Mosquito Larvae Identification in Water Storage and Assesment of Worker's Knowledege, Attitudes, and Practices

Adinda Nezma Meidina[1], Dwi Handayani[2*], Dalilah[2], Gita Dwi Prasasty[2], Susilawati[2]

[1] Department of Medical Education, Faculty of Medicine, Sriwijaya University, Palembang, Indonesia
[2] Department of Medical Parasirology, Faculty of Medicine, Sriwijaya University, Palembanga, Indonesia

*Correspondence: dwihandayani@fk.unsri.ac.id

Vector-borne diseases remain a major public health concern in tropical regions, with dengue fever continuing to be the predominant vector-borne disease in urban Indonesia. Public tourist areas with high human activity may provide favorable breeding sites, making sanitation workers' roles crucial. This study aimed to identify mosquito breeding characteristics and larval presence in water-holding containers (WHCs) and to describe the knowledge, attitudes, and practices (KAP) of sanitation workers in a historic public open space in an urban setting. A descriptive cross-sectional study using a mixed-methods approach was conducted, combining quantitative entomological surveys with qualitative in-depth interviews. All accessible WHCs at the study site were inspected for larvae, which were collected and morphologically identified, and *Aedes* larval indices (*ABJ/Angka Bebas Jentik*, HI, CI) were calculated. Sanitation workers were selected purposively as qualitative informants, and KAP data were analyzed thematically. Seven WHCs were identified, of which two outdoor natural pools (28.57%) were positive for larvae, yielding 13 larvae, all identified as *Culex spp.*, with no *Aedes spp.* detected. Consequently, *Aedes*-specific indices showed an *ABJ* of 100%, HI of 0%, and CI of 0%, indicating a low risk of dengue transmission according to WHO criteria (HI <4% and CI <3%). Sanitation workers demonstrated generally good knowledge, positive attitudes, and routine preventive practices, although understanding of the full 3M Plus concept varied. In conclusion, despite the presence of non-*Aedes* larvae in outdoor natural containers, the absence of *Aedes* breeding sites suggests effective dengue vector control supported by routine sanitation practices in the study area.

Keywords: Knowledge, Attitude, Practices, Larvae Identification, Larvae Index

INTRODUCTION

Tropical diseases continue to constitute a significant public health challenge in tropical and subtropical regions, with their transmission largely facilitated by insect vectors, particularly mosquitoes (Prodyanatasari et al., 2024). Globally, more than 3,500 mosquito species have been identified, several of which serve as vectors for major infectious diseases such as dengue, chikungunya, malaria, and filariasis (Wong et al., 2024). In Indonesia, the incidence of Dengue Hemorrhagic Fever (DHF) in 2023 reached 41.4 per 100,000 population, a figure that substantially exceeds the national elimination target (Kemenkes, 2024). South Sumatra Province, particularly Palembang City, represents one of the regions with a considerable number of dengue cases, reporting 727 cases. Meanwhile, chikungunya has been documented across 29 provinces, malaria remains concentrated in eastern Indonesia despite South Sumatra's achievement in reducing malaria morbidity (annual parasite incidence <1

per 1,000 population), and filariasis persists nationwide, with 7,955 reported cases in 2023 (Dinas Kesehatan Sumatera Selatan, 2023; Kemenkes, 2024; World Health Organization, 2023) These findings indicate that, despite notable progress in the control of certain vector-borne diseases, dengue fever continues to be the predominant mosquito-borne disease in Palembang City.

DHF is transmitted by *Aedes* aegypti and *Aedes* albopictus, mosquito species that predominantly breed in clean and stagnant water. Conversely, vectors of malaria and filariasis, such as *Culex* and Anopheles, generally prefer polluted or flowing water (Dinas Kesehatan Sumatera Selatan, 2023; Kularatne & Dalugama, 2022). Sustainable mosquito vector control requires an integrated approach that prioritizes the elimination of larval breeding sites. Multiple strategies have been implemented, including fogging, the application of larvicides, and Mosquito Nest Eradication (Pemberantasan Sarang

Nyamuk, PSN) through the 3M Plus program (Kemenkes RI, 2024).

