





Mosquito control activities associated with dengue hemorrhagic fever in Indonesia: A literature review

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Literature Review

ABSTRACT

Dengue Hemorrhagic Fever (DHF) is an endemic disease. It has become a public health concern. Mosquito control activities are needed to control vectors and prevent DHF. Therefore, we conduct a literature review of mosquito control activities associated with DHF in Indonesia. This study applies the selected articles using PRISMA (Preferred reporting items for systematic reviews and meta-analyses), and they are sourced from Science Direct, Google Scholar, Scopus, ProQuest, Ebscohost, and Portal Garuda. The criteria for the selected articles are full-text articles, published in 2015-2020, and those which are published in national journals SINTA 2 or international journals. This study reviewed 683 articles, out of which were selected for further examination. The key variables, such as draining water containers, covering water containers, burying and recycling used containers, using mosquito repellent, using larvacide, keeping larva-eating fish, having mosquito repellent plants, installing wire mesh on ventilation, showed significant correlation with Dengue Hemorrhagic Fever (DHF) incidence. Among the selected articles, 38.89% employed cross-sectional design, and the rest belonged to case-control studies. Most articles have variable draining water containers (55.56%), 50% covers water containers, 80% have a significant association between draining water containers and DHF incidence, and 66.67% have a significant association between covering water containers and DHF incidence. Most articles show that not implementing PSN (Pemberantasan sarang nyamuk) or PSN 3M (Pemberantasan sarang nyamuk, menguras, menutup, mengubur plus) is associated with the incidence of DHF and is a risk factor for the occurrence of DHF. On the other hand, the implementation of PSN or PSN 3M Plus will be a protective factor.

INTRODUCTION

Dengue hemorrhagic fever is the most phenomenal mosquito-borne viral disease in humans and a major public health.¹ Dengue virus is a single-stranded positive-sense RNA flavivirus, a member of the Flaviviridae family. The dengue virus (Denv) has four major serotypes (Denv-1, Denv-2, Denv-3, and Denv -4).² Indonesia, a transcontinental unitary sovereign state located in Southeast Asia, is a tropical country where both main mosquito vector species of Denv, *Ae. aegypti*, and *Ae. albopictus*, are endemic almost in all regions.¹ Dengue hemorrhagic fever is a public health concern in Indonesia, where cases are increasing and spreading more widely. Since it was first discovered in Surabaya in 1968 with 58 cases, 24 deaths, and 41.3% case fatality rate (CFR), this disease has spread widely throughout Indonesia until now.¹ According to data from the Ministry of Health (MoH) of Indonesia, between 2015 to 2020, the most dengue cases occurred in 2016 with a total of 204,171 cases and 1,598 deaths (IR 78.85/100,000 population and CFR 0.78%). However, there has been a decrease in the number of cases and deaths in 2020,



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namely 103,509 cases and 725 deaths (IR 38.15/100,000 population and CFR 0.70%).³ It is estimated by the WHO (World Health Organization) that about 2.5-3 billion people are in the transmitted zone. *Ae. aegypti* can live optimally at temperatures of 26-30°C and 70-80% humidity accompanied by the availability of breeding sites and food sources. In the lack of effective antiviral treatment to fight dengue infection, it is necessary to consider the control and elimination of vector populations, especially emphasizing the reproductive and growth stages, through management of environmental conditions, and biological and chemical control.²

The Indonesian MoH through the Directorate General of Communicable Disease Control has been running a national dengue prevention and control program since 1968.¹ The government has a mosquito control activities program known as *Pemberantasan Sarang Nyamuk* (Mosquito Breeding Site Eradication) or PSN with its activities of draining water containers, covering water containers, and burying used items that may be inundated with water. It is known as 3M (*Menguras* or draining, *Menutup* or covering, *Mengubur* or burying). Subsequently, the program developed into PSN 3M plus, namely the activity of eradicating mosquito nests, draining, covering, and burying, coupled with other activities such as using anti-mosquito medication such as using mosquito repellent, using larvicides, stocking, and rearing or keeping of larvae-eating fish, no hanging clothes, and others.³ This disease is related to the way people behave in the local area and the general climatic conditions. It is needed for the eradication of mosquito nets.

