Association Between Dengue Fever and Meteorological Conditions in Rural Myanmar

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Abstract

The present study utilized secondary and interdisciplinary data to provide a more comprehensive picture of dengue fever in Mandalay region, with emphasis on a rural, flood-prone township. To advance Sustainable Development Goal 3.3.5 (reducing the number of people requiring interventions against neglected tropical diseases), this study combined interdisciplinary data from infectious disease epidemiology, zoology, and geography. In 2016, 526 cases of dengue were reported across five townships in Mandalay region, with an average of 105.2 (SD = 18.94) cases per township. Four of the five townships exhibited peak dengue transmission in July, which corresponds to the year's peak rainfall and severe regional flooding. Incidence rates in the region ranged from 3.94 to 4.88 cases per 10,000 people. The incidence rate in Amarapura was not statistically significantly different from the regional incidence rate ($p = 0.38$). However, the rural township in Mandalay had a much lower case density (0.57 cases per km^2) than other townships, which ranged from 3.79-6.53 cases per km^2. These findings highlight the need to prioritize rural areas in the larger global development agenda in Southeast Asia.

Keywords: Dengue fever, One Health, Myanmar

1. Introduction

Dengue fever is a mosquito-borne virus transmitted to humans by a bite from an infected *Aedes aegypti* or *Aedes albopictus* mosquito [10]. About 40% of the world's population lives in tropical or subtropical climates where there is a risk of dengue transmission [10]. While some people infected with dengue may experience no symptoms, most often the virus is characterized by symptoms similar to influenza, such as high fever and generalized somatic pain [5]. Typically, symptoms last from 2-7 days, but in severe cases, dengue can progress to Dengue Hemorrhagic Fever (DHF) or Dengue Shock Syndrome [10].

Dengue is hyperendemic in Southeast Asia, where the increasing incidence rate creates cyclical outbreaks every few years [9]. Since 1970, when the first outbreak of DHF struck Myanmar, the country has engaged in both vector control and disease surveillance [6]. Despite more attention to vector control efforts, Myanmar continues to experience a high burden of dengue cases which strain already limited resources [9]. From 2011-2015,

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Myanmar reported a total of 89,832 cases and a fatality rate of 0.44%, most which occur during the country's wet season (May-September) [9]. It is estimated that every dengue case that requires hospitalization in Myanmar results in $81.50 USD of healthcare costs, while outpatient cases cost $23.90 per patient [9]. This translates to an annual economic burden of $14.5 million USD and 13,620 disability adjusted life years (DALYs) [9].

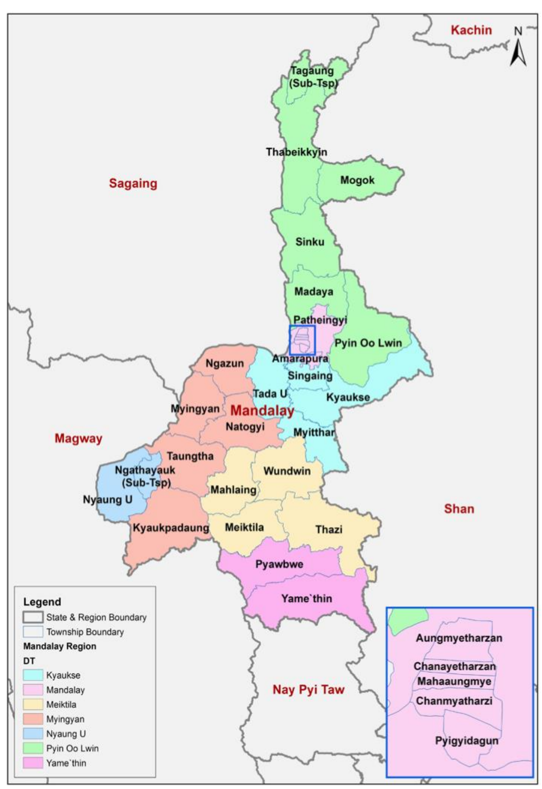
In rural Amarapura, a rural township of Mandalay City, proximity to both Thaung Ta Man Lake and the Irrawaddy River means that the intense rainfall during the wet season leads to severe seasonal flooding [3]. The increase in standing water combined with high temperatures provides both ample breeding ground for *Aedes* mosquitoes as well as shorter incubation periods for the dengue infection [8]. Understanding dengue's relationship with meteorological factors, such as rainfall, will aid in better preparing an early warning system for dengue outbreaks and allow for the deployment of health response resources to areas of Myanmar where seasonal flooding or poor health infrastructure may limit access to treatment.

