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Research article

Species Diversity of Mosquitoes and Environmental Factors as Potential Risks for Dengue Hemorrhagic Fever (DHF): A Literature Review

Ida Ayu Tika Pradnyandari*, Nurjazuli Nurjazuli, Martini Martini
Diponegoro University, Central Java, Indonesia

*Correspondent Author: Ida Ayu Tika Pradnyandari (idaayu3319@gmail.com)

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ABSTRACT

Background: Dengue Hemorrhagic Fever (DHF) remains a significant public health problem in Indonesia, with epidemiological patterns that continue to change. This research aimed to examine the diversity of dengue vector mosquito species as well as environmental factors that contribute to the increase in dengue cases.
Methods: Literature review by analyzing 11 articles that met the inclusion criteria, obtained from Google Scholar and ScienceDirect (2017-2024).
Results: Aedes aegypti and Aedes albopictus are the main species in the spread of dengue fever, with distribution influenced by environmental factors such as temperature, humidity and vegetation cover. In addition, climate change plays a role in increasing the risk of the spread of dengue fever.
Conclusion: A deeper understanding of mosquito diversity and their habitats can support more effective vector control efforts.

BACKGROUND

Dengue Hemorrhagic Fever (DHF) is an infectious disease caused by the dengue virus and transmitted through mosquitoes as vectors (Arivadany, 2024). In Indonesia, DHF remains a significant public health issue (Nadia, 2024). Dengue infections have been endemic for more than two centuries. Although this disease is generally self-limiting, in recent years, cases with more severe clinical manifestations have been increasing (Kemenkes RI, 2023). Additionally, dengue outbreaks have become more frequent. The epidemiological pattern of this disease continues to change, with case surges typically occurring in a 10-year cycle (Kemenkes RI, 2023). According to data from the Ministry of Health as of March 26, 2024, the number of DHF cases in Indonesia reached 53,131, with 404 deaths (Nadia, 2024). This figure continued to rise, and in the following week, 60,296 cases with 455 deaths were recorded (Nadia, 2024). This surge not only reflects the high incidence of DHF but also indicates an increasing number of endemic areas. Several districts/cities with the highest dengue cases this year include Tangerang Regency (2,540 cases), Bandung City (1,741 cases), West Bandung Regency (1,422 cases), Lebak Regency (1,326 cases), Depok City (1,252 cases), Kendari City (1,195 cases), Bogor City (939 cases), and Subang Regency (909 cases) (Kemenkes RI, 2023). Meanwhile, the districts/cities with the highest DHF mortality rates recorded between April 2 and April 8, 2024, include Bandung Regency (increasing from 14 to 25 deaths), Jepara Regency (from 17 to 21 deaths), Subang Regency (from 15 to 18 deaths), Kendal Regency (from 13 to 16 deaths), and Bogor Regency (from 12 to 13 deaths) (BPS Jateng, 2024). The increase in DHF cases is influenced by climate change. To reduce the incidence of DHF, the Ministry of Health is working to improve diagnostics, distribute detection tools, and provide rapid tests in primary healthcare facilities (Dalilah et al., 2022). If not promptly addressed, DHF can have serious consequences. DHF symptoms require special attention because approximately 50% of cases are asymptomatic (Sucipto et al., 2015). Therefore, a system is needed to detect this disease—whether transmitted by vectors or caused by environmental factors, including the impact of climate change (Arivadany, 2024).

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Effective mosquito-borne disease control requires a comprehensive understanding of mosquito bioecology and classification (Satoto & Murhandarwati, 2021). The Culicidae family has distinctive characteristics that make identification and description easier. However, classification into subfamilies, subgenera, and genera is often challenging, especially due to the presence of mosquito species with similar morphology, inhabiting the same environments, but with varying levels of disease transmission capability (Satoto & Murhandarwati, 2021). Therefore, this study aimed to provide a review of mosquito species diversity as DHF vectors and the environmental factors that contribute to the occurrence of DHF.

METHODS

The approach used in this study is a qualitative method through a literature review. This method aims to optimally interpret various sources by summarizing, analyzing, evaluating, and synthesizing relevant documents (Sukesi et al., 2018).

This study was conducted in January 2025 by reviewing literature from various published research studies (2017-2024). The literature review explores references related to mosquito species diversity and environmental factors contributing to the incidence of DHF. Article searches were conducted through Google Scholar and ScienceDirect using the keywords "Diversity of mosquito species and environmental factors of dengue fever potential.".