Clean water storage such as bathtubs, empty cans, used tires, places to store drinking water, flowerpots, and other artificial containers, are the places where *Ae. aegypti* larvae can be found.⁴ One of the ways considered appropriate to control the occurrence of DHF is by implementing mosquito control activities as a form of intervention in the environment where the DHF vector breeds. Community participation is very much needed in the sustainability of dengue control efforts. This strategy requires self-awareness to interact in certain situations, and this is influenced by several factors such as the level of knowledge and attitudes that will produce the expected behavior.⁵ This activity consists of draining water containers at least once a week, covering places used as water containers, and burying or recycling used items that can hold water. Additional activities are aimed at preventing mosquito bites and eradicating DHF vector larvae. The efforts that can be made include keeping larvae-eating fish, using larvicides, mosquito repellents, mosquito nets, wire gauze on ventilation, having mosquito-repellent plants, and never hanging clothes in the room.⁶

Several studies have been carried out related to mosquito control activities through PSN 3M Plus and several activities as efforts to control disease vectors and prevent DHF in the potential locations to become vector breeding sites. Some of the results of previous studies, among others, show that well-conducted mosquito control activities are a protective factor against the incidence of DHF in Sumbawa.⁷ The results of another study showed family tasks in 3M plus behavior have a relationship with the prevention of DHF in Purwodadi Village community, Ringinrejo District, Kediri Regency.⁸

Therefore, this study is conducted to review sources from previous studies regarding the association between mosquito control activities and DHF incidence in Indonesia. There have been several studies carried out related to the implementation of mosquito control activities. These previous studies were conducted in various regions in Indonesia with different research variables, study designs, and research results. In contrast to previous studies, this study uses literature review approaches by reviewing, combining, and summarizing previous studies that have been conducted in Indonesia which focused on various mosquito breed eradication activities as an effort to control the vector of dengue hemorrhagic fever and its relationship to the incidence of DHF.

METHODS

This study uses secondary data from previous research articles published in national and international journals that were sourced through online databases, including Portal Garuda, Google Scholar, Science Direct, Scopus, ProQuest, and EBSCOhost. The keywords used to find articles are presented in Table 1.

Table 1. Keywords used for article search

No	Boolean
1	"pemberantasan sarang nyamuk" OR "PSN" OR "PSN 3M Plus" OR "pengendalian vektor" OR "vector control" OR "mosquito nests eradication"
2	"pemberantasan sarang nyamuk" OR "PSN" OR "PSN 3M Plus" OR "pengendalian vektor" OR "vector control" OR "mosquito nests eradication" AND Indonesia
3	"mosquito nests eradication" AND "DHF" OR "DBD" OR "Demam Berdarah Dengue"
4	"PSN 3M Plus" AND "DHF" OR "DBD" OR "Demam Berdarah Dengue"
5	"pemberantasan sarang nyamuk" AND "DHF" OR "DBD" OR "demam berdarah dengue"
6	"pengendalian vektor" AND "DHF" OR "DBD" OR "demam berdarah dengue"
7	"vector control" AND "DHF" OR "DBD" OR "Demam Berdarah Dengue"
8	"pemberantasan sarang nyamuk" OR "PSN" OR "PSN 3M Plus" OR "pengendalian vektor" OR "vector control" AND "DHF" OR "DBD" OR "demam berdarah dengue"

The criteria applied in the selection of articles are the articles presented in Indonesia or English related to the implementation of mosquito control activities within Indonesia, articles published in 2015-2020 (because there is a 5-year dengue cycle), articles published in national journals SINTA 2 accreditations, or articles in international journals; and the articles were in the full-text. This study does not examine articles that do not concern mosquito control activities and DHF. Article screening using PRISMA analysis, such as duplicate articles, location, title, and abstract (Figure 1).⁹