The effectiveness of these interventions is highly dependent on the active participation of individuals and groups who directly interact with environments at risk of vector proliferation. From a theoretical perspective, health behavior models emphasize knowledge and attitudes as key determinants of preventive behavior. Nevertheless, empirical evidence has yielded inconsistent findings. Sunaryanti & Iswahyuni, (2020)reported a significant association between knowledge and attitudes and vector control behavior, whereas (Ravenia et al., (2018) demonstrated that knowledge and behavior were associated with larval density, while attitudes were not directly related. These discrepancies highlight the need for further evaluation across diverse contexts and populations.

Public environments characterized by high levels of human activity and inadequate sanitation management, such as tourist destinations or historic public open spaces in tropical urban settings, are particularly vulnerable to becoming mosquito breeding sites. Underutilized facilities, damaged sanitation infrastructure, and the accumulation of various forms of anthropogenic waste may create favorable microhabitats for mosquito larvae (Hasanah et al., 2023). In such environments, sanitation workers serve as frontline personnel responsible for maintaining environmental hygiene and routinely managing water-holding containers. Their daily practices directly influence the presence or absence of mosquito larvae and, consequently, the risk of vector-borne disease transmission (Yohana Sianipar et al., 2018). However, to date, few studies have simultaneously evaluated mosquito larval profiles in water-holding containers alongside the KAP of cleaning staff in public urban environments. Therefore, this study aims to identify mosquito breeding site characteristics and larval presence in WHCs, as well as to describe the knowledge, attitudes, and practices of cleaning staff, thereby providing empirical evidence to strengthen environmentally and behaviorally based vector control strategies.

METHODS
Study Design
This is an observational, descriptive, and cross-sectional study using a mixed methods approach, including quantitative entomological measurements and a qualitative approach through in-depth interviews. The study was conducted from March to November 2025 in a historic public open space area in an urban area and at the Bio-Optics Laboratory of the Faculty of Medicine, Sriwijaya University.

Population and Sample
The study population comprised all WHCs, both natural and artificial, that have the potential to serve as mosquito breeding habitats at the study site. Quantitative analysis units included WHCs, the presence of mosquito larvae, the number of larvae, and the species/genus of mosquito larvae found.

The quantitative study sample included all WHCs that met the inclusion criteria, using a total sampling technique. Inclusion criteria included accessible WHCs, both indoors and outdoors. Exclusion criteria included empty WHCs, cloudy areas that prevented larvae from being visually observed, and WHCs that were inaccessible during observation.

The qualitative study subjects were cleaning staff responsible for environmental cleanliness at the study site. The study site employed a total of 19 cleaning staff. From this population, eight cleaning staff were selected as qualitative informants using purposive sampling based on their direct involvement in environmental sanitation and mosquito control activities. Interviews were conducted until data saturation was achieved, as indicated by the repetition of information and the absence of new emerging themes.

Data Collection Procedures
Identification of WHCs was conducted through direct observation of all indoor and outdoor water containers. The characteristics of each WHC were recorded, including location, container type, and the presence of mosquito larvae. Mosquito larvae were collected using a standard 350 ml scoop, gamadot, and a plastic pipette, using a technique of one scoop per square meter for large containers. The larvae recovered were counted, separated into larvae and pupae, and then placed in labeled bottles containing the location and time of collection. The specimens were preserved in 70% alcohol and transported to the laboratory for identification.

Larval preparations were prepared through fixation, multistep dehydration, and mounting on glass slides using entellan medium. Identification of mosquito larval genus was performed using a compound microscope based on larval morphology, using standard identification keys recommended by the World Health Organization (WHO), including observation of siphons, combs, and larval resting position.

Qualitative data were obtained through in-depth semi-structured interviews to explore the knowledge, attitudes, and practices (KAP) of sanitation workers regarding mosquito breeding sites and prevention efforts, including the implementation of 3M Plus. Interviews were conducted using an interview guideline, lasted 30–45 minutes, were recorded with the informant's consent, and were transcribed verbatim.

Data Analysis
Quantitative data were presented descriptively in the form of tables, photographs, maps, and narratives. Larval density analysis was conducted based on the results of the entomological index calculations. Mosquito larval density was analyzed using entomological indicators, namely the Larvae Free Rate (*ABJ/Angka Bebas Jentik*), House Index (HI), and Container Index (CI). The calculation of *ABJ*, HI, and CI in this study was limited to *Aedes spp.* larvae, in accordance with the Indonesian Ministry of Health Regulation No. 50 of 2017, which applies these larval indices specifically for assessing *Aedes* vector density in dengue prevention programs (Peraturan

menteri kesehatan republik indonesia, 2017). The HI and CI values were then interpreted using the Density Figure (DF) to determine larval density levels. According to World Health Organization (WHO) guidelines, areas with HI < 4% and CI < 3% are considered low risk for dengue transmission, whereas HI > 35% and CI > 20% indicate a high transmission risk (World Health Organization, 2005).