RESULTS

Tabel 1. Article Review Result

No	Authors	Title	Design	Sample	Results
1.	Rafael Piovezan, Joao Paulo Oliveira Acorinthe, Jonas Henrique Teixeira de Souza, Alexandre Visockas, Thiago Salomão de Azevedo, Claudio José Von Zuben	Spatial Distribution of Culicidae (Diptera) Larvae, and Its Implications for Public Health, in Five Areas of The Atlantic Forest Biome, State of Sao Paulo, Brazil (2017) (Piovezan et al., 2017)	Cross sectional	Mosquito larvae in five rural areas of the Atlantic Forest	A total of 13,241 larvae from six mosquito species were successfully captured in 920 collections (32.52%). *Aedes albopictus* was the dominant species (64.23%), followed by *Aedes aegypti* (32.75%), *Culex quinquefasciatus* (1.32%), *Aedes fluviatilis* (1.04%), *Culex Complex Coronator* (0.40%), and *Toxorhynchites theobaldi* (0.22%). The diversity analysis showed that areas with high *Aedes aegypti* abundance had lower species diversity and were generally in densely populated areas. Since *Aedes aegypti* is a vector of dengue fever, chikungunya, and Zika virus, entomological control is needed, especially in transition areas, to reduce the risk of disease transmission.
2.	Ifeoluwa Kayode Fagbohun,	Seasonal Abundance and	Cross sectional	Mosquito larvae and	Five mosquito species from three genera were

	Emmanuel Taiwo Idowu, Taiwo Samson Awolola, Olobunmi Adetoro Otubanjo	Larval Habitats Characterization of Mosquito Species in Lagos State, Nigeria (2020) (Fagbohun et al., 2020)		adults in four local areas in Lagos State, Nigeria.	identified: Anopheles gambiae complex, Anopheles funestus complex, Culex quinquefasciatus, Aedes aegypti, and Aedes albopictus. Culex quinquefasciatus was the most dominant species (37.7%), followed by Aedes aegypti (31.1%) and Anopheles gambiae (26.9%), while Aedes albopictus was the least abundant (1.9%). Larval abundance showed significant statistical relevance (P<0.001). The Simpson diversity index ranged from 0.6751 to 0.6926, the Shannon index ranged from 1.187 to 1.242, and evenness values ranged from 0.6566 to 0.7134. The physicochemical parameters of larval habitats had a pH of 7.2-7.7, conductivity of 0.35-0.83, temperature of 28.7-31.3°C, and total dissolved solids (TDS) of 330-571.5 mg/L.
3	Sri Yuliawati, Dewi Fajar Kharisma, Martini Martini, Lintang Dian Saraswati, Retno Hestiningsih, Susiana Purwatisari	Population of Dengue Fever Vectors in Rural Areas of Semarang City: Cross-Sectional Survey on Aedes sp. Bionomics (2020) (Yuliawati et al., 2020)	Cross sectional	100 households distributed across each hamlet in Rowosari	The larval density in Rowosari was very high, with HI (44.1%), CI (31.7%), BI (74.9%), and OI (64.1%), indicating a high risk of dengue fever transmission. The resting density of Aedes aegypti was 0.67 indoors and 0 outdoors, while Aedes albopictus had 0.13 indoors and 0.06 outdoors. Two Aedes species were found: Aedes aegypti (53%) and Aedes albopictus (4.7%). To reduce the risk of dengue transmission,

					regular cleaning of water containers both indoors and outdoors is recommended.
4	Monica Izquierdo-Suzan, Paula B. Zavala-Guerrero, Hugo Mendoza, Renato Portela Salamao, Mauricio Vazquez-Pichardo, Juan Von Thaden, Rodrigo A. Medellin	Mosquito (Diptera: Culicidae) Diversity And Arbovirus Detection Across An Urban And Agricultural Landscape (2024) (Izquierdo-Suzán et al., 2024)	Deskriptive Exsplanatory	Mosquitoes in fragmented tropical dry forests in Central Mexico during 2021	21 mosquito species from 6 genera were found, with Culex quinquefasciatus being the most common, followed by Aedes aegypti, Aedes albopictus, and Aedes epactius. Areas with denser native vegetation cover showed higher mosquito species richness, which could increase disease transmission risks. Additionally, Zika and dengue viruses were detected in 85% of the captured mosquito species, emphasizing the need for intensified vector control in the region.
5	Purwatiningsih, Rike Oktarianti, Rendy Setiawan, Wahyu Tri Agustin, Aida Mursyidah	Diversity of Mosquito Species as Potential Disease Vectors (Diptera: Culicidae) in Baluran National Park, Indonesia (2021) (Purwatiningsih et al., 2021)	Deskriptive Exsplanatory	Mosquitoes in Baluran National Park	Seven mosquito species were identified: Aedes aegypti, Aedes albopictus, Aedes indonesiae, Culex quinquefasciatus, Culex vishnui, Culex mammilifer, and Culex sitiens. Aedes indonesiae was the most abundant species (69.4%), while Culex vishnui, Culex mammilifer, and Culex sitiens were found in very low numbers (2.92%). Aedes aegypti and Aedes albopictus are known vectors of dengue fever and chikungunya, while Culex quinquefasciatus is a vector of lymphatic filariasis, and Culex vishnui and Culex sitiens are Japanese encephalitis vectors. However, the role of Aedes indonesiae and