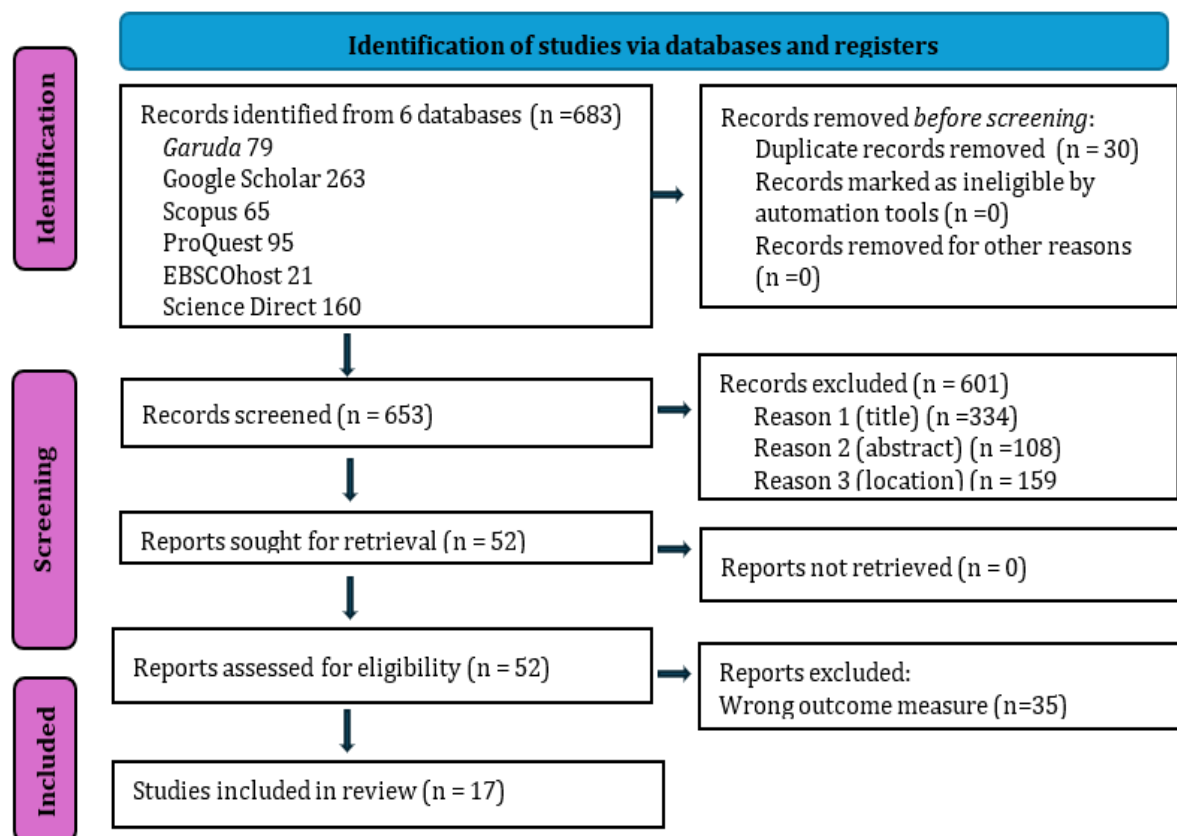


Figure 1. PRISMA flow diagram⁹

Table 2. Summary review of the association between mosquito control activities and DHF incidence in Indonesia