Qualitative data were analyzed using thematic analysis, which included open coding, grouping codes into categories, and developing main themes. Data validity was maintained through source triangulation, by comparing interview results between informants and key informants.

Research Ethics

This research has obtained research ethics approval with Exempt Status from the Medical and Health Research Ethics Committee of the Faculty of Medicine, Sriwijaya University, under Protocol Number 129-2025. All informants provided written informed consent before participating in the study.

RESULT AND DISCUSSION

The study area consisted of interconnected indoor and outdoor facilities within a historic public open space. A total of seven water-holding containers (WHCs) were identified and examined, comprising five artificial containers (buckets) located inside restroom buildings and two natural water pools located outdoors. No discarded artificial containers such as bottles, cans, or used tires were observed during the survey. Of the seven WHCs, four (57.14%) were located indoors and three (42.86%) were located outdoors. All indoor WHCs were free of mosquito larvae, whereas larvae were detected exclusively in outdoor natural containers (Table 1). Two WHCs tested positive for mosquito larvae, both of which were natural pools located outdoors. The detailed observational results from the aforementioned water reservoirs are presented in Table 2.

Table 1

Presence of Larvae Based on WHCs Location (n=7)

WHCs Location	Number of WHCs		Positive		Negative	
	n	%	n	%	n	%
Indoor	4	57.14	0	0.00	4	80.00
Outdoor	3	42.86	2	100.00	1	20.00
Total	7	100.00	2	100.00	5	100.00

*Percentages for positive and negative columns were calculated based on column totals

Table 2

Presence of Larvae Based on WHCs Type (n=7)

WHCs Type	Number of WHCs		Positive		Negative	
	n	%	n	%	n	%
Bucket	5	71.42	0	0.00	5	100.00
Large ponds	1	14.29	1	50.00	0	0.00
Small ponds	1	14.29	1	50.00	0	0.00
Total	7	100.00	2	100.00	5	100.00

A total of 13 mosquito larvae were collected from the two positive WHCs. Eight larvae were found in the larger outdoor pool, while five larvae were found in the smaller pool (Table 3). No larvae were detected in any artificial containers, including all buckets located in indoor restroom facilities.

Table 3

Distribution of Individual Larvae Collected from Larva-Positive WHCs (n = 13)

WHCs Type	n	%
Large ponds	8	61.54
Small ponds	5	38.46
Total	13	100.00

* Larvae were collected exclusively from two WHCs that tested positive in Table 2

All collected larvae were identified morphologically at the laboratory level and were classified as belonging to the genus *Culex*. No *Aedes spp.* larvae were identified in any inspected WHCs, either indoors or outdoors (Table 4). Larval density indices, including the Larva-Free Index (*ABJ*), House Index (HI), and Container Index (CI), were calculated exclusively for *Aedes spp.* larvae, in accordance with the Indonesian Ministry of Health Regulation No. 50 of 2017, which applies these indices specifically for dengue vector surveillance. (Kemenkes RI, 2017). In this study, a 'house' for HI and *ABJ* calculation was defined operationally as a functional building unit within the study area, consistent with public facility–based dengue surveillance.

Tabel 4

Index Larva Result

Indicator	Parameter Value
Larva-Free Index (%)	100.00
House Index (%)	0.00
Container Index (%)	0.00

Since no Aedes spp. larvae were detected in any inspected building or container, the calculated indices were as follows: *ABJ* 100.00%, HI 0.00%, and CI 0.00% (Table 4). These values indicate the absence of *Aedes spp.* breeding activity within the surveyed area at the time of observation.

