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Social Determinants and Leprosy in High Endemic Regions of Myanmar: an Ecological Study between 2016 and 2019

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Abstract

Leprosy has been a public health problem in Myanmar for many centuries. This study aims to explore the situation of leprosy and the association between leprosy and social determinants at the township level in seven endemic regions in Myanmar. The objectives of the study are to (i) describe the incidence and severity of leprosy and the disability due to leprosy in Myanmar between 2016 and 2019, and (ii) determine the correlation between leprosy incidence and social determinants in Myanmar in 2019. We used annual surveillance data of leprosy cases between 2016 and 2019 from the National Leprosy Control Program, Myanmar, and social determinant variables from the 2019 General Administration Department Census Report of Myanmar. An ecological cross-sectional study was conducted. Univariable and multivariable analyses applying zero-inflated negative binomial regression models were used. A geographic information system mapping was used to visualize leprosy cases, disease severity, and disability due to leprosy between 2016 and 2019. The number of all leprosy indicators changing pattern was seen obvious between regions. The eastern region showed relatively an increase in detection of new cases in 2019 compared with years 2017 and 2018. The increase in the detection of multibacillary leprosy cases was also observed in the eastern region during this period. Yet, the detection of Grade-II disability cases across regions remained relatively stable throughout study years. The number of tuberculosis cases per 1,000 population was significantly correlated with leprosy incidence at the township level (risk ratio 1.27, 95% confidence interval 1.04–1.55). These findings highlight the importance of enhancing active case finding campaigns in high-endemic regions, especially the eastern states of Myanmar. Integration of leprosy and tuberculosis case-finding programmes is likely to help leverage resources and maximize efforts to cope with leprosy problems in Myanmar.

Keywords: leprosy, township, social determinants, Myanmar

Introduction

Leprosy, also known as Hansen's disease, is a chronic infectious disease caused by *Mycobacterium leprae*.[1] The disease mainly affects the skin, peripheral nerves, mucosal surfaces of the upper respiratory tract, and eyes of an infected person. People of all ages are at risk of the disease. Leprosy is curable and early treatment is recommended to avert potential disabilities. Prolonged and close contact with untreated leprosy cases is a key risk factor.[2]

Leprosy is classified based on skin smear results and the degree of disability. In the classification of skin smears, the disease is categorized into paucibacillary leprosy and multibacillary leprosy (MB), a more severe form of the disease. The World Health Organization proposes a grading system for leprosy-related disabilities.[3] Grade-II disability (G2D) is related to late diagnosis and complications, including deformities. MB leprosy is reported to have a positive association with G2D.[4] Bangladesh, India, Indonesia, Myanmar, Nepal, and Sri Lanka are the leading nations with high leprosy incidence in Asia.[4,5]

Myanmar launched a policy to eliminate leprosy in 2003. By late 2019, there were 2,287 previously registered leprosy cases in the country and the national prevalence rate was 0.4 per 10,000 population. High endemic areas of leprosy in Myanmar in 2019 were Ayeyarwady, Bago, Magway, Mandalay, Nay Pyi Taw, Shan, Sagaing, and Yangon. Nay Pyi Taw was just union territory under Mandalay Region. In total, seven regions consisting of 210 townships, (making up about 63.6% of the 330 townships nationally) were considered high endemic areas.

Despite some existing knowledge about the leprosy situation in Myanmar, little is known about the relationship between various social determinants and leprosy in Myanmar. Social determinants of health are conditions in the places where people live, learn, work, and play that affect a wide range of health risks and outcomes.[6,7]

Previous ecological studies in leprosy endemic countries, such as Brazil, have found significant relationships between leprosy and social determinants, including employment status, income, race, health quality, comorbid diseases (especially tuberculosis) and education.[8–10,20] However, a similar analysis has not yet been conducted in Myanmar. To reach the goal of strategic direction, it is necessary to identify individual and community determinants; this will support the planning and implementation of appropriate public health interventions. The interventions should also be tailored to specific priority subgroups in the population, for example, the unemployed, people in rural areas, and people in endemic areas where there is a high prevalence of MB leprosy.