Author, Years	Objective	Method	Location	Outcomes
Setiawan et al., 2003 ¹⁰	To know the relationship between 3M Plus behavior and the incident of Dengue Hemorrhagic Fever (DHF) at Umbulharjo 1 Community Health Center, Yogyakarta City, Special Region of Yogyakarta in 2022/2023.	Cross sectional, 87 respondents	Umbulharjo 1 Public Health Centre, Yogyakarta City	Draining water reservoirs (p=0.000), closing water reservoirs (p=0.000), recycling used goods (p=0.009), keeping larvae-eating fish (p=0.071), installing wire mesh (p=0.093), hanging clothes in the house (p=0.001)
Sutriyawan, 2021 ¹¹	To prevent DHF through mosquito nest eradication.	Case control, 50 respondents	Babakansar Public Health Centre, Bandung City	Draining water containers (p=0.002), covering water containers (p=0.046), recycling used containers (p=0.020), installing wire mesh on the ventilation (0.000), using mosquito repellent (p=0.001)
Rismawati & Nurmala, 2017 ¹²	To analyze the relationship between host and environment PSN behavior and DHF incidence in RW 15, Wonokusumo urban Village, Surabaya City.	Cross sectional, 78 respondents	Surabaya City	Mosquito control activities action (draining water containers, not hanging used clothes, using mosquito repellent, using larvicide (abate), covering water containers, and burying used items) (p=0.000)
Jihaan et al., 2017 ¹³	To know the relationship between family PSN behavior and the incidence of DHF in Pancoran Mas urban Village, Depok City.	Cross sectional, 136 respondents	Depok City	Draining water containers (p=0.379), covering water containers (p=0.551), hanging used clothes (p= 0.566)
Suryanto, 2018 ¹⁴	To analyze the relationship between PSN behavior factors and DHF incidence in Dringu Subdistrict, Probolinggo District.	Cross sectional, 100 respondents	Dringu Subdistrict, Probolinggo Regency	Mosquito control activities action (draining water containers, covering water containers, burying items that may be inundated with water, keeping larvae-eating fish, and using abate powder) (p=0.025), installing wire mesh on the ventilation (p=0.035)
Utami, 2015 ¹⁵	To identify and analyze the relationship between community PSN behavior and DHF incidence in Putat Jaya Surabaya.	Cross sectional, 397 respondents	Surabaya City	Mosquito control activities action (draining water containers, covering water containers, and burying used items that may be inundated with water) (p=0.009)
Agustin, 2019 ¹⁶	To know the relationship between 3M Plus PSN behavior and DHF incidence in 2017 in the Tenggilis Public Health Centre, Surabaya.	Case control, 22 respondents	Working area of Tenggilis Public Health Centre, Surabaya	Mosquito control activities action (draining water containers, covering water containers, recycling items that may be inundated with water, using larvicide, and keeping larvae-eating fish) (p=0.361)
Ishak et al., 2019 ¹⁷	To analyze the relationship between the use of ventilation screens, the use of mosquito repellents, the habit of hanging clothes and the effectiveness of fogging with the incidence of DHF in the working area of Pontap Public Health Centre, Palopo.	Case control, 70 respondents	Working area of Pontap Public Health Centre, Palopo	No using mosquito repellent (p=0.000; OR= 7.222), hanging clothes (p=0.000; OR= 10.545)

Author, Years	Objective	Method	Location	Outcomes
Wijirahayu & Sukesi, 2019 ¹⁸	To know the relationship between physical conditions and the incidence of DHF.	Case control, 32 respondents	Working area of Kalasan Public Health Centre, Sleman Regency	Installing wire mesh on the ventilation (p=0.039; OR= 0.072)
Apriyani et al., 2017 ¹⁹	To analyze the relationship between sanitation of mosquito control environment and the presence of <i>Aedes sp.</i> larvae with DHF disease in Banguntapan Subdistrict, Bantul Regency.	Case control, 104 respondents	Bantul Regency, Yogyakarta	Draining water containers (p=0.001; OR= 4.09), covering water containers (p=0.558; OR= 0.49)
Satoto et al., 2020 ²⁰	To demonstrate the association of factors related to mosquito control with dengue transmission in Mataram City.	Case control, 180 respondents	Mataram City	No installing wire mesh on the ventilation (p=0.003; OR= 6.27)
Sucipto et al., 2015 ²¹	To identify mosquito control factors that influence dengue incidence in Semarang City.	Case control, 108 respondents	Semarang City	No using mosquito repellent (p=0.036; OR= 5.4), hanging clothes (p=0.046; OR= 3.9)
Lestari et al., 2019 ²²	To identify 3M factors associated with DHF incidence in Deket Subdistrict, Lamongan.	Case control, 78 respondents	Deket Subdistrict, Lamongan	Draining water containers (p= 0.000; OR= 0.000), covering water containers (p= 0.000; OR= 0.021), burying used items (p= 0.000; OR= 0.064)
Satoto et al., 2019 ²³	To demonstrate the relationship between mosquito control-related behaviors and dengue transmission in Gergunung Village, Klaten Regency.	Case control, 102 respondents	Gergunung Village, Klaten Regency	No using mosquito repellent (p= 0.398; OR= 1.43), no installing wire mesh on the ventilation (p= 0.999; OR= 1.00)
Rini & Wahyono, 2020 ²⁴	To determine the relationship between environmental factors related to mosquito control and DHF incidence in Purbalingga Regency.	Case control, 408 respondents	Purbalingga Regency	No installing wire mesh on the ventilation (p= 0.003; OR= 2.20)
Mubarok et al., 2018 ²⁵	To analyze the relationship between hygiene behavior through the habit of hanging clothes with dengue cases in Semarang.	Case control, 94 respondents	Semarang City	Hanging clothes (p= 0.009; OR= 3.839)
Hadwiningrum & Sulistya, 2019 ²⁶	To assess risk factors for self-protection, including the use of mosquito repellents and the habit of hanging clothes with the incidence of DHF.	Case control, 51 respondents	Caturharjo and Triharjo Villages, Pandak Subdistrict, Bantul Regency Yogyakarta	No using mosquito repellent (p= 0.18; OR= 2.88)