Figure 1. Larvae Resting Position

Figure 1 shows larvae resting at an angle to the water surface, which is characteristic of siphon-bearing mosquito larvae. Morphological examination revealed that all larvae possessed a long, slender, cylindrical siphon with more than three pairs of siphonal setae. Additional diagnostic features included curved comb scales with small lateral spines and a partially closed anal saddle. These characteristics are consistent with larvae of the genus *Culex* (Figures 2 and 3). Larval identification was performed on third- and fourth-instar larvae, as these stages exhibit well-developed diagnostic structures such as the siphon, comb scales, and anal saddle, allowing reliable genus-level identification. Early instar larvae were not used for taxonomic determination (Gallichotte et al., 2021).
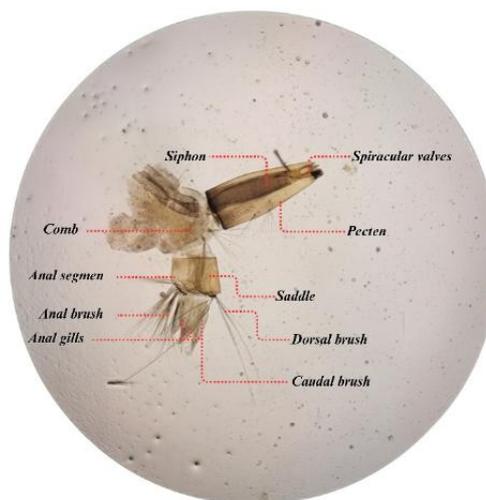

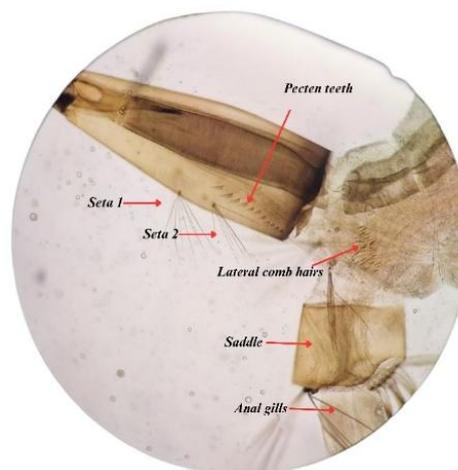**Figure 2.** *Culex* larvae with 10×4 magnification

Figure 3. *Culex* larvae with 10×10 magnification

To ensure identification accuracy, all larval specimens were examined independently by two investigators using standard morphological identification keys recommended by the World Health Organization (WHO). Any discrepancies in morphological interpretation were discussed until consensus was reached. Based on this procedure, all larvae collected during the survey were consistently identified as belonging to the genus *Culex*. Data from the morphological identification of larvae collected during the field survey are presented in Table 5.

Table 5

Genus of Mosquito Larvae in Various WHCs

TPA	Genus			
	Aedes	Anopheles	Culex	Mansonia
Bucket	0	0	0	0
Large ponds	0	0	8	0

TPA	Genus			
	Aedes	*Anopheles*	*Culex*	*Mansonia*
Small ponds	0	0	5	0
Total	0	0	13	0

Nursanti et al., (2024) stated that the most ideal container for the development of *Aedes* larvae is an indoor, uncovered, plastic or ceramic water container that is light-colored, filled with well water at a temperature of 25–30°C and a pH of 7–9, and used continuously without frequent draining. However, this study found no *Aedes* larvae in buckets within either the men's or women's toilets. This absence is likely due to routine cleaning practices, as sanitation staff regularly empty and wash these containers, preventing the formation of stagnant water that would otherwise attract *Aedes* mosquitoes (Hancock & Camp, 2022; Tewari et al., 2023). This finding is consistent with (Permana Putri et al., 2023) who reported that mosquito larvae in tourism areas were more frequently detected in outdoor containers, particularly natural water bodies, rather than in well-maintained indoor facilities. In contrast, studies conducted in other tourist destinations have reported a high presence of *Aedes* larvae in both artificial and natural containers (Ilyas et al., 2025), highlighting that the absence of *Aedes* in the present study may reflect effective container management rather than unsuitable environmental conditions.

In the outdoor area, a large pond containing murky water served as a potential habitat for *Culex* mosquitoes (Hancock & Camp, 2022; Krol et al., 2024). Other aquatic organisms, including tadpoles, were also observed in both ponds. (Kaura et al., 2023) found that frog tadpoles can prey on up to 97% of mosquito larvae across various instars, which may explain why only eight *Culex* larvae were found in the large pond and five in the small pond during the survey.