The objectives of this study are (1) to describe the epidemiological situation of leprosy in terms of incidence, severity and disability at the township level in the seven high endemic regions in Myanmar between 2016 and 2019, and (2) to determine the association between leprosy incidence and social determinants of health in 2019.

Methods

An ecological cross-sectional study was conducted and the unit of analysis was township. The study areas included 210 townships in the seven high burden leprosy endemic areas in Myanmar. The period of study was 2016–2019 for objective 1, and 2019 for objective 2. The analysis was limited to 2019 for the second objective due to the lack of social determinant data from the national census before 2019.

For objective 1, we analysed three main variables at the township level over time: (i) annual incidence proportion of leprosy, (ii) multibacillary proportion, and (iii) proportion of new G2D cases. These leprosy indicators were obtained from the National Leprosy Control Program, Department of Disease Control, Ministry of Health. For objective 2, we included social determinant variables, which were selected based on expert consultation and a literature review. The social determinant data were obtained from the General Administration Department, Ministry of Internal Affairs. The operational definitions of the outcome variables are shown in Table 1 while those of selected social determinants are shown in Table 2.

Table 1. Operational definitions of the outcome variables at township level (leprosy indicators)

Variables	Definitions
Incidence proportion of leprosy (new case detection rate)	Number of newly detected cases per 100,000 population in a year
Multibacillary proportion (severity based on smear result)	Number of new MB cases per total number of newly detected cases each year
G2D proportion (severity based on disability level)	Number of new cases with G2D per total number of newly detected cases each year

Table 2. Operational definitions of selected social determinant variables at the township level

Variables	Definitions
Literacy rate	Percentage of literate people per total population
Unemployment rate	Percentage of unemployed labor per all labor force
Ethnic group proportion	Percentage of ethnic groups per total population (e.g., Shan, Karen, and Rakhine)
Tuberculosis prevalence	Total number of existing tuberculosis cases in the area per 1,000 population
Rural population proportion	Percentage of rural residents per total population

Note: The variables reflect socioeconomic status of the population

Data analysis was carried out using Stata (version 16) and Microsoft Excel® (2013). Descriptive statistics, including percentage, mean and standard deviation were used. Median and interquartile range were also presented for data validity. Choropleth maps were created to visualize leprosy indicators at the township level over time. Pearson's correlation was used to examine the relationship between leprosy indicators in 2019 and social determinant variables (univariable analysis). Then all social determinant variables were included in the multivariable model. Zero-inflated negative binomial regression model was used because more than twenty percent of townships reported zero cases. Adjusted rate ratios and 95% confidence intervals were calculated. Zero-inflated negative binomial was selected instead of conventional regression models because (i) the outcomes are frequency counts where the population volume in a township was considered the offset, (ii) some townships reported the absence of cases (zero values), and (iii) overdispersion of data.

As this study involved secondary data analysis and did not include an analysis of individual-level data, ethics approval was not required.

Results

Based on the National Leprosy Control Program, the annual leprosy indicators during 2016–2019 are presented in Table 3. The mean incidence proportion across four study years was 9.96 new cases per 100,000 population, while MB cases accounted for 80% and G2D constituted approximately 10% of total new cases. Increasing trends in leprosy incidence and MB proportion were observed between 2016 and 2019. The proportion of G2D cases decreased in 2017, then rebounded in 2018–2019. In 2019, MB cases accounted for about 84.0% of all new cases. Additional data from National Leprosy Control Program revealed that the fraction of child cases constituted about 4.2% of all new cases in 2019.

