

## **The Relationship Between Floods and Dengue Fever Incidence: Epidemiology, Risk Factors, and Prevention**

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### **ABSTRACT**

In recent years, climate change has led to increased rainfall resulting in flooding, which has a close relationship with a rise in dengue fever (DBD) cases as it creates an ideal environment for the *Aedes aegypti* mosquito, the main vector of the disease. Dengue fever is one of the major health problems in tropical countries such as Indonesia, which has the highest number of cases in Southeast Asia. The method used in this literature review was to determine the topic, then identify keywords to search for journals in English using databases including Google Scholar, ScienceDirect, PubMed, and SINTA. This review analyzes the relationship between flooding and the incidence of dengue fever, and discusses epidemiology, risk factors, and prevention, as flooding is a frequent natural disaster in Indonesia. The conclusion is that there is a relationship between flooding and dengue fever, because floods create puddles of water that can serve as breeding grounds for *Aedes aegypti*. Dengue fever is endemic in more than 100 countries, especially in tropical and subtropical regions. Various risk factors can exacerbate its incidence, including environmental, socioeconomic, and behavioral factors. Dengue can be prevented in multiple ways, one of which is implementing the 3M Plus Mosquito Nest Eradication (PSN) program: draining water reservoirs, closing containers that can hold water, and reusing used goods that have the potential to become mosquito nests. These measures need to be implemented to reduce dengue fever cases.

**Keyword :** *Aedes aegypti* mosquito; dengue fever; disaster; epidemiology; floods;

## Introduction

Floods are the most frequent type of natural disaster, occurring as a result of sea level rise and extreme rainfall, both of which are consequences of climate change <sup>1</sup>. In recent decades, the intensity and frequency of flooding events have increased globally, with low-lying and coastal nations being disproportionately affected. Indonesia, as an archipelagic country with tropical climate and high rainfall intensity, is particularly vulnerable to flooding. In Indonesia, flooding is one of the most common natural disasters and often causes significant environmental damage, including loss of topsoil, contamination of water sources, and destruction of infrastructure <sup>2</sup>. Beyond its environmental impacts, flooding also contributes to the emergence of various diseases, including dengue fever, as it creates ideal breeding grounds for *Aedes aegypti* mosquitoes, the primary vector of the disease <sup>3</sup>.

Dengue fever (DBD) is a viral infection transmitted through the bite of infected female *Aedes* mosquitoes, primarily *Aedes aegypti* and to a lesser extent *Aedes albopictus*. The disease manifests with a wide spectrum of clinical symptoms, ranging from mild febrile illness to severe dengue hemorrhagic fever and dengue shock syndrome, which can be fatal if not promptly treated. According to World Health Organization (WHO) data, Indonesia has recorded the highest number of dengue fever cases in Southeast Asia from 1968 to 2009 <sup>4</sup>. Even in recent years, Indonesia continues to report hundreds of thousands of cases annually, with the peak of transmission typically occurring during the rainy season when standing water from both rainfall and flooding provides abundant mosquito breeding sites.

Dengue fever is a mosquito-borne viral disease predominantly found in tropical and subtropical regions <sup>4</sup>. The global burden of dengue has increased dramatically over the past five decades, with an estimated 390 million infections occurring annually worldwide, of which approximately 96 million manifest clinically. The expansion of dengue into previously unaffected areas has been linked to climate change, urbanization, and increased human mobility. Several risk factors can increase an individual's susceptibility to dengue infection. Environmental factors play a crucial role, as *Aedes aegypti* mosquitoes thrive in warm and humid areas. Consequently, countries such as Canada, Russia, and most of Northern Europe report no endemic dengue cases because the vector mosquito cannot survive in low temperatures <sup>2,4</sup>.

In addition to environmental conditions, there are various other risk factors, including socioeconomic and behavioral factors, that influence dengue transmission <sup>2</sup>. Socioeconomic factors such as population density, inadequate waste management, and lack of access to clean

water supply can force communities to store water in open containers, which become mosquito breeding habitats. Behavioral factors include low levels of community participation in mosquito nest eradication programs, poor awareness of early symptoms, and limited use of personal protective measures such as insect repellent and bed nets. Furthermore, housing conditions such as lack of window screens and poor ventilation also contribute to higher mosquito-human contact rates.

