

Potential Effects of Climate Change on Disabilities in Leprosy

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Leprosy may cause disability in patients if not treated properly, especially due to delays in diagnosis and treatment. However, climate change complicates this situation by worsening access to health services, as well as increasing risk factors associated with environmental conditions. Unfavorable environmental conditions, such as increasing global temperatures, may accelerate the spread of *Mycobacterium leprae*, the bacterium that cause leprosy, and in turn worsen disability rates in patients. Therefore, it is necessary to study more deeply how climate change significantly contributes to increased disability in leprosy patients. This is expected to determine the relationship between climate change and the prevalence of leprosy and the incidence of disability in leprosy patients. Furthermore, it is hoped that there will be the development of public health policies that focus on mitigating the impact of climate change on the prevalence of leprosy and consequent disabilities in some.

Keywords: Leprosy, Climate change, Disability, Epidemiology

Introduction

Climate change is one of the greatest challenges to global health in the 21st century. Its impacts are felt across multiple dimensions of human health and well-being. The World Health Organization (WHO) estimates that climate change is responsible for approximately 150,000 deaths and 5 million disabilities (Disability Adjusted Life Years, DALYs) each year due to impacts on health systems and environmental conditions (Nigatu et al 2014, Shi 2018). These impacts include direct effects such as heat-related illnesses and injuries from extreme weather events, as well as indirect effects such as the spread of infectious diseases, malnutrition, and mental health disorders (Padhy et al 2015, Sunyer 2010).

Furthermore, The Lancet Countdown on Health and Climate Change has identified key indicators highlighting the link between climate change and health. The report emphasizes the importance of integrated public health strategies within climate policy to address this challenge ((Fox et al 2019, Watts et al 2019). Climate change exacerbates existing health inequalities, particularly among vulnerable populations in low-income countries (Khanal et al 2024, Whitfield et al 2022). These impacts are felt more acutely by marginalized groups, including those living in dense urban heatwaves, outdoor workers, and individuals with preexisting health conditions (Khanal et al 2024, Pandve 2011).

Socioeconomic conditions play a significant role

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in the relationship between climate change and leprosy. Populations in poor areas often lack adequate access to health services and live in environments that are more conducive to disease transmission. The presence of waste collection services and good sanitation conditions have been associated with lower leprosy prevalence, highlighting the importance of socioeconomic factors in disease dynamics (Pescarini et al 2021). As climate change affects socioeconomic conditions through population displacement, resource scarcity, and increased poverty, leprosy risk may increase, especially in areas already burdened by the disease (Li et al 2021). Climate change exacerbates these environmental factors by altering weather patterns, leading to extreme weather events such as floods and droughts. These changes can disrupt local ecosystems and impact overall human health. Increasing temperatures and changing rainfall patterns may create conditions more conducive to the spread of leprosy, especially in areas that are already vulnerable due to socioeconomic factors (Bryson et al 2020, El-Sayed & Kamel 2020). Furthermore, migration patterns influenced by climate change may also affect leprosy transmission. Migrants often move from rural to urban areas in search of better living conditions, which may lead to increased contact with infected individuals and increase transmission rates (Murto et al 2013). The interaction between environmental changes and human behavior, such as migration and urbanization, further complicates the epidemiological landscape of leprosy (Wood et al 2017).

Leprosy, caused by the bacterium *Mycobacterium leprae*, is also one of the diseases whose development is influenced by climate change. The relationship between climate change and leprosy is a complex interaction between environmental, social, and biological factors that influence the

incidence and transmission of this disease. This epidemiological study shows that environmental factors such as humidity, temperature, and vegetation are very important in understanding the epidemiology of leprosy. For example, areas with high humidity and certain types of vegetation have been associated with increased incidence of leprosy, as these conditions can facilitate the survival and transmission of *M. leprae* (Tedesse Argaw et 2006, Li et al 2021).

Leprosy causes disability in patients if not treated properly, especially due to delays in diagnosis and treatment. However, climate change complicates this situation by worsening access to health services, as well as increasing risk factors associated with environmental conditions. Unfavorable environmental conditions, such as increasing global temperatures, can accelerate the spread of its causative organism *Mycobacterium leprae* and in turn worsen disability rates in patients (Adriaty et al 2020). Therefore, it is necessary to study more deeply how climate change significantly contributes to increased disability in persons affected by leprosy.

There are connections between climate change and resulting disabilities among people affected by leprosy. Climate change exacerbates the challenges faced by people affected by leprosy, increasing their risk of developing disabilities due to multiple interconnected factors: (1) Increased disease transmission; (2) Delayed diagnosis and treatment; (3) Food insecurity and malnutrition; (4) Exacerbation of existing disabilities; and (5) Social and economic consequences. Climate change can affect leprosy disability, because environmental conditions around leprosy clients increase the risk of transmission and worsen the client's condition. This will have an impact on the vulnerability of leprosy clients to disability, thus

requiring better rehabilitation efforts (Pender 2022, Walker 2023).