					Culex mammilifer as vectors is still unknown. The mosquito diversity index was classified as moderate.
6	Novia Gesriantuti, Yeeri Badrun, Ardila Yunita	Keanekaragaman Jenis dan Distribusi Nyamuk Vektor Penyakit Berdasarkan Ovitrap Di Kelurahan Tuah Karya, Kecamatan Tampan, Kota Pekanbaru (2018) (Gesriantuti et al., 2018)	Cross sectional	Nyamuk di Kelurahan Tuah karya, Kecamatan Tampan, Kota Pekanbaru	Ditemukan 3 spesies nyamuk yaitu Aedes albopictus, Ae.aegypti, dan Culex quinquefasciatus. Spesies Ae.albopictus merupakan spesies yang dominan di Kelurahan Tuah Karya dengan Indeks Nilai Penting (INP) 99,92%. Penyebaran nyamuk lebih banyak di luar rumah.
7	Raodatul Jannah, Bambang Suryadi, Yuliadi Zamroni, Galuh Tresnani	Species Diversity and Distribution of *Aedes* Mosquitoes in Senggigi Beach, West Lombok (2019) (Jannah et al., 2019)	Deskriptive Exsplanatory	Mosquito larvae in Senggigi Beach, West Lombok	This study identified two mosquito species, *Aedes aegypti* and *Aedes albopictus*, with their primary breeding habitats in artificial containers. The highest larval density was recorded at 57.7 larvae/100 mL in boats, while the lowest density was 2 larvae/100 mL in trash bins. *Aedes aegypti* had a 100% index value in fishpond habitats, whereas *Aedes albopictus* showed a 100% index value in three habitats: used tires, styrofoam boxes, and used bowls. *Aedes albopictus* was found breeding in both clear and polluted water, mainly in home yards with dense vegetation and low population density. In contrast, *Aedes aegypti* was found only in clear water near densely populated residential areas.
8	Laila Annisa Rahmah, Galuh Tresnani,	Identification of Mosquito Species and Their Habitat	Deskriptive Exsplanatory	Mosquitoes in Kekeri Village,	This study identified six mosquito species: *Culex*

	Bambang Fajar Suryadi, Eka Sunarwidhi Prasedya	Characteristics in Kekeri Village, Gunung Sari District, West Lombok Regency (2019) (Rahmah et al., 2019)		Gunung Sari District	*quinquefasciatus, Cx. tritaeniorhynchus, Cx. bitaeniorhynchus, Cx. sitiens, Aedes aegypti*, and *Mansonia uniformis*. Mosquito habitats were found in residential areas, rice fields, and plantations, with an average temperature of 26.6°C-27°C, humidity of 69.3%-69.6%, and wind speed of 14 km/h-14.7 km/h. The vegetation in these habitats included trees, rice plants, grass, corn, and vegetables such as pumpkins, long beans, and chili peppers. The highest Relative Abundance Index (RAI) was recorded for *Culex tritaeniorhynchus* (55.8%), found in all habitat types, while *Culex bitaeniorhynchus* and *Mansonia uniformis* had the lowest RAI (1.03%).
9	Jumari Ustiawaty, Idham Halid, Edy Kurniawan, Maula Annisa	Identification of Mosquito Larvae as Disease Vectors and Their Habitat Characteristics in Penimbung Village, Gunung Sari District, West Lombok (2022) (Ustiawaty, 2022)	Deskriptive Exsplanatory	Mosquito larvae in Penimbung Village, Gunung Sari District	This study identified mosquito larvae from three genera: *Culex sp.*, *Aedes sp.*, and *Anopheles sp. Culex sp.* larvae were found in puddles, drainage ditches, rice fields, and rivers, with habitat characteristics of pH 7-8, salinity 0.2-0.3 ppm, clear or murky water, temperature 25-26°C, and depth of 8-20 cm. *Aedes sp.* larvae were found in puddles and rivers with pH 7-8, salinity 0.2-0.3 ppm, clear water, temperature 27°C, and depth of 8-20 cm. Meanwhile, *Anopheles sp.* larvae were only found in rice fields with pH 7, salinity 0.2 ppm,