The relationship between flooding and dengue fever is complex and not simply linear. On one hand, heavy floods can wash away existing mosquito larvae and breeding sites, temporarily reducing mosquito populations. On the other hand, receding floodwaters leave behind numerous stagnant puddles, discarded containers, and debris that serve as new breeding grounds. Moreover, during post-flood conditions, displaced populations often live in temporary shelters with inadequate sanitation, further increasing exposure to mosquito bites. Therefore, understanding this relationship is critical for designing effective public health interventions <sup>5</sup>.

Therefore, public knowledge regarding dengue fever is essential to enable early detection and understanding of its causes, epidemiology, risk factors, and prevention strategies. Without adequate knowledge, communities may fail to recognize early warning signs, delay seeking medical help, or neglect vector control measures. Health education has been proven to be an effective tool in improving community behavior related to dengue prevention. Several studies have shown that well-designed health promotion campaigns significantly increase the adoption of 3M Plus (draining, closing, and recycling) and other evidence-based practices. This literature review aims to analyze the relationship between flooding and the increase in dengue fever cases, as well as to discuss the epidemiology, risk factors, and prevention of the disease. By synthesizing current evidence, this review is expected to provide recommendations for policy makers, health workers, and communities in reducing the dual burden of flooding and dengue in endemic regions.

## **Material and Methods**

This study employed a literature review design to examine the relationship between flooding and the incidence of dengue fever, including its epidemiology, risk factors, and prevention strategies. The review process was conducted systematically through the following stages. First, the research title was defined as "The Relationship Between Floods and Dengue Fever Incidence: Epidemiology, Risk Factors, and Prevention." Second, relevant keywords were identified to guide the literature search. The keywords used included

"floods," "dengue fever," "epidemiology," "risk factors," "prevention," and "vector-borne diseases." These keywords were applied individually or in combination using Boolean operators (AND, OR) to optimize search specificity.

Third, a systematic literature search was performed using four scientific databases: Google Scholar, ScienceDirect, PubMed, and SINTA. The search was restricted to publications from 2016 to 2025 to ensure the currency and relevance of the evidence. Fourth, article selection criteria were established. The inclusion criteria were: (a) studies examining the relationship between flooding and dengue fever incidence; (b) articles addressing epidemiology, risk factors, or prevention of dengue fever in the context of flooding; (c) publication types including original research and systematic or narrative reviews; and (d) articles published in peer-reviewed journals. The exclusion criteria were: (a) non-English articles; (b) opinion pieces, editorials, or conference abstracts without full text; and (c) studies not specifically linking flooding to dengue transmission. Fifth, after initial screening of titles and abstracts, full-text articles were retrieved and assessed for eligibility based on content relevance, source credibility (e.g., journal reputation and indexing status), and methodological quality. Sixth, selected articles were subjected to data extraction and analysis. Key findings were synthesized to identify patterns regarding the epidemiology of flood-induced dengue fever, contributing risk factors (environmental, socioeconomic, and behavioral), and recommended prevention strategies, particularly vector control measures such as the 3M Plus program.

Finally, the synthesized results were organized to construct a comprehensive literature review that provides an evidence-based understanding of how flooding influences dengue fever incidence and offers practical recommendations for public health interventions.

## **Discussion**

This journal review analyzes the relationship between flooding and the incidence of dengue fever and discusses epidemiology, risk factors, and prevention because flooding is a natural disaster that occurs frequently in Indonesia.

### **Relationship between Floods and Increased Cases of Dengue fever**

Flooding has an impact on the spread of mosquito-borne diseases, especially dengue fever. Poor drainage infrastructure in urban areas exacerbates the situation, as poorly channeled rainwater creates stagnant water which is an ideal place for the *Aedes aegypti* mosquito, the main vector of dengue virus to breed. From the collected journals, it shows that there is an increase in dengue cases and an estimated 6.1 billion people will be at risk of

dengue by 2080 due to global warming<sup>5</sup>. Because global warming can increase rainfall which results in flooding.

