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Relationship Between Breeding Places, 3M Plus Practices, and Insecticide use with Dengue Fever Incidence: A Literature Review

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Abstract
Introduction: *Dengue hemorrhagic fever remains a major public health problem in tropical countries, including Indonesia. Environmental conditions, community behavior, and vector control practices contribute significantly to dengue transmission.* ***Objective:*** *This literature review aimed to analyze the relationship between breeding places, the 3M Plus strategy (draining, covering, reusing, and additional control efforts), and insecticide use with the incidence of dengue fever* ***Method:*** *This study used a systematic literature review approach by searching Google Scholar, PubMed, DOAJ, and Garuda databases for articles published between 2015 and 2025. Studies examining breeding places, 3M Plus practices, and insecticide use in relation to dengue incidence were included.* ***Results and Discussion:*** *Eight studies met the inclusion criteria. Poorly managed water containers and inadequate waste management were associated with increased Aedes aegypti density and dengue incidence. Consistent implementation of 3M Plus practices was associated with reduced larval indices and dengue cases. Insecticide use was effective for short-term control but limited by resistance and improper application.* ***Conclusion:*** *Integrated vector management combining environmental sanitation, consistent 3M Plus practices, appropriate insecticide use, and community education is essential for sustainable dengue prevention.*

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Introduction

Dengue hemorrhagic fever (DHF) is a disease spread by mosquitoes and has become a big problem for public health around the world (Saputra, Ariyani, & Dewi, 2023); (Sari, Djamaluddin, Djam'an, & Sembodo, 2022). In the last 50 years, the number of dengue cases has gone up more than 30 times, and the World Health Organization (WHO) has listed dengue as one of the top ten health issues affecting the globe. The WHO says that about 2.5 to 3 billion people live in places where dengue can spread, mainly in warm, rainy areas like tropical and subtropical countries. Over the past 50 years, the number of dengue cases has increased thirtyfold, making it one of the biggest health threats today (Djalaluddin, Ananda, & Heriyati, 2025)

To fight dengue, global efforts focus not just on treating cases but also on stopping the disease before it starts. Studies from Southeast Asia, Latin America, and Africa show that when communities take action and work together with government and other groups, it can help reduce mosquito breeding places. For example, in Thailand and Vietnam, regular checks of homes and efforts to remove places where mosquitoes can lay eggs helped reduce dengue cases by 35 to 50% over five years. This shows that when people take part in monitoring and take local action, it gives long-term benefits that go beyond just using chemicals.

In Indonesia, dengue is a regular problem, and the number of cases is often higher than the government's goal of no more than 10 cases per 100,000 people. In 2024, there were over 60,000 reports of dengue and more than 450 deaths across the country. Indonesia's warm weather, with temperatures between 21 and 29 degrees Celsius, lots of rain, and changing humidity, creates perfect conditions for mosquitoes that spread dengue, like Aedes aegypti and Aedes albopictus (Aprianto, Tosepu, Irma, & Rusliafa, 2025); (Prayoga, Pramana, Pratidina, & Pratiwi, 2024); (Mawaddah, Pramadita, & Triharja, 2022); (Widyantoro, Nurjazuli, & Hanani, 2021)

At the provincial level, Central Java has some of the highest dengue cases. In 2024, there were 15,547 cases and 244 deaths, mostly among children. The changing rainfall, not enough trash management, and poor drainage create ideal places for mosquitoes to breed. In Tegal City, dengue rates have often been above the national goal of no more than 10 cases per 100,000 people, reaching 39.21 in 2019 and 16.68 in mid-2025. The larva-free index, which shows how well mosquito breeding places are controlled, has also stayed below the national target of at least 95%, averaging around 90% (Widyantoro et al., 2021); (Nugraha, Haryanto, Wulandari, & Pakasi, 2021); (Rakhmatsani & Susanna, 2024)