DHF: Dengue Hemorrhagic Fever; PSN: *pemberantasan sarang nyamuk*; 3M: *menguras, menutup, mengubur*

RESULT

The articles employed in this study are those sourced from the Portal Garuda, Google Scholar, Scopus, ProQuest, Ebscohost, and Science Direct, after which the article selection will be carried out. This selection conducted in this study is according to PRISMA as shown in Figure 1.⁹ A total of 683 research articles in Indonesia and English published in 2015-2020 were found (Garuda Portal=79 articles; Google Scholar=263 articles; Scopus= 65 articles; ProQuest=95 articles; EBSCOhost=21 articles; Science Direct=160 articles). Furthermore, articles that have duplicates (30 articles) are removed, and a total of 653 articles are obtained. The articles obtained are then screened based on research location, title, abstract, and text. There were 601 articles removed. After the screening, based on the inclusion criteria, 52 full-text articles are evaluated for eligibility following the screening. The 35 articles are excluded because there are improper outcome measures. The final stage is to get 17 research articles to be analyzed. The extraction of 18 articles that have been selected for analysis is in Table 2. The following is a description of the review article to be analyzed.

Table 2 shows that 38.89% of research articles use a cross-sectional study design and 61.11% use a case-control study design. The location is 83.33% in Java (Bandung, Surabaya, Depok, Semarang, Probolinggo, Sleman, Yogyakarta, Purbalingga, Klaten). Other locations are Sumatera (Medan) and Sulawesi (Palopo). Most articles show that not implementing PSN or PSN 3M Plus (no using repellent, no installing wire mesh on the ventilation, hanging clothes, keeping larva-eating fish, no using abate/larvicides) are associated with the incidence of DHF and are risk factors for the occurrence of DHF. On the other hand, implementing PSN (mosquito control activities action such as draining water containers, covering water containers, and burying used items that may be inundated with water) will be a protective factor. The variables of mosquito control activities associated with DHF incidence are listed in Table 3.

Table 3 consists of a review of 17 articles that studied the association between 9 variables to DHF incidence in Indonesia. There are 10 articles which have variable draining water containers at least once a week. 80% of the articles show a significant relationship between draining water containers at least once a week and DHF incidence. The 10 articles have the variable covering water containers, whereas 70% of the articles show a significant relationship between covering water containers and DHF incidence. There are 5 articles which have the research variable burying used items that may be inundated with water, where 80% of the articles show a significant relationship between burying used items that may be inundated with water with DHF incidence. There are only 2 articles that discuss recycling used items that may be inundated with water, 50% of which show a significant relationship between recycling used items that may be inundated with water and DHF incidence. In addition, 6 articles have the research variable using mosquito repellent, where 66.67% of the articles show a significant relationship between using mosquito repellent and DHF incidence. Furthermore, the use of abate, which in this case is categorized as using larvacides, was discussed in 4 articles. A total of 75% of the articles showed a significant relationship between using larvacides and DHF incidence. There are 3 articles which have the research variable keeping larvae-eating fish, where 66.67% of the articles show a significant relationship between keeping larvae-eating fish and DHF incidence. There is only 1 article that discusses mosquito-repellent plants, which shows a significant relationship between mosquito-repellent plants and DHF incidence with DHF incidence.