Table 3. Mean value of annual leprosy indicators (%) in Myanmar during 2016–2019

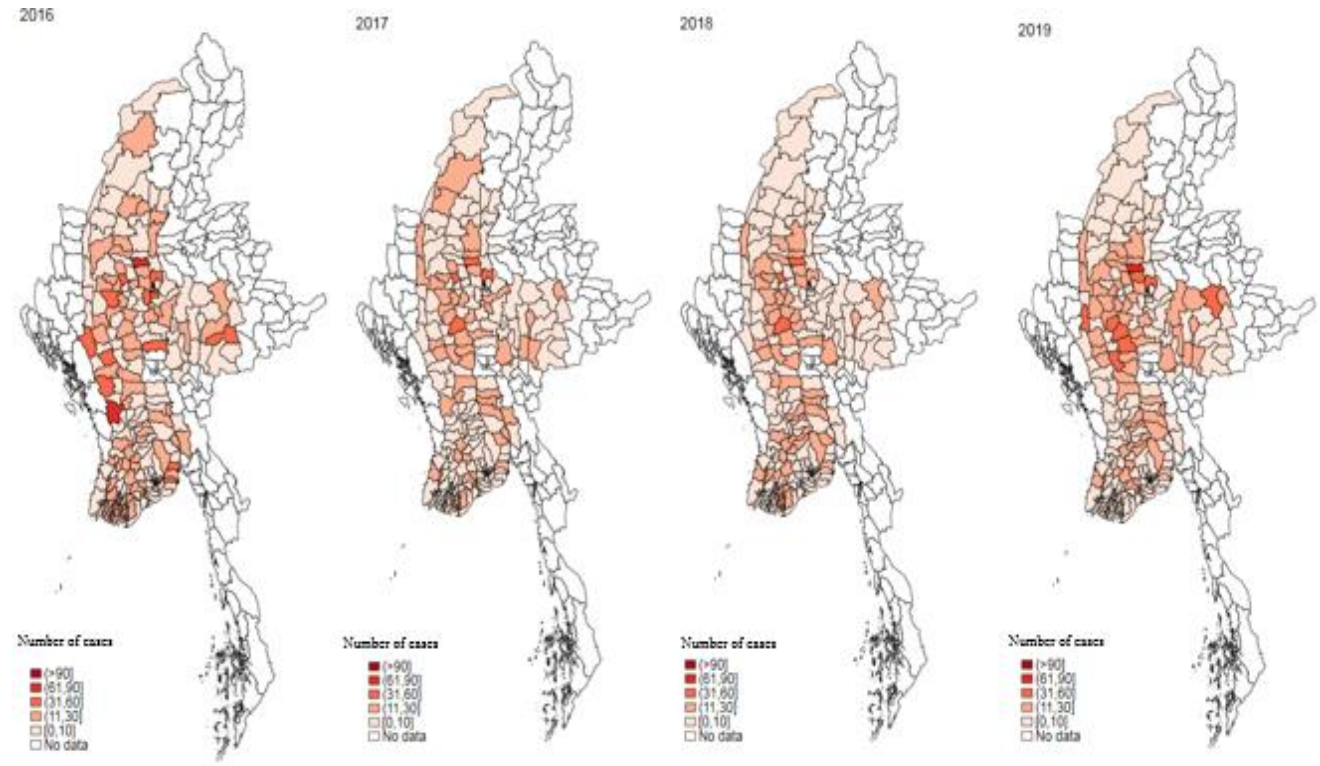
Leprosy indicators	Years mean (standard deviation)				
	2016	2017	2018	2019	Total
Incidence per 100,000 population	10.02 (63.51)	8.42 (67.36)	9.73 (84.81)	11.66 (82.51)	9.96 (74.99)
Multibacillary proportion (%)	77.64 (19.59)	77.95 (20.27)	82.15 (20.72)	84.03 (17.00)	80.48 (90.58)
G2D proportion (%)	10.75 (17.10)	7.96 (13.65)	12.99 (22.23)	11.85 (19.07)	10.86 (18.23)

The median leprosy incidence proportions during 2016–2019 are shown in Table 4. The indicators varied between 2.52 and 3.56 cases per 100,000 population during the study years. This implied the data had a right-skewed distribution. In contrast, the median proportion of MB cases among new cases was close to the corresponding mean. The median G2D proportion was zero in most years.