The detection of *Culex* larvae exclusively in outdoor natural pools is consistent with their known breeding preference for shaded and stagnant water. Although methods for assessing *Culex* larval density have been described in previous studies, this study did not aim to quantify *Culex* density (Xavier et al., 2024). Therefore, the entomological indices reported here are limited to *Aedes spp.* for dengue vector surveillance. This study recorded an *ABJ* (larval-free index) of 100%, a House Index (HI) of 0.00%, and a Container Index (CI) of 0.00%, indicating that all buildings and water reservoirs were free of *Aedes* larvae, thereby classifying the environment as larva-free. According to WHO guidelines, areas with an HI <4% and a CI <3% are considered to have no risk of dengue transmission, whereas transmission risk is high when HI exceeds 35% and CI exceeds 20% (Ayettey et al., 2023; Enslen et al., 2020; Ha et al., 2021). Accordingly, the findings of this study suggest a very low density of *Aedes* vectors, resulting in a minimal likelihood of dengue transmission. The 100% *ABJ* further reinforces this conclusion and indicates that the "Pemberantasan Sarang Nyamuk (PSN)" program in the area is functioning effectively, as demonstrated by the absence of potential habitats for *Aedes* vector development (Kemenkes RI, 2024). Data from in-depth interviews with sanitation workers are presented in Tables 6–8.

Table 6
Knowledge of Cleaning Staff

Item	Statement	Source
Knowledge that mosquitoes can transmit diseases to humans	*"I have heard that mosquitoes can spread diseases such as malaria and dengue fever."*	AH
	"Yes, mosquitoes can act as vectors of diseases, such as dengue fever and skin infections."	HD
	"I have had dengue fever before, so I know mosquitoes can cause dengue, malaria, and filariasis."	IP
	"I have heard that mosquitoes can spread diseases, such as dengue fever and diarrhea."	OK
	"Yes, mosquitoes can cause diseases such as malaria and dengue fever."	LK
	"Yes, mosquitoes can cause dengue fever and skin itching."	LD
	"I have heard that mosquitoes can cause diseases, such as dengue fever."	KW
	"I know that mosquitoes can transmit dengue fever, malaria, and filariasis."	AR

Item	Statement	Source
Knowledge about mosquito breeding	*"Mosquitoes develop from larvae, then pupae, and then become adult mosquitoes. They start from eggs."*	AH
	"Mosquitoes develop from eggs, depending on environmental conditions."	HD
	"Usually in clean stagnant water such as rainwater puddles, ditches, or water containers. Mosquitoes lay eggs in water and then develop into mosquitoes."	IP
	"Usually in drains, puddles, or dirty places that collect water. From eggs they become larvae and then mosquitoes."	OK
	"Mosquitoes usually live in dirty and dark places with water, where they lay eggs and then become mosquitoes."	LK
	"Usually in bushes, rooms, or humid places; eggs become larvae and then develop into mosquitoes."	LD
	"Usually in dirty places, garbage, or stagnant water. From eggs they become larvae and then mosquitoes."	KW
	"Usually in stagnant water, used containers, or flower pots with rainwater. The development starts from eggs, larvae, and then becomes mosquitoes."	AR
Knowledge about dengue fever symptoms	*"The signs include red spots, high fever, and sweating."*	AH
	"The signs are chills, vomiting, dizziness, and high fever."	HD
	"There are red spots that do not fade and a high fever."	IP
	"High fever, red spots, and weakness."	OK
	"Yes, fever, chills, and reddish spots."	LK
	"The symptom is a persistent high fever."	LD
	"The signs are chills, body heat, and weakness."	KW
	"Usually high fever, red spots, sometimes accompanied by headache and vomiting."	AR
Knowledge about dengue fever prevention and 3M Plus	*"Mosquito-borne diseases can be prevented depending on our lifestyle. I have heard of 3M, but I only remember draining water containers."*	AH
	"Yes, it can be prevented if treated quickly by a doctor and through environmental cleaning. I do not know what 3M is."	HD
	"It can be prevented by draining, covering, and burying unused items."	IP
	"Maintaining environmental cleanliness and disposing of stagnant water. I have heard of 3M, but I forgot."	OK
	"Dengue fever is prevented by cleaning the environment. I do not really know what 3M is."	LK

Item	Statement	Source
	"Maintain cleanliness; I do not know what 3M is."	LD
	"Prevention is done by maintaining cleanliness, covering stagnant water, and using mosquito repellents. I do not know what 3M stands for."	KW
	"Dengue fever can be prevented by maintaining cleanliness and eliminating stagnant water. The 3M program consists of draining, covering, and burying unused containers."	AR

Analysis of the in-depth interview data revealed a generally adequate level of knowledge among sanitation workers regarding mosquito breeding and mosquito-borne diseases. All eight participants recognized mosquitoes as vectors capable of transmitting diseases, most commonly mentioning dengue fever and malaria. However, misconceptions regarding mosquito-borne diseases were identified in several participants, particularly the belief that skin infections or gastrointestinal illnesses could also be transmitted by mosquitoes.