Dengue continues to spread because of environmental factors, especially places where mosquitoes breed in water around homes. These places include things like bathtubs, buckets, jars, and even things people throw away, like tires and cans. Studies have shown that when these breeding areas are not managed properly, there are more mosquitoes, which leads to more dengue cases (Sahawati & Shafwan, 2025); (Arsyad, Nabuasa, & Ndoen, 2020)

Other studies show that dengue doesn't just come from weather conditions. It also depends on how people act and how well they manage their surroundings. When there are lots of breeding sites, people don't follow good practices like removing standing water, and they use insecticides in ways that aren't safe, it makes the problem worse. Because of this, this review looks at how these factors together affect dengue and focuses on ways to control it through community efforts (Sahawati & Shafwan, 2025)

In response, Indonesia has used the 3M Plus strategy. This includes emptying water containers, covering them tightly, and reusing old items. They also use extra steps like putting larvicide in water, using fish that eat mosquito larvae, and using mosquito nets or repellents. But even with these efforts, the number of places without mosquito larvae is still below the national goal of 95% (Marlinae et al., 2021)

Another common method is using insecticides, such as fogging, larvicides, and sprays for homes. These can help quickly lower mosquito numbers. But using them too much over time has caused mosquitoes to become resistant, led to unsafe practices in communities, and raised concerns about the environment. So, the best approach is to mix environmental control, better behavior from people, and careful use of insecticides (Ngadino, Setiawan, & Hermiyanti, 2024)

Method

This review adopted a systematic literature review approach to identify, analyze, and synthesize relevant research findings published between 2015 and 2025 concerning the relationship between breeding places, 3M Plus practices, and insecticide use with dengue fever incidence.

Search Strategy: Electronic searches were conducted through Google Scholar, PubMed, DOAJ, and Garuda. The search keywords included: *"dengue hemorrhagic fever," "breeding place," "Aedes aegypti," "3M Plus," "vector control,"* and *"insecticide use."*

Inclusion Criteria:

- Studies published between 2015–2025 in English or Indonesian.
- Research focusing on environmental and behavioral risk factors for dengue.
- Designs including observational studies (cross-sectional, case-control), intervention studies, or literature reviews.
- Full-text availability.

Exclusion Criteria:

- Studies unrelated to dengue prevention.
- Articles not accessible in full text.
- Reports or conference abstracts without empirical data.

Result and Discussion

1. Result

A total of eight relevant studies were reviewed. The findings consistently indicated that unmanaged water containers and poor sanitation increased mosquito breeding, while households practicing 3M Plus reported lower dengue incidence. Insecticide application provided immediate vector reduction but faced sustainability challenges

Table 1
Summary of reviewed studies (2019–2025)

No	Author & Year	Focus Variable	Design	Sample	Main Findings
1	Arsyad et al., 2020	Environmental sanitation	Cross-sectional	99 HH	Significant association between sanitation knowledge, attitude, practice, and dengue incidence
2	Wijirahayu & Sukesi, 2019	Ventilation & lighting	Case-control	32 houses	Ventilation and lighting significantly associated with DHF cases
3	Djalaluddin et al., 2025	PHBS education	Pre-post test	22 people	Increased knowledge & skills for dengue prevention after health education
4	Aprianto, 2025	Water container, waste, 3M practice	Cross-sectional	364 respondents	Significant association between water container condition, waste presence, 3M, insecticide use with dengue incidence
5	Ningsih et al., 2022	Mosquito species & breeding	Field survey	100 mosquitoes	Breeding places strongly correlated with mosquito abundance
6	Yati et al., 2020	Sanitation & larvae presence	Cross-sectional	80 HH	Sanitation significantly associated with larvae presence
7	Homer et al., 2025	Behavioral factors	Review (6 journals)	—	Clothing habits, insecticide use, and cleaning containers associated with dengue incidence
8	Rusmini et al., 2020	Environmental hygiene	Cross-sectional	110 HH	Poor waste management increased Aedes density

