number of affected nerves as the main factor associated with the development of disability.^{25,27}

Furthermore, those who suffered the disease for more than 2 years before the diagnosis were also associated with a higher risk of having G1D and G2D. Other retrospective studies also discovered patients with a duration of symptoms greater than 12 months and 24 months were more likely to develop disability.^{16,29} The longer the duration of symptoms the higher the likelihood of developing nerve damage and sensory loss, both of which subsequently lead to disability.^{6,29} Symmetric lesion distribution was also found to be a risk factor for developing a disability in leprosy. Previous studies have shown the risk of disability was lower for patients whose lesion distribution is asymmetrical.³⁰ These findings provide information that can be integrated in the future, to identify leprosy patients at early risk of physical disabilities, monitor the progression of this disease more closely, and therefore prevent any further deformity. Long-term follow-up is necessary to monitor factors associated with the development of disabilities, as is the provision of interventions promoting self-care, appropriate management of early disability, and the availability of rehabilitation services.^{1,5,18} Our study discovered even after elimination, the number of cases with disability is still high, therefore the national leprosy control program should investigate the leprosy case detection system and work on improving early case detection. A comprehensive effort to enhance early case detection is needed, including health promotion among the community, healthcare personnel training, and increasing active case-finding activities.^{1,6,23} There were several limitations to this study. This study was a time-bound, cross-sectional study. The data were collected from manual medical records, leading to a loss of some information. A multicenter study is warranted to confirm this study's findings.

Conclusions

This study found that, despite a decline in new leprosy cases, the disability rate is still prevalent, with G2D predominance. Most patients were detected by passive case findings, developed disability before treatment, and had a duration of disease less than 2 years. These results suggest that delayed case detection is still an issue that will lead to leprosy burdens in the future. Several risk factors associated with disability have been identified and might assist in early identification and careful follow-up. Further improvement in the early detection and prevention of disability is still needed in the post-elimination era through health promotion, healthcare personnel training, and active case-finding activities.

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Table 1. General Characteristics of the study population

Characteristics	N = 189
Disability, n (%)	
No disability	97 (51.4)
Grade 1 disability	36 (19)
Grade 2 disability	56 (29.6)
Age in years, mean \pm SD	46 \pm 15
Sex, n (%)	
Female	65 (34.4)
Male	124 (65.6)
Types of Leprae, n (%)	
MB	186 (98.4)
PB	3 (1.6)
Disease duration, n (%)	
< 2 years	126 (66.7)
\geq 2 years	63 (33.3)
Education level, n (%)	
Up to primary school graduates	94 (49.7)
At least secondary school graduates	95 (50.3)
Occupation, n (%)	
Unemployed	50 (26.5)
Student	11 (5.8)
Farmer	54 (28.6)
Private employee	45 (23.8)
Others	29 (15.3)

Table 2. Sociodemographic and Clinical Characteristics of the study population, grouped based on the disability grades

Characteristics	No disability N = 97	Grade 1 N = 36	Grade 2 N = 56	p-value
Age in years, mean ± SD	46 ± 15	47 ± 15	46 ± 16	0.9
Sex, n (%)				0.022
Female	40 (41.2)	14 (40.5)	11 (19.6)	
Male	57 (58.8)	22 (59.5)	45 (80.4)	
Leprosy reaction, n (%)				<0.001
No	89 (91.8)	23 (64.9)	33 (58.9)	
Yes	8 (8.2)	13 (35.1)	23 (41.1)	
Types of Leprae, n (%)				0.2
MB	94 (96.9)	36 (100)	56 (100)	
PB	3 (3.1)	0 (0.0)	0 (0.0)	
Disease duration, n (%)				<0.001
< 2 years	91 (93.8)	23 (64.9)	11 (19.6)	
≥ 2 years	6 (6.2)	13 (35.1)	45 (80.4)	
Education level, n (%)				0.1
Up to primary school graduates	42 (43.3)	20 (56.8)	32 (57.1)	
At least secondary school graduates	55 (56.7)	16 (43.2)	24 (42.9)	
Occupation, n (%)				0.3
Unemployed	33 (34.0)	10 (27.0)	8 (14.3)	
Student	4 (4.1)	2 (5.4)	5 (8.9)	
Farmer	22 (22.7)	11 (29.7)	21 (37.5)	
Private employee	23 (23.7)	8 (21.6)	14 (25.0)	
Others	15 (15.5)	6 (16.2)	8 (14.3)	
History of relapse, n (%)				0.010
No	97 (100)	35 (97.3)	51 (91.1)	
Yes	0 (0.0)	1 (2.7)	5 (8.9)	
History as defaulters, n (%)				0.034
No	94 (96.9)	36 (100)	50 (89.3)	
Yes	3 (3.1)	0 (0.0)	6 (10.7)	
Case detection mode, n (%)				0.4
Passive findings	81 (83.3)	32 (89.2)	51 (91.1)	
Active findings	16 (16.7)	4 (10.8)	5 (8.9)	
Contact history, n (%)				0.099
No	62 (61.1)	26 (72.2)	28 (50.0)	
Yes	35 (38.9)	10 (27.8)	28 (50.0)	
Nerve enlargement, n (%)				<0.001
No	49 (64.5)	3 (8.8)	1 (1.9)	
1 nerve	25 (32.9)	19 (55.9)	16 (29.6)	
2 nerves	2 (2.6)	12 (35.3)	37 (68.5)	
Lesion distribution, n (%)				0.010
Asymmetry	31 (36.5)	5 (13.9)	10 (18.2)	
Symmetry	54 (63.5)	31 (86.1)	45 (81.8)	
Types of lesion, n (%)				0.2
Macule	78 (91.8)	29 (80.6)	48 (87.3)	
Plaque	7 (8.2)	6 (16.7)	7 (12.7)	
Nodule	0 (0.0)	1 (2.8)	0 (0.0)	
Smear results, n (%)				0.055
Negative	17 (28.3)	4 (17.4)	4 (9.3)	
Positive	43 (71.7)	19 (82.6)	39 (90.7)	