### **Epidemiology**

Globally the epidemiology of dengue fever is endemic in more than 100 countries, mainly in tropical and subtropical regions such as Southeast Asia, Latin America, the Western Pacific, and Africa. The incidence of dengue fever continues to increase globally, with an estimated 390 million cases per year, of which approximately 96 million cases are clinically symptomatic<sup>5</sup>. Asia accounts for about 70% of the total global dengue cases, this is because Asia has an environment that supports the breeding of *Aedes aegypti* mosquitoes. Some Asian countries such as Indonesia and Thailand experience an increase in cases during the rainy season. Outside of Asia, an increase in cases has also occurred in Africa and the Middle East, with more cases being reported from regions such as Gabon and Afghanistan<sup>6</sup>. The spread of dengue virus is also starting to reach non-endemic areas such as Florida (USA), France, Spain, Japan and southern China. This is due to climate change and human mobility.

In addition to global epidemiology, there is also regional epidemiology, namely in Southeast Asia as well as Africa and the Middle East. Southeast Asia has the highest dengue burden in the world. Indonesia and Thailand recorded a pattern of increased cases during the rainy season. Sri Lanka experienced the largest epidemic in 2017 with 186,101 cases and more than 320 deaths<sup>7</sup>. Whereas in Africa and the Middle East dengue is increasingly being reported in countries such as Gabon and Afghanistan, indicating a geographical expansion of the disease into areas that were not previously endemic<sup>6</sup>. This could be due to climate change as well as human mobility.

The epidemiology of dengue fever in Indonesia itself, especially in DKI Jakarta, has varying levels of dengue fever vulnerability, namely high vulnerability levels (19 sub-districts), including Cengkareng, Cakung, Pulogadung, Jatinegara, and Tanjung Priok. Medium vulnerability level (10 sub-districts), including Duren Sawit, Kalideres, Kebayoran Lama, and Tanah Abang and low vulnerability level (15 sub-districts), including Thousand Islands, Kelapa Gading, and Palmerah. East Jakarta had the highest number of cases, while Kepulauan Seribu had the lowest or zero cases in 2016. The main factors contributing to high dengue cases in Jakarta are flooding and population density<sup>8</sup>.

### **Risk Factors**

Risk factors are conditions or characteristics that can increase the likelihood of a person developing a disease, in this case dengue fever. There are three risk factors for dengue

fever: environmental factors, socioeconomic factors, and behavioral factors. Environmental risk factors include flooding, which creates stagnant water that is a breeding ground for dengue vector mosquitoes<sup>9</sup>. In addition, urbanization and poor environmental sanitation systems are also risk factors for dengue fever. Furthermore, socioeconomic factors, such as low socioeconomic status, are also risk factors for dengue fever due to limited access to clean water, poor sanitation, and lack of education on dengue prevention<sup>5</sup>. And also population mobility can increase the spread of the dengue virus. The last risk factor is behavioral factors such as lack of public awareness about dengue fever and how to prevent it<sup>7</sup>. In addition, the habit of storing water without a lid can also become a nest for the *Aedes aegypti* mosquito<sup>8</sup>.

### **Prevention**

To prevent the transmission of dengue fever due to flooding, various precautions can be implemented by improving health services in affected areas by providing stock of medicines. In addition, disease surveillance systems must be strengthened to detect dengue cases early and prevent their spread<sup>2</sup>. Providing clean water and improving sanitation is also one way to reduce the breeding grounds of the *Aedes aegypti* mosquito, which is the vector of dengue fever<sup>10</sup>. Community education is also needed so that they understand the importance of maintaining environmental hygiene, using mosquito repellents, and implementing mitigation and emergency response measures<sup>7</sup>. In an effort to control mosquito vectors, the 3M Plus Mosquito Nest Eradication (PSN) program should be promoted, namely by draining water reservoirs, closing containers that can hold water, and reusing used items that have the potential to become mosquito nests.<sup>8</sup> In addition, fogging optimization needs to be carried out in high-risk areas<sup>2</sup>. The 1 House 1 Jumantik (G1R1J) movement should also be implemented so that people are more active in ensuring their environment is free from mosquito larvae<sup>8</sup>. As an additional measure, people can utilize mosquito repellent plants such as lavender, lemongrass, basil, and lemon to reduce the mosquito population around the house<sup>11</sup>. By implementing these things in a disciplined and sustainable manner, the risk of dengue transmission due to flooding can be minimized, so that public health is maintained<sup>2</sup>.