The articles that discuss the issue of installing wire mesh on ventilation are 8 articles. About 62.5% of the articles show an association between installing wire mesh on ventilation and DHF incidence. While articles that have hanging clothes variables are 7 articles. A total of 85.71% of articles show a significant relationship between hanging clothes and DHF incidence.

Table 3. Association between mosquito control activities and DHF Incidence

Mosquito Control Activities	DHF Incidence				Article's Number
	Numbers of Articles significant association	(%)	Numbers of Articles Not significant association	(%)	
Draining water containers at least once a week	8	80	2	20	1, 2, 3, 4, 5, 6, 7, 8, 11, 14
Covering water containers	7	70	3	30	1,2, 3, 4, 5, 6, 7, 8, 11, 14
Burying used items that may be inundated with water	4	80	1	20	3, 6, 7, 8, 14
Recycling used items that may be inundated with water	2	66.67	1	33.33	1, 2, 8
Using mosquito repellent	4	66.67	2	33.33	1, 2, 3, 9, 15, 18
Using larvicides	3	75	1	25	2, 3, 6, 8
Keeping larvae-eating fish	2	66.67	1	33.33	1, 6, 8
Installing wire mesh on ventilation	5	62.5	3	37.5	1, 2, 6, 9, 10, 12, 15, 16
Hanging clothes	6	85.71	1	14.29	1, 3, 4, 5, 9, 17, 18

DISCUSSION

One of the vector control efforts undertaken is mosquito control activities which aims to eradicate the *Ae. aegypti* mosquito from its breeding sites. Mosquito control activities are carried out through 3M Plus activities, including draining water containers, covering water containers, and burying used items that may be inundated with water. The 3M Plus activities have additional control activities, including keeping larva-eating fish, using mosquito repellents, installing wire mesh on ventilation, planting mosquito repellent plants, and using larvicides (abate) in water containers that are difficult to drain.

Relationship of draining water containers with DHF incidence

There are 8 of 10 articles (80%) studying draining water containers showed a relationship between draining the water containers at least once every week with the incidence of DHF. The determinant of the presence of mosquitoes is influenced by the presence of breeding places of *Ae. aegypti*. One factor that influences mosquito breeding is water containers.²⁷ Eggs of mosquitoes need 7-10 days to progress into adult mosquitoes. Mosquitoes that are vectors for dengue will lay their eggs on the inner walls of water-filled containers at the surface of the water. These mosquitos' eggs will stick to the walls of the container like glue and can last in dry conditions for up to 8 months. Mosquito eggs will then hatch and become larva. The *Ae. aegypti* mosquito breeds in fresh water, i.e., tap or rainwater, which is in or around the house and requires only a small amount of water to lay its eggs. The most common breeding sites for *Ae. aegypti* mosquitoes are containers with straight edges. Bowls, cups, old tires, flower vases, plastic sheeting, and other containers could be used to collect water to make good breeding sites.^{28,29} Mosquito control activities by draining water containers which is carried out routinely at least once a week, can be an effort to control the DHF vector by eliminating opportunities for mosquitoes to have breeding grounds. In addition to draining, it is also necessary to clean the walls of the tub and water reservoir to remove attached mosquito eggs.³⁰

Relationship of covering water containers with DHF incidence

There are 7 of 9 articles (70%) show that there is a relationship between closing water containers and the DHF incidence. *Ae. aegypti* mosquito larva are found in open-water containers. This condition forms a comfortable breeding site for *Ae. aegypti* mosquitoes. *Aedes aegypti* mosquitoes will find it easier to enter, exit, and lay eggs in uncovered water reservoirs.³¹ A study

in Tanjung Pinang showed 88.53% of 863 containers are not closed.²⁷ Another study in Lamongan shows the covering water container is a protective factor from the incidence of DHF.²² Studies in Kupang City show that closed containers contain only 2.6% larvae and pupae while opened or half closed 36.9%.³² Therefore, closing water containers needs to be done because it is one of the efforts to stop the transmission of DHF by eliminating opportunities for mosquitoes to breed so that the eggs and larvae of the *Ae. aegypti* mosquitoes can be eradicated before they grow into adult mosquitoes.^{30,31,33}