Table 4. Median value of annual leprosy indicators (%) in Myanmar during 2016–2019

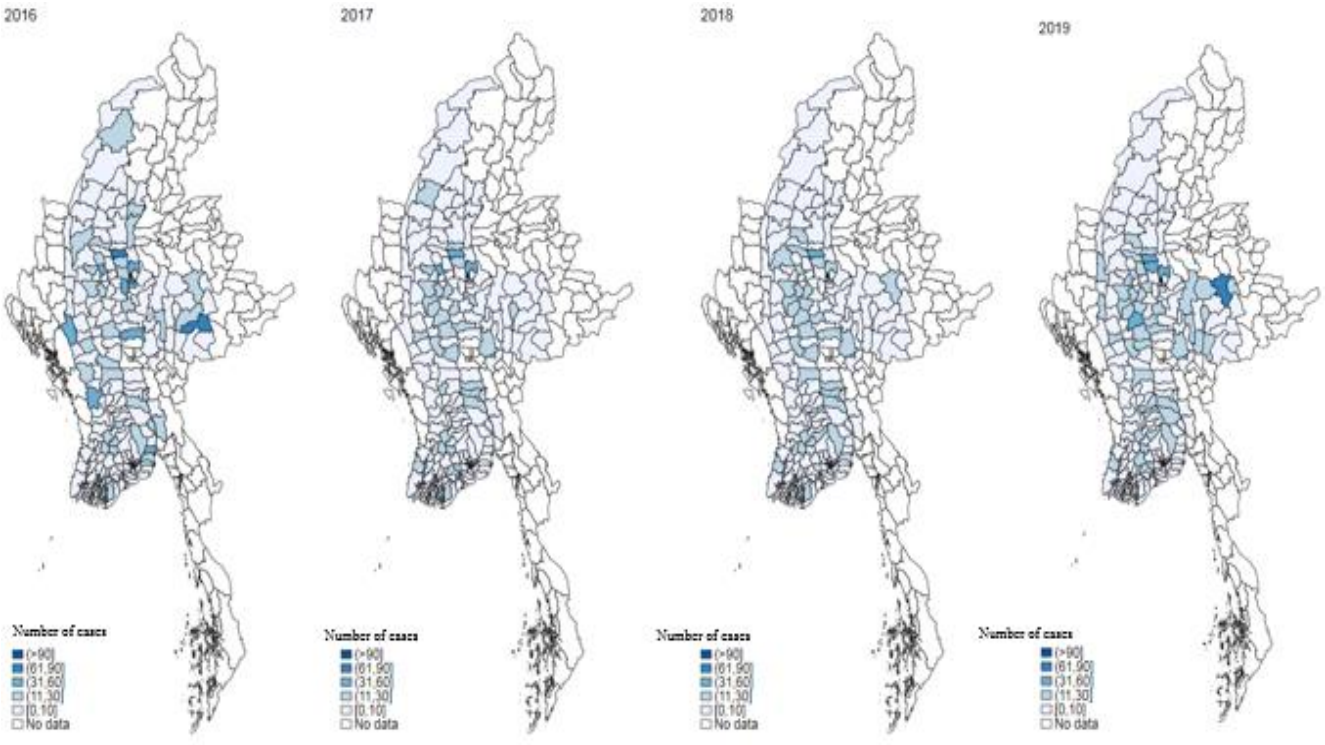
Median leprosy indicators	Years median (interquartile range)				
	2016	2017	2018	2019	Total
Incidence proportion of leprosy	3.09 (5.54)	2.52 (5.17)	2.73 (4.69)	3.56 (6.21)	2.81 (5.29)
Multibacillary proportion (%)	80.00 (25.00)	80.90 (33.34)	85.71 (27.27)	88.89 (27.18)	83.34 (33.34)
G2D proportion (%)	3.28 (16.67)	0.00 (10.53)	0.00 (17.65)	0.00(19.58)	0.00(16.66)