					murky water, temperature 26°C, and depth of 4 cm.
10	Dila Hening Windyaraini, Fiela Tiarani Siregar, Asti Vanani, Titi Marsifah, Soenarwan Hery Poerwanto	Identification of *Culicidae* Family Diversity for Vector and Mosquito-Borne Disease Control at Universitas Gadjah Mada, Yogyakarta (2020) (Windyaraini et al., 2020)	Exsplanatory Study	Mosquito larvae in 5 clusters of Universitas Gadjah Mada (Science and Engineering, Medical, Agro, Vocational School, and Social-Humanities)	A study conducted at Universitas Gadjah Mada identified 153 mosquitoes in the larval and pupal stages, consisting of *Aedes aegypti*, *Aedes albopictus*, *Anopheles spp.*, and *Culex spp.* The species with the highest number of larvae and pupae was *Aedes albopictus*, while *Anopheles spp.* was only found in a single pupal stage. A total of 50 containers were identified as mosquito breeding sites, with six containers found to be positive for larvae. The most common breeding site was buckets. Environmental observations showed that the temperature in each container ranged from 24-28°C, with a pH of 6-7.
11	Diawo Diallo, Babacar Diouf, Alioune Gaye, El Hadji NDiaye, Ndeye Marie Sene, Ibrahima Dia, Mawlouth Diallo	Dengue Vectors in Africa : A Review (2020) (Diallo et al., 2022)	Prospective Study	Literature on dengue fever vectors	Dengue virus has been predominantly isolated from *Aedes furcifer*, *Aedes luteocephalus*, and *Aedes taylori* in forest environments, while in urban areas, it has been found in *Aedes aegypti* and *Aedes albopictus.*

DISCUSSION

Based on the findings from the reviewed literature, several mosquito species have been identified as significant disease vectors, playing a crucial role in the transmission of various viral infections such as dengue fever, Zika virus, and chikungunya. The diversity, distribution, and habitat of these vector mosquitoes have been the focal point of numerous studies conducted across different geographical locations, each contributing valuable insights into the complex interactions between mosquitoes, their environments, and human populations.

In the Atlantic Forest of Brazil, a notable study by Piovezan et al. (2017) revealed that Aedes albopictus and Aedes aegypti were the dominant species within the larval mosquito population. This study highlighted the alarming trend of higher mosquito densities in densely populated urban areas, suggesting that human activities and urbanisation substantially influence mosquito proliferation. The researchers meticulously documented the environmental conditions that favoured these species, noting that the availability of stagnant water sources, such as discarded containers and poorly maintained water systems, provided ideal breeding grounds. This underscores a critical public health concern, as urban areas often

experience increased incidences of mosquito-borne diseases, necessitating robust control strategies focused on larval habitat management (Piovezan et al., 2017).

Similarly, in Lagos, Nigeria, Fagbohun et al. (2020) conducted a comprehensive study that identified Culex quinquefasciatus as the most prevalent mosquito species in the region. Their research emphasised the significant impact of environmental factors, including water pH, temperature, and conductivity, on larval abundance. For instance, they found that higher temperatures correlated with increased mosquito activity, which could be attributed to the accelerated development rates of larvae in warmer waters. This relationship between environmental conditions and mosquito populations is critical for understanding the potential for disease outbreaks, particularly in urban settings where climate change may exacerbate these conditions (Fagbohun et al., 2020).

In Indonesia, the situation is equally concerning. A study by Yuliawati et al. (2020) conducted in Rowosari, Semarang, highlighted a significantly high indoor population of Aedes aegypti. This finding points to the pressing need for targeted larval control efforts in residential areas, as indoor environments often provide sheltered breeding sites that are less accessible to traditional vector control measures. The study illustrated how domestic settings, characterised by water storage practices and urban infrastructure, can inadvertently support mosquito populations, thereby increasing the risk of dengue transmission in densely populated urban centres (Yuliawati et al., 2020).

