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The Influence of Environmental Factors on the Development of Dengue Fever

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Abstract. *Dengue fever (DF) remains a significant public health concern, particularly in tropical regions such as Indonesia. This narrative review explores the influence of environmental factors on the development and transmission of DF. Key environmental determinants, including standing water, temperature, humidity, urbanization, and climate change, play pivotal roles in shaping the epidemiology of DF. Poor sanitation and inadequate waste management provide breeding grounds for Aedes aegypti mosquitoes, while rising temperatures and fluctuating rainfall patterns accelerate mosquito reproduction and virus transmission. Urbanization exacerbates DF risks by fostering unplanned infrastructure development and population density, limiting green spaces essential for mosquito predator habitats. Additionally, the review highlights the critical role of family behavior and community participation in dengue prevention, particularly through education on healthy and clean living practices. Addressing these factors requires collaborative strategies, integrating public education, urban planning, and climate adaptation to mitigate DF risks effectively. This study underscores the need for sustainable, multi-sectoral approaches to manage DF, reduce its incidence, and protect public health.*

Keywords: *Dengue, Fever, Mosquitoes, Epidemiology*

1. INTRODUCTION

Dengue fever (DF) is a significant public health issue, particularly in tropical countries such as Indonesia This disease is a viral infection transmitted through the bites of Aedes aegypti and Aedes albopictus mosquitoes. The Ministry of Health of the Republic of Indonesia has reported a significant increase in the number of DF cases in recent years, reaching thousands of cases annually. Data from 2022 revealed that over 80,000 cases of DF were reported in Indonesia, with 1.2% of these cases resulting in fatalities (Kemenkes RI, 2022). The development of dengue fever is closely associated with environmental factors.

Standing water, high humidity, and warm temperatures are conditions that support the growth and reproduction of mosquitoes. According to research by Asmuni et al. (2020), dengue epidemics are more likely to occur in areas with consistently high rainfall and average temperatures exceeding 27 degrees Celsius. These findings illustrate how an increase in dengue cases can be driven by climate change and other ecological factors. Additionally, factors contributing to the spread of mosquitoes carrying the dengue virus include rapid urbanization and changes in land use. In urban areas, the abundance of water storage containers such as bathtubs and other vessels becomes breeding grounds for mosquitoes. In other research results show that increasing humidity, as well as rainfall,

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have been shown to increase the risk of dengue fever transmission in various regions in Indonesia (Putri, 2023).

Moreover, rapid urbanization and changes in land use also contribute to the spread of mosquitoes carrying the dengue virus. In urban areas, the abundance of water storage sites, such as bathtubs, stagnant water in drains, and various containers, serves as breeding grounds for mosquitoes. Research by Fahrizal et al. (2019) found that the level of urbanization in a region has a positive coefficient of 4.6308, indicating that any change in status from a rural district to an urban city, typically accompanied by increased population density, can result in a rise in the dengue fever incidence rate (IR) by 4.6308 per 100,000 population.Therefore, it is crucial to gain a deeper understanding of how environmental factors can influence the development of dengue fever.

This review explores the influence of various environmental factors on the development of dengue fever. The findings aim to inform policymakers and communities about preventive strategies to control the disease. Additionally, the article seeks to identify specific environmental factors that contribute to the rise in dengue cases and offer practical recommendations to mitigate the associated risks.

2. METHODS

This narrative review synthesizes findings from recent studies on the relationship between environmental factors and dengue fever. Literature was sourced from databases from Google Scholar, focusing on studies published between 2018 and 2023. Keywords used in the search included 'dengue fever', 'environmental factors', 'urbanization', and 'climate change'. Inclusion criteria involved studies discussing environmental factors and DF epidemiology in tropical regions, particularly Indonesia. Articles discussing solely clinical aspects of DF were excluded.

3. RESULTS AND DISCUSSIONS

Physical Environmental Factors

Physical environmental factors play a crucial role in the development of dengue fever (DF). One of the most significant factors is the presence of stagnant water, which serves as breeding grounds for Aedes aegypti mosquitoes. Research by Nurul Izza and Mulasari (2023) indicates that regions with poor sanitation and numerous pools of water experience a 30% higher prevalence of DF compared to areas with better-managed

environments. The data indicate that regions with over five storage facilities experience up to a 30% increase in DF incidence compared to those with better sanitation.

Besides stagnant water, temperature and humidity also influence mosquito activity. Optimal temperatures for Aedes aegypti range from 25°C to 30°C, while high humidity supports the reproductive process of these mosquitoes. Saputra et al. (2023) observed that high humidity increases the risk of DF transmission, as mosquitoes live longer and are more likely to spread the dengue virus in level about 70% face increased risks of contracting DF. Climate changes leading to elevated temperatures and humidity contribute to rising DF case counts. The lifespan of mosquitoes, flight distance, breeding speed, biting habits, resting, and other factors are influenced by humidity. In Majene Regency, for example, an average humidity level of 78.4% was linked to prolonged mosquito lifespans, intensifying virus transmission risks (Rahma, 2022). Aedes mosquitoes more frequently suck the blood of people infected with the dengue virus and survive longer to transmit the dengue virus to others, which can increase dengue cases (Rahma, 2022).

For instance, in some Indonesian districts, heavy rainfall during the wet season leads to increased stagnant water formation. In Aceh Besar Regency, Sofia et al report (2016) notes a significant surge in DF cases during rainy seasons. This underscores the significance of understanding physical environmental factors particularly those related to water and weather in shaping DF epidemiology.

Understanding these factors necessitates appropriate interventions like good sanitary management and vector control programs. Preventive measures such as emptying storage containers and educating communities about maintaining cleanliness must be sustained efforts. By reducing environmental hazards expected can contribute to lowering DF case counts (Prameswarie, 2023).