Figures 1–3 show the geographical distribution of cases in Myanmar townships, with darker color shades reflecting higher numbers of leprosy cases. Only hyper endemic regions were included in study. Townships in the central regions (Ayeyarwaddy, Mandalay, and Yangon) presented with a relatively higher number of new leprosy cases. In 2016, most of the new and MB cases were detected in the central region compared with other regions. The detection rate of new cases in 2017 and 2018 appeared to be lower in all regions, relative to year 2016. However, higher detection of new cases was observed in 2019, especially in the eastern region. The same change pattern was also found in MB cases. Yet there were no obvious differences in the geographical concentration of G2D cases across years.



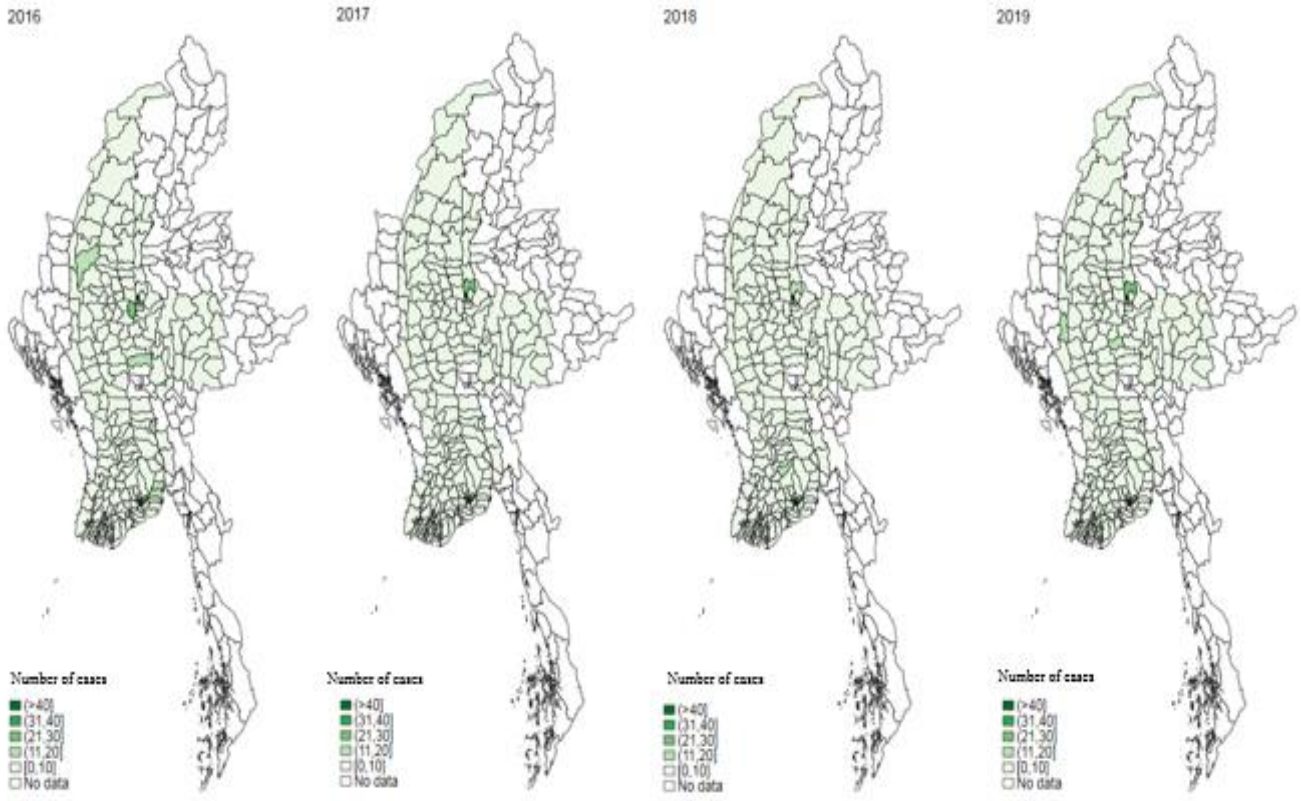
Note: White areas in map ("no data" in legend) were not included as study sites