*Contact history is missing in 7 patients, nerve enlargement is missing in 25 patients, lesion distribution and types of lesions is both missing in 13 patients, and smear results is missing in 63 patients.

Table 3. Distribution of the disability grade based on the disability location

Location	Grade	Total cases with disability (N=92) n (%)
Eye	No disability	82 (89.2)
	Grade 1	4 (4.3)
	Grade 2	6 (6.5)
Hand	No disability	41(44.6)
	Grade 1	23 (25)
	Grade 2	28 (30.4)
Feet	No disability	26 (28.3)
	Grade 1	34 (36.9)
	Grade 2	32 (34.8)

Table 4. Types of disability

Grade	Types of disability	Total (N=92) n (%)
Grade 1 disability	Hypoesthesia/anaesthesia	30 (25)
	Muscle weakness	17 (14.2)
	Decreased vision	5 (4.2)
Grade 2 disability	Wrists drop	2(1.7)
	Claw hand	17 (14.2)
	Hand absorption	1 (0.8)
	Hand ulcer	1 (0.8)
	Foot drop	13 (10.8)
	Claw toes	4 (3.3)
	Foot ulcer	18 (15)
	Contracture	3 (2.5)
	Mutilation	2 (1.7)
	Lagophthalmos	4 (3.3)
	Madarosis	2 (1.7)
	Saddle nose	1 (0.8)

Table 5. Multinomial logistic regression

Characteristics	Grade 1		Grade 2	
	OR (95%CI)	P-value	OR (95%CI)	P-value
Age	1.00 (0.98-1.03)	0.8	1.00 (0.98-1.02)	0.8
Sex				
Female	Ref	Ref	Ref	Ref
Male	1.10 (0.50-2.41)	0.8	2.80 (1.29-6.08)	0.009
Leprosy reaction				
No	Ref	Ref	Ref	Ref
Yes	6.29 (2.33-16.97)	<0.001	7.67 (3.12-18.83)	<0.001
Types of Leprae				
MB	Ref	Ref	Ref	Ref
PB	62026.4 (0-∞)	1.0	42116.47 (0-∞)	1.0
Disease duration				
< 2 years	Ref	Ref	Ref	Ref
≥ 2 years	7.58 (2.58-22.29)	<0.001	74.45 (24.40-227.23)	<0.001
Education level				
Up to primary school graduates	Ref	Ref	Ref	Ref
At least secondary school graduates	0.61 (0.28-1.32)	0.2	0.56 (0.29-1.09)	0.087
History of relapse, n (%)				
No	Ref	Ref	Ref	Ref
Yes	15957367.07 (0-∞)	1.0	29461385.02 (0-∞)	1.0
History as defaulter, n (%)				
No	Ref	Ref	Ref	Ref
Yes	0.00 (0-∞)	1.0	3.72 (0.89-15.51)	0.071
Case detection mode, n (%)				
Passive findings	Ref	Ref	Ref	Ref
Active findings	0.63 (0.20-2.04)	0.4	0.49 (0.17-1.42)	0.2
Contact history, n (%)				
No	Ref	Ref	Ref	Ref
Yes	0.60 (0.26-1.40)	0.2	1.57 (0.80-3.08)	0.2
Nerve enlargement, n (%)				
0 nerve	Ref	Ref	Ref	Ref
1 nerve	12.41 (3.35-45.98)	<0.001	31.36 (3.93-250.22)	0.001
2 nerves	98.00 (14.70-653.44)	<0.001	906.50 (79.17-10379.71)	<0.001
Lesion distribution, n (%)				
Asymmetry	Ref	Ref	Ref	Ref
Symmetry	3.56 (1.25-10.10)	0.017	2.58 (1.14-5.84)	0.022
Types of lesion, n (%)				
Macule	Ref	Ref	Ref	Ref
Plaque	2.31 (0.71-7.43)	0.2	1.62 (0.54-4.92)	0.4
Nodule	15486531.14 (0-∞)	1.0	-	-
Smear results, n (%)				
Negative	Ref	Ref	Ref	Ref
Positive	1.88 (0.56-6.33)	0.3	3.85 (1.19-12.45)	0.024

*Contact history is missing in 7 patients, nerve enlargement is missing in 25 patients, lesion distribution and types of lesions is both missing in 13 patients, and smear results is missing in 63 patients.

Fig. 1. Distribution of new patients in Mojokerto District across the study period