Impact of Climate Change on the Spread of Leprosy

Climate change plays a significant role in changing the pattern of spread of infectious diseases, including leprosy. Leprosy is caused by the bacterium *Mycobacterium leprae*, which is greatly influenced by environmental factors such as temperature, humidity, and vegetation. Studies have shown that areas with high humidity and certain types of vegetation have a higher incidence of leprosy, as these conditions facilitate the survival and transmission of the bacteria (Tedesse Argaw et al 2006, Li et al 2021). With climate change increasing global temperatures and altering rainfall patterns, environmental conditions in some regions are becoming more conducive to the spread of *M. leprae*. Increasing global temperatures have been associated with changes in the geographic distribution of various infectious diseases. In the context of leprosy, increasing temperatures may create more favorable conditions for the survival of the bacteria in certain environments, expanding the geographic areas where the disease can thrive (Bryson et al 2020, El-Sayed & Kamel 2020). Climate change causes significant increases in temperature and humidity, which in turn increases the prevalence of leprosy in these areas (Pescarini et al 2018).

In addition to temperature, changes in rainfall patterns also affect the spread of leprosy. Areas experiencing increased rainfall may be at higher risk for leprosy due to increased environmental humidity that allows *M. leprae* to survive longer in its natural habitat. This condition is especially true in rural areas with dense vegetation and little access to adequate sanitation (Tedesse Argaw et al 2006). As rainfall patterns change due to climate change, the risk of leprosy spreading to newer

areas might increase, especially in developing countries with limited health infrastructure.

Influence of Socio-Economic Conditions on the Spread of Leprosy

Socio-economic conditions are also important factors that exacerbate the spread of leprosy amidst climate change. Populations living in poor areas often do not have adequate access to health services and live in environments that are vulnerable to infectious diseases. Studies have shown that poor sanitation, overcrowding, and limited access to health facilities are associated with increased leprosy prevalence in poor areas (Pescarini et al 2021). These conditions are exacerbated by climate change, which increases the risk of natural disasters such as floods and droughts, which ultimately affect living conditions and increase the risk of disease spread. In addition, limited access to health services in poor areas leads to delays in diagnosis and treatment of leprosy, which can increase the risk of disability. Many individuals in these areas are unable to access timely treatment, resulting in more severe leprosy and irreversible nerve damage (Gopalakrishnan et al 2021). Thus, climate change exacerbates existing socio-economic inequalities, which in turn worsens the health impacts of leprosy.

Population displacement due to climate change also affects the epidemiological dynamics of leprosy. When natural disasters such as floods and droughts force populations to migrate from rural to urban areas, the risk of leprosy transmission increases. This migration is often accompanied by crowded living conditions in informal settlements in urban areas, where access to sanitation and health services is very limited (Murto et al 2013). This condition increases the possibility of contact between infected individuals and healthy populations, thereby increasing the spread of the disease.

Increased Disability Due to Leprosy and Climate Change

Current climate change has significant impacts on health, especially for those with leprosy. High rainfall, unstable temperatures, and increased humidity have an impact on the physical condition of leprosy sufferers, which is getting worse. These environmental factors can accelerate nerve damage, worsen skin wounds, and affect the mobility of sufferers, thus requiring more intensive medical attention. Some of the possible impacts include: (1) Secondary Infection – High humidity can cause wounds on the skin of leprosy sufferers to be more susceptible to secondary infections, especially by bacteria or fungi; (2) More Severe Nerve Damage – Unstable temperatures can worsen the condition of nerves that have been affected by leprosy, causing the sensation of pain or numbness to worsen, (3) Increased Risk of Trophic Ulcers – Unstable humidity and temperature can accelerate the formation of open wounds or trophic ulcers on parts of the body that often experience pressure, such as the feet and hands; and (4) Immune Disorders – Extreme weather changes can affect the immune system of sufferers, which can slow down the healing process or worsen their condition. To overcome these impacts, leprosy sufferers are advised to maintain skin cleanliness, wear comfortable and dry clothing, and undergo regular medical check-ups to prevent further complications (Ahmed 2024, Pender 2022).

Climate change is possibility impacted for increased health vulnerability for people affected by leprosy. People affected by leprosy experience nerve damage that is reducing their ability to sense pain or temperature, and then extreme heat can lead to burns and other injuries. Higher temperatures and humidity can worsen ulcers and infections, making it harder to manage symptoms. Climate disasters (floods,

storms, droughts) can disrupt medical supply chains and healthcare services, leaving those with disabilities without essential medication, mobility aids, and wound care. Progressively, long period of climate change affected exacerbation of existing disabilities. Extreme weather events make it harder for people with leprosy-related disabilities to access medical care, rehabilitation, and assistive devices. Changes in temperature and humidity can worsen nerve damage, ulcers, and secondary infections in people with leprosy-related disabilities (Ahmed 2024, Lockwood & Darlong 2023, Pender 2021 & 2022).