### **Conclusion**

There is a relationship between flooding and dengue fever, as floods create puddles of water that can be breeding grounds for the *Aedes aegypti* mosquito. The epidemiology of dengue fever itself is that dengue fever is endemic in more than 100 countries, especially in tropical and subtropical regions. In addition, there are various risk factors that can exacerbate

the incidence of dengue fever, be it factors originating from the environment, socio-economic factors, or behavioral factors. Dengue fever can also be prevented in various ways, one of which is by implementing the 3M Plus Mosquito Nest Eradication (PSN) program, namely by draining water reservoirs, closing containers that can hold water, and reusing used goods that have the potential to become mosquito nests. This needs to be implemented to reduce dengue fever cases.

## References

1. Shah AA, Ye J, Shaw R, Ullah R, Ali M. Factors affecting flood-induced household vulnerability and health risks in Pakistan: The case of Khyber Pakhtunkhwa (KP) Province. *Int J Disaster Risk Reduct.* 2020;42:10134.
2. Wibawa BSS, Wang YC, Andhikaputra G, Lin YK, Hsieh LHC, Tsai KH. The impact of climate variability on dengue fever risk in Central Java, Indonesia. *Clim Serv.* 2024;33:100433.
3. Carazo Gallego B, Montesinos Sanchis E, Martínez Campos L, López Medina EM, Alegría Coll I, García López Hortelano M, et al. Enfermedades infecciosas más frecuentes asociadas a inundaciones en niños. *An Pediatr (Barc).* 2025.
4. Jing Q, Wang M. Dengue epidemiology. *Glob Health J.* 2019;3(2):37–45.
5. Namirimu T, Kim S. Dengue fever: epidemiology, clinical manifestations, diagnosis, and therapeutic strategies. *Ann Clin Microbiol.* 2024;27(2):131–41.
6. Suhr F, Steinert JJ. Epidemiology of floods in sub-Saharan Africa: a systematic review of health outcomes. *BMC Public Health.* 2022;22(1):268.
7. Jayawickreme KP, Jayaweera DK, Weerasinghe S, Warapitiya D, Subasinghe S. A study on knowledge, attitudes and practices regarding dengue fever, its prevention and management among dengue patients presenting to a tertiary care hospital in Sri Lanka. *BMC Infect Dis.* 2021;21:1–14.
8. Widyatami AI, Suryawan DA. Pengelompokan daerah rawan demam berdarah dengue di Provinsi DKI Jakarta. *Indones Health Inf Manag J (INOHIM).* 2021;9(1):73–82.
9. Shokri A, Sabzevari S, Hashemi SA. Impacts of flood on health of Iranian population: Infectious diseases with an emphasis on parasitic infections. *Parasite Epidemiol Control.* 2020;9:e00144.
10. Saatchi M, Khankeh HR, Shojafard J, Barzanji A, Ranjbar M, Nazari N, et al. Communicable diseases outbreaks after natural disasters: A systematic scoping