Relationship of installing wire mesh on ventilation with DHF incidence

Five of the 8 articles (62.5%) that study the installment of wire mesh show a relationship between installing wire mesh on ventilation and the incidence of DHF. One way to physically control vectors and prevent DHF is to install wire gauze on ventilation. Wire gauze made of iron, copper, aluminum, or plastic is attached to the vents with a protective function so mosquitoes cannot go through the house. This can help reduce contact between humans and mosquitoes. Through the bite of a female *Ae. aegypti* mosquito, the dengue virus that causes DHF disease is transmitted to humans. The female *Ae. aegypti* mosquito requires blood to produce eggs. The *Ae. aegypti* mosquito is also known to feed on blood, sometimes from many individuals in one gonotrophic cycle. The female *Ae. aegypti* mosquito has a habit of biting during the day, especially for about two hours after sunrise and a few hours before sunset but may bite at night.³⁴ Installing wire mesh on the ventilation can prevent dengue vector mosquitoes from entering so that mosquitoes cannot rest in the house and bite humans. In this way, it can help prevent the *Ae. aegypti* 's transmission of DHF. Therefore, it is recommended that people use wire gauze for ventilation.^{35,36} Installing wire mesh on the house's ventilation is a physical preventative effort against mosquitoes and a protection to reduce contact with mosquitos in the family environment. The goal is to prevent mosquitoes from entering the house or the bedroom.³⁷

The relationship of burying used items with DHF incidence

Used items or disposable sites are containers that are generally placed outside the house. They do not belong to households and have the potential to accumulate rainwater so that they can become breeding sites for mosquitoes.³³ There are 4 of 18 articles that show a correlation between burying used items that may be inundated with water and the incidence of DHF. This is in line with the study in Lamongan which shows that burying unused things is associated with DHF. Burying unused things is a protective factor from the incidence of DHF.³⁸ Used items such as used cans, used plastics, used buckets, and so on, which are around the house that can hold water or be flooded when it rains, are places that have the potential to become breeding sites for *Ae. aegypti* mosquitoes. Therefore, used items that can hold water are recommended to be buried in the ground so as not to be flooded with water and become the breeding sites for *Ae. aegypti* mosquitoes.³⁹

The relationship between using mosquito repellent and DHF incidence

Four articles showed the relationship between using mosquito repellent and DHF incidence. The use of mosquito repellent is also one of the efforts that can be done to prevent the transmission of dengue disease, such as the resulting study from Sumbawa. That study shows the habit of using insect repellents is a prevention factor for the incidence of DHF.⁴⁰ This mosquito repellent is available in various forms, including mosquito coils, spray, electric, or lotion. Anti-mosquito repellent contains chemicals in the form of insecticides, among others, organochlorine, organophosphate, carbamate, pyrethroids, and dichlorodiphenyltrichloroethane (DDT), which help kill adult mosquitoes.⁴¹ A study in Pekanbaru shows that respondents who do not have the habit of using mosquito repellent are at risk of experiencing dengue fever 2.76 times greater than respondents who have the habit of using mosquito repellent.³⁷ Using mosquito repellent prevents humans from being exposed to mosquito bites and contracting DHF disease. Therefore, people should use mosquito repellent, especially during the day, considering that *Ae. aegypti* mosquitoes have a habit of biting during the day.⁴² *Ae. aegypti* actively consume human blood during the day

(diurnal) with two peak bites in the morning between 8-9 o'clock and between 16-17 in the afternoon.³⁷