Figure 1. Geographical distribution of all new leprosy cases in seven high endemic regions in Myanmar, 2016–2019



Note: White areas in map ("no data" in legend) were not included as study sites

Figure 2. Geographical distribution of multibacillary leprosy cases in seven high endemic regions in Myanmar, 2016–2019



Note: White areas in map ("no data" in legend) were not included as study sites

Figure 3. Geographical distribution of grade-II disability leprosy cases in seven high endemic regions in Myanmar, 2016–2019

Social determinant variables in 2019 are shown in Table 5. About 96.9% of the population was literate, and 8.3% were unemployed. The ethnic groups comprised 17.1% of the total population. About two-third of the population lived in rural areas. The mean prevalence of tuberculosis cases per 1,000 population was 1.5.

Table 5. Social determinants of health in the seven high endemic regions of leprosy in Myanmar, 2019 (n=210 townships)

Variables	Mean (standard deviation)
Literacy rate (%)	96.9[a] (9.2)
Unemployment rate (%)	8.3 (8.9)
Ethnic group percent (%)	17.1 (28.7)
Percentage of people living in rural areas (%)	62.3 (38.1)
Number of tuberculosis cases per 1,000 population	1.5 (1.1)

Note: [a]Some townships reported a literacy rate of more than 100%

In the univariable analysis shown in Table 6, a positive correlation coefficient implied that the value of social determinants went along with the value of leprosy indicators, and negative if otherwise. There was a significant positive correlation between tuberculosis prevalence and new leprosy cases. There was also a significant positive correlation between tuberculosis prevalence and G2D proportion. However, no significant correlations were found between the MB proportion and any social determinant variable.

Table 6. Univariable analysis between leprosy indicators and social determinants

Social determinant variables	Leprosy incidence		MB proportion		G2D proportion	
	Correlation coefficient	*P*-value	Correlation coefficient	*P*-value	Correlation coefficient	*P*-value
Literacy rate	-0.002	0.98	-0.05	0.51	0.03	0.65
Unemployment rate	-0.06	0.37	-0.03	0.72	-0.01	0.87
Prevalent tuberculosis cases per 1,000 population	0.21	<0.01	0.12	0.09	0.16	0.02
Percentage of ethnic population	-0.003	0.97	0.01	0.87	-0.06	0.41
Percentage of rural population	-0.12	0.09	-0.07	0.35	-0.11	0.10

Results of the multivariable analysis are shown in Table 7. After controlling for other variables, we found that for each unit increase in the tuberculosis prevalence, the incidence of leprosy increased by about 27% (*p*-value 0.02). A one-percentage-point increase in the rural population was associated with a 2.2-fold increase in leprosy incidence, although the significance was only marginal (*p*-value 0.06). Both multivariable analysis of MB leprosy and G2D with social determinants showed no significant result.

Table 7. Multivariable analysis of leprosy incidence and social determinants

Independent variables	Risk ratio	95% confidence interval	*P*-value
Literacy rate	0.24	0.02–2.79	0.25
Unemployment rate	0.22	0.03–1.92	0.17
Prevalent number of tuberculosis cases	1.27	1.04–1.55	0.02
Ethnic group percentage	1.30	0.58–2.90	0.52
Rural population percentage	2.18	0.97–4.93	0.06

Discussion

This study revealed a slight rising trend of leprosy indicators from 2016 to 2019 in seven leprosy endemic regions of Myanmar.[4] Moreover, a high proportion of MB cases among new cases was observed. MB leprosy mostly occurs in people with a weakened immune response against *M. leprae*, with a high bacillary load, and MB cases are likely to be important sources of disease transmission.[14] Therefore, active case detection and active surveillance among contacts are critical for early detection of new cases and breaking the transmission chain.[14] Local strategies to diagnose and treat MB cases should be prioritized in townships with high leprosy burden.