2. Discussion

Breeding Places and Dengue Incidence

Household water containers and thrown-out things are main places where Aedes aegypti mosquitoes breed. Research shows a strong link between not managing these containers well and more dengue cases (Sahawati & Shafwan, 2025). When old waste like tires, cans, and bottles pile up, it makes more mosquitoes. These breeding areas are very important for how dengue spreads. Open or not cleaned water containers, such as bathtubs, jars, and buckets, are where Aedes aegypti mainly live. Studies by Arsyad et al. (2020) and Ningsih et al. (2022) show that places with lots of water holding containers have higher numbers of mosquito larvae and more dengue cases (Arsyad et al., 2020)

Waste, especially things that don’t break down like plastic bottles, used tires, and cans, becomes breeding grounds after it rains. Not managing waste properly makes this worse. When rain patterns meet poor sanitation, it creates small habitats that help mosquitoes grow quickly. So, keeping the environment clean is very important for stopping dengue.

3M Plus Practice and Dengue Prevention

The 3M Plus program is a community-based approach that has proven effective in lowering the number of mosquito larvae and dengue cases. Households that regularly drain, cover, and reuse containers saw a lower risk of dengue. However, challenges include inconsistent action and not enough awareness (Arsyad et al., 2020)

The 3M Plus strategy includes draining, covering, and reusing, plus extra steps. It has been a main part of Indonesia's dengue prevention efforts for a long time. Its success depends on people's involvement and consistent behavior. Studies by Wijirahayu & Sukesi (2019) and Aprianto (2025) found that families that regularly follow 3M Plus have much fewer dengue cases than those that don't. Draining helps stop mosquito eggs from sticking to surfaces, and covering water containers prevents female mosquitoes from laying eggs. Recycling and managing waste reduce places where mosquitoes can breed.

The basic 3M (Drain, Cover, Bury) is part of physical control, while 3M Plus adds more steps. Physical control involves direct actions to remove mosquito breeding areas. Chemical control uses pesticides, and biological control uses natural predators or other organisms to manage pests.

The "Plus" parts include using larvicides (like abate), adding fish that eat mosquito larvae, keeping ornamental plants free from water, and using mosquito repellents. When these steps are done properly, they can help reach a Larva-Free Index (ABJ) of at least 95%, greatly reducing the chance of disease spread. Yet, in many Indonesian cities, including Tegal, the ABJ is still below the target due to lack of awareness, irregular monitoring, and inconsistent community involvement.

One important thing is that daily actions need to become routine. Using community volunteers called Jumantik has helped people take part in weekly inspections and report possible breeding spots. Educational efforts have also improved knowledge and behavior. Djalaluddin et al. (2025) found that health education increased understanding of dengue prevention by 40% and encouraged better home hygiene practices. Still, 3M Plus efforts face issues like urban migration, poor waste collection systems, and changes in weather. To make these programs work well, cooperation between health offices, local governments, and communities is essential.

Insecticide Use and Limitations

Insecticides, like fogging, larviciding, and spraying, are still widely used, especially when there are outbreaks. These methods can quickly lower mosquito numbers, but they don't last very long. Mosquitoes can become resistant to these chemicals, and using them incorrectly can reduce how well they work over time. To keep things effective in the long run, it's important to use insecticides along with other methods like 3M Plus.

Using insecticides is a common and quick way to deal with dengue outbreaks. In Indonesia, people often use fogging, larvicides, and household sprays. Fogging can quickly reduce adult mosquitoes, especially during outbreaks. But it only helps for a short time—usually one to two weeks—because it doesn't kill mosquito eggs or larvae (Ngadino et al., 2024)

Using insecticides too much or without proper control has made mosquitoes more resistant. Studies show that Aedes aegypti mosquitoes are becoming less sensitive to common insecticides like pyrethroids and organophosphates. Improper mixing of insecticides, using them in the same area too often, and letting communities fog without professional help make the resistance problem worse (Marlinae et al., 2021)

There are also health and environmental problems with using insecticides. People may get breathing issues or allergic reactions from inhaling chemical residues. Water sources can become polluted, and important insect species might disappear. These risks show why it's important to use insecticides carefully, following official guidelines and under health authority supervision.