The relationship of using larvicide with DHF incidence

There are 3 articles (17.65%) that show the relationship between using larvicide and DHF incidence. Dengue vector control by using larvicide is one form of chemical control that can be done. The regular use of abate aims to eradicate *Ae. aegypti* mosquito larvae from growing into adult mosquitoes. Providing larvicide in the form of 1% temephos sand granules is an effective way to eradicate *Ae. aegypti* larvae.⁴¹ Spreading abate powder can reduce the growth of mosquitoes because abate powder aims to kill mosquito larvae so that they do not grow into adult mosquitoes.¹²

The relationship of keeping larvae-eating fish with DHF incidence

A total of 2 articles (11.76%) shows a relationship between keeping larvae-eating fish and the incidence of DHF. Using larvae-eating fish against *Ae. aegypti* mosquito larvae is a form of biological control and is easy to do. Keeping larvae-eating fish is considered an effort to eradicate dengue vectors because larvae-eating fish inside water containers will eat existing mosquito larvae so that the larvae will not breed into adult mosquitoes. Some types of larvae-eating fish that can be used include tinhead fish (*Aplocheilichthys panchax*), Nile tilapia fish (*Oreochromis niloticus*), Tilapia fish (*Oreochromis mossambicus*), and Betta fish (*Betta sp.*). Using larva-eating fish to eradicate DHF vectors is effective and does not pose an environmental risk.⁴³

The relationship between recycling used items and DHF incidence

There are 2 articles (11.76%) that show the relationship between recycling used items and the incidence of DHF. The used items around the house, such as used cans, used buckets, used bottles, plastic, and other used items, that can contain or be flooded by rainwater, are places that have the potential to be a place for *Ae. aegypti* mosquitoes to breed. Utilizing used items around the house that can hold water is recommended by the community as an effort to prevent the creation of breeding sites for *Ae. aegypti* mosquitoes.³⁹ However, another study in Pekanbaru shows that there is no relationship between recycling used items and the incidence of DHF.³⁷

Relationship of habit of hanging clothes with DHF incidence

There are 7 articles (87.25%) from 8 articles that find a significant correlation between the habit of hanging clothes and DHF incidence. The *Ae. aegypti* mosquito needs time to rest to mature its eggs. In this process, female *Ae. aegypti* mosquitoes also need human blood to help speed up the egg maturation process because human blood is the source of protein needed by mosquitoes.⁴⁴ Mosquito resting places are generally low plants, such as grass usually found in the house's yard, on old tires, bricks, and scrap metal. In addition, the *Ae. aegypti* mosquito usually rests inside the room on hanging objects, such as clothes. Dark and damp places are places favored by *Ae. aegypti* mosquitoes.³⁴ The practice of hanging used clothes inside and in the room, especially outside the wardrobe, is a behavior that can support the availability of a resting place for the *Ae. aegypti* mosquito because these mosquitos prefer resting in hanging and moist places after consuming human blood.¹² Having the habit of hanging clothes gives the *Ae. aegypti* mosquito a resting place. Therefore, it is recommended that people do not hang their clothes after using them to prevent them from being used as resting places for mosquitoes.

CONCLUSION

Implementing mosquito control activities with PSN or PSN 3M Plus has an association with the DHF incidence. Most articles show that not implementing PSN or PSN 3M Plus is associated with the incidence of DHF and is a risk factor for DHF. On the other hand, implementing PSN or PSN 3M Plus will be a protective factor.

CONFLICT OF INTEREST

There is no conflict of interest.

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AUTHOR CONTRIBUTION

YDP: Search articles from journals to be analyzed and reviewed, write the manuscript. SS: Adding articles, writing manuscripts, improving and editing manuscripts. YHD: Writing and correcting manuscript. NAYD: Correcting the manuscript that has been prepared.

LIST OF ABBREVIATIONS

DHF: Dengue Haemorrhagic Fever; DBD: *Demam Berdarah Dengue*; Denv: Dengue virus; CFR: Case Fatality Rate; MoH: Ministry of Health; DDT: Dichlorodiphenyltrichloroethane; IR: Incidence Rate; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analyses; PSN: *Pemberantasan Sarang Nyamuk*; PSN 3M Plus: *Pemberantasan Sarang Nyamuk-Menguras Menutup Mengubur*

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