About 10% of new cases presented with G2D during 2016–2019. The large proportion of G2D partly reflects a deficit in the country's health system to perform early case detection and partly reflects delayed health-seeking of the patients.[15]

There are a few differences between the findings of this study and a report by World Health Organization. Globally and in South-East Asia, the number of reported new cases of leprosy and cases with G2D declined during 2011–2019.[5] These differences can be explained by the fact that the leprosy profile at the township level, particularly in endemic regions, differs from the profile at the national level. Additionally, a high level of case detection is not just a reflection of the disease burden but it also involved reflects the operation of the system or the intensity of programmatic activities (including case-finding campaigns). We found that townships with a higher number of G2D cases were concentrated in the central region. In addition, MB cases were accumulated more in the eastern region.[16] This phenomenon is partly due to a shift in case findings campaigns from the central and western parts of the country during 2016 to the eastern region in 2019.

We did not find a significant association between literacy rates and leprosy indicators. This is in contrast with the findings from other countries.[17] However, we identified a positive correlation between rural population percentage and leprosy detection, although the significance was marginal. This result is consistent with a study in Bangladesh which highlights the importance of active case finding campaigns for leprosy in rural areas.[18] People living in a rural setting are likely to face barriers that hamper access to healthcare, such as large distances between residences and the nearest health facility and communication hurdles, compared with those living in urban settings.[18]

The prevalence of tuberculosis was positively correlated with leprosy incidence in the multivariable analysis. A study from the Netherlands found that leprosy and tuberculosis have significant cross-reactivity at the T-cell level.[11] This finding coincides with studies from the United Kingdom and the United States of America, suggesting that leprosy and tuberculosis have similar geographic endemicity and tend to present with coinfection in a patient.[19,20] This result reaffirms the idea that active case finding strategies for leprosy should be conducted in tandem with tuberculosis active case finding campaigns.

Limitations

This study has some limitations which are worth mentioning. First, the nature of an ecological study is prone to the ecological fallacy. Therefore, results of this study should be interpreted with caution, particularly when applying them to individual-level phenomena. Second, not all social determinant variables were collected in the routine data collection system of the Ministry of Internal Affairs. Thus, some important variables, such as household economic status and healthcare resources, were not included in the analysis. Third, this study was not free from reporting bias. Although the choropleth maps showed some potential

spatial relationships, a spatial effect analysis was not formally conducted. Some townships might over-represent the cases because they have referral centers where many cases were transferred. In contrast, townships with a small number of cases or those containing only low-level health facilities which are not able to handle leprosy care might be prone to zero-case reporting. Finally, the nature of a cross-sectional study prevents claiming a strong causal inference. Further study that explores the change of social determinants and leprosy indicators in a longitudinal fashion is warranted to identify a more solid causal inference.

Conclusion

An increasing trend of leprosy incidence and proportion of MB leprosy cases were observed in endemic regions of Myanmar. Most cases were localized in the central region, and a rising trend was seen in the eastern region. A positive relationship between leprosy incidence and tuberculosis cases suggests a need to integrate the disease control programmes of both diseases. A strong correlation was also found between leprosy incidence and percentage of rural population. Further studies that collect social determinant variables at the household and individual levels are recommended.

Recommendations

The authorities should enhance and prioritize active case finding programmes in townships exhibiting rising trends in leprosy incidence. In addition, a leprosy active case finding programme should be performed in parallel with those for tuberculosis cases. Rural areas should be considered target sites for active case finding. Barriers to healthcare access in rural settings should be promptly addressed. Future studies that employ primary data collection and incorporate more social determinants that represent the socioeconomic status of the observations rather than a reliance on surrogate variables is recommended. Further studies exploring the leprosy incidence and social determinants at the individual or household level will help extend the academic value in the field of leprosy epidemiology.

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Declaration of Conflicting Interests

The authors declare that there is no conflict of interest.

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