The role of families

Families play a vital role in maintaining environmental cleanliness to prevent the spread of dengue fever. Poor sanitation practices, such as uncovered water storage, inadequate waste management, and minimal mosquito eradication measures, contribute significantly to DF incidence in many regions of Indonesia (Damanik, 2023). Proactive family behaviors, such as cleaning stagnant water, maintaining home cleanliness, and using mosquito nets and repellents, significantly reduce the risk of DF infection. Educational programs focusing on Healthy and Clean Living Behavior (PHBS) are instrumental in empowering communities to prevent DF outbreaks.

The government and health institutions have a responsibility to enhance education on sanitation and PHBS to the public. Preventive measures such as teaching how to clean up stagnant water, proper waste disposal, and monitoring mosquito breeding signs around the house can help reduce DHF cases in the community. By increasing awareness and knowledge on the importance of sanitation and PHBS, it is hoped that the public can actively contribute to preventing the spread of DHF (Merbawani, 2023). Furthermore, prevention efforts such as fogging, mosquito breeding site eradication, and awareness campaigns need to be consistently carried out to reduce DHF cases in Indonesia. Through good cooperation between families, the government, and health institutions, it is hoped that the spread of DHF can be mitigated and the public health can be well maintained.

Community-based initiatives, such as the 3M Plus program (draining, covering, and recycling), have proven effective in reducing transmission when consistently implemented (Kosasih et al., 2021). However, these programs often face challenges due to limited public awareness and local resource constraints. Collaboration between families, communities, and governments is essential to ensure education and interventions are effectively implemented, thereby reducing the risk of DF.

The Impact of Urbanization

Rapid urbanization in Indonesia has significantly influenced the spread of dengue fever (DF). Urbanization is often accompanied by rapid population growth and unplanned infrastructure development, leading to poorly managed water storage facilities, such as bathtubs or clogged drains, which provide ideal breeding grounds for Aedes aegypti mosquitoes.

A study by Saputra et al. (2023) A study by Saputra et al. (2023) found that in urban areas, higher population densities correlate with increased mosquito populations. In some households, over three water storage containers were found, serving as potential sources of mosquito breeding. The presence of mosquito larvae in water storage containers (WSC) is influenced by the condition of the water, as well as the community's habits of covering and cleaning these containers at home. A significant portion of the mosquito life cycle occurs in water, making the number of WSC closely related to the presence of mosquito larvae. The habit of leaving WSC uncovered provides greater opportunities for mosquitoes to lay their eggs, ultimately increasing the larval population.

The challenges of vector control in urbanized areas are increasingly complex due to the limited availability of green open spaces, which serve as natural habitats for mosquito predators (Ojayli et al., 2022). This issue is further exacerbated by the fast-paced lifestyle

of urban residents, who often overlook environmental cleanliness. The lack of time for regular home maintenance increases the likelihood of stagnant water accumulation, creating ideal breeding grounds for Aedes aegypti mosquitoes.

Moreover, insufficient public awareness about the importance of environmental sanitation contributes significantly to the rising incidence of dengue fever in urban areas. Addressing this issue requires a holistic approach to urban planning that prioritizes the development of adequate sanitation infrastructure and the preservation of green open spaces. Local governments should integrate vector control programs into urban development plans while actively involving communities in maintaining environmental cleanliness. Such coordinated efforts could effectively reduce the incidence of dengue fever in urban settings.

Climate Change

Climate change is increasingly recognized as a significant factor in the spread of dengue fever. Rising global temperatures and shifting rainfall patterns are altering the distribution and activity of Aedes aegypti mosquitoes, the primary vector of the disease. With higher temperatures, the mosquito's lifecycle accelerates, increasing the likelihood of dengue virus transmission. According to the World Health Organization (WHO), a mere 1°C rise in temperature can raise the risk of dengue fever transmission by up to 10%. Pascawati et al. (2019) highlighted how high temperatures in Mataram City not only sped up the mosquito's lifecycle from egg to adult but also enhanced virus replication, further intensifying the risk of human infection.

Rainfall patterns also play a critical role. Heavy rains create additional breeding sites by forming puddles, while drought conditions often lead people to store water in open containers, inadvertently providing ideal environments for mosquito breeding. Research by Arivadany (2024) found that areas experiencing significant fluctuations in rainfall are particularly vulnerable to dengue outbreaks.

The implications of climate change extend beyond dengue fever, as other vector-borne diseases are also likely to become more prevalent. This underscores the urgent need for governments and health institutions to act. Developing adaptation strategies that account for climate change's impact on public health is vital. Measures such as reducing greenhouse gas emissions and enhancing environmental conservation can help mitigate these risks.

On a community level, education is key. Empowering people to protect the environment and adopt sustainable practices can significantly reduce the impact of climate

change. Together, these efforts spanning policy, science, and individual action offer hope for controlling the spread of dengue fever and safeguarding public health in a changing world.

4. CONCLUSION

The development of dengue hemorrhagic fever is deeply influenced by various environmental factors, including poorly managed physical environments, insufficient attention to sanitation, rapid urbanization, and the far-reaching effects of climate change. These factors have created conditions that allow dengue cases to rise, posing a significant threat to public health.

Addressing this challenge requires collective action. Governments, communities, and health institutions must work hand in hand to tackle the root causes. Empowering families through education about the importance of maintaining environmental cleanliness and proper sanitation is a vital step. Simple, everyday actions like cleaning water storage areas, covering containers, and reducing mosquito breeding grounds can make a significant difference.

To create lasting change, these efforts must be part of a holistic and sustainable approach. By fostering collaboration, raising awareness, and implementing effective prevention strategies, we can reduce the burden of dengue fever. Together, we have the power to build healthier communities, where people can thrive without the constant fear of this preventable disease.

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