Leprosy primarily affects the skin and peripheral nerves, leading to nerve damage that reduces the ability to sense pain, temperature, or touch. As a result, individuals with leprosy may not notice injuries, burns, or infections, which can worsen over time without proper care. Extreme heat poses a significant risk for people with leprosy because: (1) Loss of sensation prevents them from feeling when their skin is burning; (2) Delayed response to heat exposure can lead to severe burns before they realize there's an injury; and (3) Repeated injuries may result in ulcers, infections, and permanent tissue damage. Because of these risks, people affected by leprosy need protective measures such as: wearing appropriate footwear to avoid burns from hot surfaces, using gloves or tools to handle hot objects, regularly inspecting their skin for unnoticed injuries, and keeping affected limbs moisturized and protected (Ahmed 2024, Pender 2022).

One of the most significant impacts of the increased spread of leprosy due to climate change is the increase in disability among sufferers. Disability in persons affected by leprosy is mostly caused by nerve damage caused by the infiltration of *M. leprae* bacteria into the peripheral nervous system. Factors such as late diagnosis, lack of

adequate treatment, and limited access to health rehabilitation are the main causes of the high rate of disability in persons affected by leprosy (Pratama et al 2022).

Studies have shown that persons affected by leprosy who receive treatment late have a higher risk of experiencing permanent disability. Nerves that have been infected by *M. leprae* often experience permanent damage if not managed appropriately and timely (Dharmawan et al 2023, Gopalakrishnan et al 2021). With the increasing prevalence of leprosy due to climate change, more individuals may be exposed to the risk of irreversible nerve damage, ultimately increasing the disability rate in affected populations. Disability caused by leprosy is also exacerbated by leprosy reactions, such as acute neuritis, which can accelerate the process of nerve damage (Susanto et al 2022). These reactions often occur in the advanced stages of the disease and can lead to physical deterioration of the patient. Patients with multibacillary (MB) leprosy having higher bacterial load, are at greater risk of developing severe leprosy reactions, ultimately worsening disability (de Paula et al 2019, Santos et al 2015). Therefore, more effective leprosy control and early diagnosis are essential to reduce the risk of disability amidst climate change.

Adaptation and Mitigation Strategies for the Impact of Climate Change on Leprosy

One important strategy is to increase access to better health services, especially in areas that are vulnerable to climate change and have high leprosy prevalence rates (Whitfield et al 2022). Strengthening health systems, including early diagnosis and appropriate treatment, is essential to reduce disability rates in people with leprosy.

In addition, policies that integrate health considerations into climate policies are also needed to address the long-term impacts of

climate change on the spread of infectious diseases, including leprosy (Watts et al 2019). Climate policies that take health impacts into account can help reduce the risk of natural disasters that exacerbate the spread of leprosy, such as floods and droughts, and increase the resilience of vulnerable communities to climate change. Another adaptation strategy that needs to be considered is increasing public awareness of the importance of sanitation and healthy environmental conditions in preventing the spread of the disease. Educational programs aimed at increasing public knowledge about ways to prevent leprosy transmission and the importance of early treatment can contribute significantly to reducing the prevalence and impact of leprosy in areas affected by climate change (Schnitter & Berry 2019).

The relationship between climate change and leprosy becomes clearer when we look at how climate change affects the social and economic conditions of vulnerable communities (Susanto 2020). Tropical and subtropical regions that are already struggling with the disease will be further burdened by the impacts of climate change such as rising temperatures, changing rainfall patterns, and extreme weather events that worsen the living conditions of poor communities. These changes not only affect the health of individuals but also disrupt public health systems that are already limited in their ability to deal with outbreaks of diseases such as leprosy (Mahardita et al 2019).

Conclusion

Climate change is a major challenge that affects various aspects of human life, including health. In the context of leprosy, climate change has the potential to increase the risk of disability in patients through various mechanisms, both direct and indirect. Climate change intensifies the potential risks of disabilities among people

affected by leprosy by worsening transmission conditions, delaying treatment, increasing malnutrition, and disrupting healthcare access. Addressing these challenges requires integrated public health, climate adaptation, and social support strategies to protect vulnerable populations. This article is expected to provide newer insights into how climate change may affect the health of leprosy patients, especially in terms of disability, and provide basis for policy recommendations that can be implemented to mitigate its impacts. This will not only contribute to the scientific literature but also help in designing more adaptive and sustainable public health strategies in the future.

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