2. Methods

Study Area

The present study looks at secondary data from five townships of Mandalay: Amarapura, Pyigyidagun, Aungmyetharzan, Mahaaungmye, and Chanayetharzan.

Figure 1 : Map of Mandalay Region, showing the townships



Dengue Data.

Data on dengue cases were based on monthly case reports from all five townships obtained from the Mandalay Health Office, Department of Disease Control during the year of 2016. Cases were reported based on the World Health Organization (WHO) clinical definition of dengue [6].

Census Data.

Information regarding the geographical size and human population of each township was obtained from the most recent national census, which occurred in 2014 [7].

3. Results and Discussion

Amarapura is the largest of the five neighboring townships with an area of 205 km^2. The four remaining townships are considerably smaller, ranging from only 13.1 km^2 to 28.6 km^2. Amarapura is also the only rural township studied here. Only 34% of residents in Amarapura are considered "urban" residents, compared to 00% of households in the other townships.

Table 1. *Size of Mandalay City Townships*

Township	Geographical Area (km^2)	Population
Amarapura	205	237,618
Aungmyetharzan	28.6	265,779
Chanayetharzan	13.1	197,175
Mahaaungmye	14.8	241,113
Pyigyidagun	25.6	237,698

In 2016, the five townships studied here reported 526 cases of dengue. The average number of cases was 105 (SD = 18.94). In four townships (Amarapura, Pyigyitagon, Aungmyetharzan, and Chanayetharzan), dengue cases peaked in July. The lowest incidence rate was in Mahaaungmye (3.94 cases per 10,000 population), while the highest incidence rate occurred in Amarapura (4.88 cases per 10,000 population). The differences in incidence rates were not statistically significantly different from each other. However, rural Amarapura saw dengue cases that were much more geographically disperse, with only 0.57 cases per km^2. The case density for the urban townships 6.53 cases per km^2 in Chanayetharzan to 3.79 cases per km^2 in Pyigyidagun. Rainfall data for the Mandalay region shows that dengue cases largely mirror the seasonal changes in precipitation [1].

__Table 2.__ Dengue in Mandalay City Townships

Township	Cases	Incidence (per 10,000 pop.)	Case Density (cases per km^2)
Amarapura	116	4.88	0.57
Aungmyetharzan	128	4.82	4.48
Chanayetharzan	79	4.01	6.53
Mahaaungmye	95	3.94	6.42
Pyigyidagun	108	4.54	3.79

4. Conclusions

The central region of Myanmar, including the five townships of Mandalay studied here, receive predictable annual patterns of increased precipitation during the country's wet season [1]. While much of the Mandalay region is urban, there are pockets of rural land that receive the same heavy rainfall, without the benefit of the city's improved drainage systems. In Amarapura, proximity to large bodies of water produce severe flooding [3]. With the warmer temperatures and increase in water comes an expected uptick in mosquito borne diseases like dengue [2].

Urban townships around Mandalay have higher dengue case densities, meaning the cases are closer together geographically. However, the improved transportation and health delivery infrastructure of urban contexts is better equipped to handle the burden of dengue in times of outbreak. In Amarapura, which is both the only rural township and the township with the highest incidence of dengue, cases are much more spread out over a larger geographic area. Infected patients must travel further distances to reach care facilities, which may become impossible in years with dangerous flooding.

The relatively predictable patterns of rainfall and zoonotic disease provides the opportunity to create early warning systems for dengue outbreaks and deploy the resources necessary for an effective response. Studies on dengue surveillance have shown that meteorological conditions can be used to predict outbreaks of dengue fever as much as five months in advance [4]. Such a system would allow rural residents, like those in Amarapura, to mitigate their risk of contracting dengue. It would also allow additional health resources for the treatment of dengue to be deployed to flood-prone rural areas before seasonal rains make transportation more difficult.

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