Many studies suggest using chemical methods together with environmental and biological approaches. Using larvicides along with 3M Plus and removing breeding sites is a better, longer-lasting way to control mosquitoes. The World Health Organization (WHO, 2019) also supports Integrated Vector Management (IVM), which combines all possible methods—environmental, biological, and chemical—using them in a way that is safe, effective, and cost-efficient.

Integrated Vector Control

Dengue prevention needs a complete plan that includes keeping the environment clean, changing how people act, and controlling the mosquitoes directly. Research shows that just doing one thing isn't enough. Instead, combining different actions works better and lasts longer.

In places like Tegal and other areas with many dengue cases, managing the problem at the community level is very important. The Ministry of Health's *Gerakan 1 Rumah 1 Jumantik* program is a good example. It helps families take charge by checking and removing places where mosquitoes can breed every week. This makes the community more active in watching for and stopping mosquito breeding (Ngadino et al., 2024)

The 3M Plus program helps with chemical control by looking at why mosquitoes are a problem in the first place. When people work together to keep their areas clean and get rid of standing water, it breaks the cycle where mosquitoes can breed. Using insecticides and fogging should only be done when there are a lot of mosquito larvae, as a backup plan.

To make these efforts work, policies need to support these actions. Local governments must keep trash collected, fix drainage systems, and keep people informed through ongoing campaigns. Schools and workplaces can also help spread awareness about dengue. When the community, schools, and health departments work together, the prevention efforts can last longer.

Public health actions that focus on changing behavior have better long-term results than just using fogging when there's an outbreak. Teaching people about dengue leads to real improvements in reducing mosquito breeding and fewer cases of the disease (Arsyad et al., 2020)

Environmental, Climatic, and Socioeconomic Interactions

Environmental factors, especially temperature, rainfall, and humidity, affect how mosquito populations grow. Research shows that Aedes aegypti mosquitoes do best in places where the average temperature is between 21°C and 29°C and the air is moist, with humidity over 70%. When it rains a lot, water can sit in things like buckets, gutters, and trash, which helps mosquitoes lay eggs and multiply quickly.

At the same time, things like how much money people have and how well their communities are planned also matter a lot. When people live in areas with many people close together, bad city planning, and not much money, it's harder to keep things clean and get health information. This makes places like slums especially at risk because of crowded homes and poor waste disposal, which give mosquitoes more places to breed.

In Tegal City, for example, the way people live in crowded areas and the lack of good drainage systems have linked to high numbers of dengue cases. Combining both environmental and social issues shows that fighting dengue needs teamwork between health groups and other areas like city planning, waste control, and dealing with climate changes.

Conclusion

Literature reviewed in this study justifies that dengue prevention should not depend on a single strategy because breeding places, the consistency of 3M Plus practices, and insecticide use operate in a tightly connected system that ultimately shapes dengue incidence. Unmanaged water containers, inadequate waste disposal, and stagnant water sources remain the main ecological drivers of Aedes aegypti proliferation, while 3M Plus can substantially suppress breeding and reduce infection risk only when implemented consistently—yet its effectiveness is frequently weakened by gaps in awareness, behavior change, and routine monitoring. Insecticides may deliver rapid, short-term reductions in vector density, but their impact is temporary and may create long-term problems such as resistance and environmental contamination when applied improperly. Therefore, the evidence supports an integrated vector management approach that simultaneously strengthens environmental management, sustains community participation, expands health education, and ensures responsible insecticide application to achieve more effective and sustainable dengue control.

LIMITATIONS OF THE REVIEW

This study is limited to published literature from 2015–2025, potentially excluding relevant unpublished or regional reports. Additionally, heterogeneity in study designs and regional contexts may affect comparability. Future research should include quantitative meta-analysis to estimate pooled associations between environmental and behavioral variables and dengue incidence.

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