Expanding on the findings from Mexico, a recent study by Izquierdo-Suzán et al. (2024) revealed that an astonishing 85% of mosquito species identified in tropical deciduous forests were carriers of Zika and dengue viruses. This alarming statistic highlights the critical role that biodiversity plays in the epidemiology of mosquito-borne diseases. The dominance of Culex quinquefasciatus in this region further emphasises the need for integrated vector management strategies that consider the ecological dynamics of these habitats. The study also noted that human encroachment into these forests disrupted natural habitats, leading to increased human-mosquito interactions, which could facilitate the spread of viruses (Izquierdo-Suzán et al., 2024).

In another significant study conducted in Baluran National Park, Indonesia, Purwatiningsih et al. (2021) identified seven mosquito species, including Aedes aegypti and Aedes albopictus, which are well-known vectors of dengue fever and chikungunya. The findings from this research indicate that even within protected areas, the presence of these vectors poses a risk to both wildlife and human populations. The study highlighted the importance of monitoring mosquito populations in natural reserves, as these areas can serve as reservoirs for disease transmission, potentially leading to outbreaks in surrounding communities (Purwatiningsih et al., 2021).

Research conducted by Gesriantuti et al. (2018) in Pekanbaru demonstrated that Aedes albopictus was predominantly found in outdoor environments, while a contrasting study by Jannah et al. (2019) in Senggigi Beach, West Lombok, reported that Aedes aegypti larvae were more commonly associated with clear water in densely populated areas. This dichotomy illustrates the adaptability of these species to different ecological niches, with Aedes albopictus displaying a remarkable ability to thrive in a variety of environmental conditions. Such adaptability raises concerns about the potential for these species to exploit changing habitats as urbanisation continues to expand (Gesriantuti et al., 2018; Jannah et al., 2019).

The impact of environmental factors on mosquito distribution cannot be overstated. In West Lombok, studies by Rahmah et al. (2019) and Ustiawaty et al. (2022) demonstrated that temperature, humidity, and wind speed are pivotal in influencing mosquito dispersal patterns. Their findings revealed that Culex tritaeniorhynchus was the dominant species in certain areas, underscoring the importance of local climatic conditions in shaping mosquito populations. The interplay between these environmental variables and mosquito behaviour provides valuable insights for predicting potential disease outbreaks and implementing effective vector control measures (Rahmah et al., 2019; Ustiawaty et al., 2022).

At Universitas Gadjah Mada in Yogyakarta, Windyaraini et al. (2020) found that Aedes albopictus was more frequently encountered in water containers with temperatures ranging from 24-28°C and a pH level of 6-7. These specific conditions create an optimal environment for larval development, highlighting the importance of monitoring water quality in potential breeding sites. The study emphasised the necessity for community engagement in vector control efforts, as public awareness and participation are crucial for reducing mosquito breeding habitats in residential areas (Windyaraini et al., 2020).

A study by Diallo et al. (2020) elucidated the differences in the dominance of dengue vector mosquito species between forested and urban areas in Africa. Their research indicated that Aedes aegypti is significantly more prevalent in urban environments, where human activities create favourable conditions for breeding. This finding reinforces the notion that urbanisation is a key driver of mosquito population

dynamics, necessitating a shift in vector control strategies to address the unique challenges posed by urban settings (Diallo et al., 2020).

These studies collectively indicate that Aedes aegypti and Aedes albopictus are the primary disease vectors in various regions, with their distribution intricately influenced by factors such as population density, environmental conditions, and the availability of larval habitats. The species diversity tends to be higher in areas characterised by dense vegetation cover, which provides a plethora of breeding sites and sustenance for adult mosquitoes. Conversely, highly urbanised areas often exhibit higher densities of Aedes aegypti, a species well-adapted to thrive in human-altered landscapes.

The findings from these diverse studies underscore the urgent need for comprehensive mosquito control strategies that consider the specific habitat characteristics of each region. By understanding the ecological dynamics that influence mosquito populations, public health officials can develop targeted interventions that mitigate the risk of disease transmission. Addressing the challenges posed by urbanisation, climate change, and environmental degradation will be crucial in effectively managing mosquito populations and safeguarding public health against the threats posed by mosquito-borne diseases.

CONCLUSION

Conclusion should answer the objectives of the study. Provide a clear scientific justification for your study, and indicate possible recommendation for health practice and future practice.

CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

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