- review for incidence, risk factors, and recommendations. *Prog Disaster Sci.* 2024;23:100334.
11. Permatananda PANK, Rusni NW, Pandit IGS, Aryastuti AASA. Mitigasi bencana, kesehatan lingkungan, dan pengendalian vektor penyakit pada kelompok warga terdampak banjir bandang di Desa Penyarangan, Jembrana. *Community Dev J.* 2023;4(3):6309–16.
  12. Liu Q, Yuan J, Yan W, Liang W, Liu M, Liu J. Association of natural flood disasters with infectious diseases in 168 countries and territories from 1990 to 2019: A worldwide observational study. *Glob Transit.* 2023;5:149–59.
  13. Montenegro D, Cortés-Cortés G, Balbuena-Alonso MG, Warner C, Camps M. Wolbachia-based emerging strategies for control of vector-transmitted disease. *Acta Trop.* 2024;260:107410.
  14. Rosser JI, Openshaw JJ, Lin A, Taruc RR, Tela A, Tamodding N, et al. Seroprevalence, incidence estimates, and environmental risk factors for dengue, chikungunya, and Zika infection amongst children living in informal urban settlements in Indonesia and Fiji. *BMC Infect Dis.* 2025;25(51).
  15. Petrova D, Lowe R, Stewart-Ibarra A, Ballester J, Koopman SJ, Rodó X. Sensitivity of large dengue epidemics in Ecuador to long-lead predictions of El Niño. *Clim Serv.* 2019;15:100096.
  16. Tahir MJ, Siddiqi AR, Ullah I, Ahmed A, Dujaili J, Saqlain M. Devastating urban flooding and dengue outbreak during the COVID-19 pandemic in Pakistan. *Med J Islam Repub Iran.* 2020;34:169.
  17. Khan MB, Yang ZS, Lin CY, Hsu MC, Urbina AN, Assavalapsakul W, et al. Dengue overview: An updated systemic review. *J Infect Public Health.* 2023;16:1625–42.
  18. Kularatne SA, Dalugama C. Dengue infection: Global importance, immunopathology and management. *Clin Med.* 2022;22(1):9–13.
  19. Coalson JE, Anderson EJ, Santos EM, Madera Garcia V, Romine JK, Luzingu JK, et al. The complex epidemiological relationship between flooding events and human outbreaks of mosquito-borne diseases: a scoping review. *Environ Health Perspect.* 2021;129(9):096002.
  20. Lim JK, Fernandes JF, Yoon IK, Lee JS, Mba RO, Lee KS, et al. Epidemiology of dengue fever in Gabon: Results from a health facility-based fever surveillance in Lambaréné and its surroundings. *PLoS Negl Trop Dis.* 2021;15(2):e0008861.
  21. Sahak MN. Dengue fever as an emerging disease in Afghanistan: Epidemiology of

- the first reported cases. *Int J Infect Dis.* 2020;99:23–27.
22. Vohra LI, Aqib M, Jamal H, Mehmood Q, Yasin F. Rising cases of dengue and malaria in flood-affected areas of Pakistan: A major threat to the country's healthcare system. *Disaster Med Public Health Prep.* 2023;17:e323.
  23. Sutriyawan A, Aba M, Habibi J. Determinan epidemiologi demam berdarah dengue (DBD) di daerah perkotaan: Studi retrospektif. *J Nurs Public Health.* 2020;8(2):1–9.
  24. Zebua R, Gulo VE, Purba I, Gulo MJK. Perubahan epidemiologi demam berdarah dengue (DBD) di Indonesia tahun 2017–2021. *SEHATMAS J Ilm Kesehat Masyarakat.* 2023;2(1):129–36.
  25. Irma I, AF SM. Trend penyakit demam berdarah dengue (DBD) di Sulawesi Tenggara berbasis ukuran epidemiologi. *JUMANTIK J Ilm Penelit Kesehat.* 2021;6(1):70–78.
  26. Amalia M, Nursapriani. Edukasi tentang pentingnya menjaga lingkungan dan perilaku masyarakat dengan kejadian demam berdarah dengue (DBD). *NUSANTARA J Pengabdian Kpd Masyarakat.* 2021;1(2):11–21.
  27. Karomah B, Sari IM. Aplikasi model ARIMA musiman untuk meramalkan jumlah penderita demam berdarah dengue (DBD). *J Kolaboratif Sains.* 2024;7(2):874–86.
  28. Yulendasari R, Rilyani R, Widodo S, Rizwan AK, Hidayah AR, Herliza H. Penyuluhan kesehatan demam berdarah dengue di Kelurahan Pidada, Panjang, Bandar Lampung. *J Public Health Concerns.* 2023;3(1):52–57.
  29. Mirahesti ESM. Evaluasi perencanaan prabencana banjir Bengawan Solo Kabupaten Bojonegoro tahun 2014. *J Berkala Epidemiol.* 2016;4(2):262–74.
  30. Husna I, Putri DF, Triwahyuni T, Kencana GB. Analisis faktor yang mempengaruhi kejadian demam berdarah dengue di wilayah kerja Puskesmas Way Kandis Bandar Lampung tahun 2020. *J Analis Kesehatan.* 2020;9(1):9–16.
  31. Sandra T, Sofro MAU, Suhartono, Martini, Hadisaputro S. Faktor-faktor yang berpengaruh terhadap kejadian demam berdarah dengue pada anak usia 6–12 tahun di Kecamatan Tembalang. *J Epidemiol Kesehat Komunitas.* 2019;4(1):1–10.