Regarding mosquito breeding, most participants correctly identified standing water as a key breeding site and were aware of the general life cycle of mosquitoes, including egg, larval, and adult stages. Nevertheless, variability in understanding was observed, with some participants associating mosquito breeding primarily with dirty or outdoor environments, while underestimating the role of indoor water containers.

Knowledge of dengue fever symptoms was consistently reported by the majority of workers, who commonly mentioned high fever and skin manifestations. In contrast, understanding of dengue prevention strategies, particularly the 3M Plus program, was limited. Only a minority of participants were able to correctly describe all components of the 3M Plus program, while most reported partial or no knowledge of its definition.

Table 7
Attitudes of Cleaning Staff

Item	Statement	Source
Agree that mosquito-borne diseases can be prevented	*"Agree."*	AH
	"Agree."	HD
	"Agree."	IP
	"Strongly agree."	OK
	"Agree."	LK
	"Agree."	LD
	"Agree."	KW
	"Strongly agree."	AR
Agree that you will help with mosquito vector eradication activities, such as the 3Ms	*"Agree."*	AH
	"Agree."	HD
	"I agree."	IP
	"Yes, I agree."	OK
	"No, I do not want to get infected."	LK

Item	Statement	Source
	"Yes, it must be done."	LD
	"Agree."	KW
	"Definitely."	AR

Overall, sanitation workers demonstrated positive attitudes toward the prevention of mosquito-borne diseases. Nearly all participants agreed that such diseases are preventable and expressed a willingness to support mosquito control efforts, including the implementation of 3M activities. Despite this generally positive attitude, one participant expressed reluctance to engage directly in mosquito control activities due to concerns about personal safety and the risk of disease transmission while working in high-risk environments. This finding indicates that while preventive attitudes were largely favorable, perceived occupational risks may influence individual willingness to participate fully in vector control activities.

Table 8
Behavior of Cleaning Staff

Item	Statement	Source
Drain the bathtub	"We drain and clean the bathtub regularly."	AH
	"Usually once a month, but there is a special officer responsible, not me."	HD
	"There is no bathtub here, but we drain buckets every morning and evening."	IP
	"Yes, we drain, scrub, and refill with clean water."	OK
	"We drain it every day, morning and evening."	LK
	"Three times a week, usually in the morning when it is quiet."	LD
	"We drain the bathtub every day and add larvicide so that larvae do not develop."	KW
	"We drain it twice a week so that larvae cannot survive."	AR
Cover water reservoirs	"When water is stored, it is covered so mosquitoes cannot enter."	AH
	"Stagnant water is drained so it does not become a mosquito breeding site."	HD
	"If there is stagnant water, it is scooped out and discarded to prevent mosquito breeding."	IP
	"Stagnant water is removed so there are no larvae."	OK
	"If there is standing water, it is cleaned so it can flow."	LK
	"If there is stagnant water, we drain it to reduce mosquitoes."	LD
	"Rainwater is drained so it does not form puddles."	KW

Item	Statement	Source
	"If there is standing water, we cover it so mosquitoes do not lay eggs there."	AR
Bury trash	"No, we collect it and give it to waste collectors."	AH
	"Sometimes; otherwise, we collect and recycle it."	HD
	"Usually we collect it, burn it, and then submit it to the waste bank."	IP
	"Bottles and cans are burned or disposed of in trash bins."	OK
	"Bottles and cans are disposed of or burned so they do not become mosquito breeding sites."	LK
	"Bottles are collected; some are burned and the rest are discarded."	LD
	"We throw them away or sell them to collectors."	KW
	"We collect the waste and do not leave it exposed to become mosquito breeding sites."	AR
Take measures to prevent dengue fever, such as the 3Ms	"I have participated in 3M activities, conducted once a month at home and at work."	AH
	"I have participated."	HD
	"Very often."	IP
	"I have participated."	OK
	"I participate frequently, every Saturday."	LK
	"Rarely, about once a month."	LD
	"We always cover stagnant water and clean the house."	KW
	"Often at home or at work, because it is frequently socialized."	AR

In terms of practices, most sanitation workers reported routinely implementing mosquito-breeding site control measures as part of their daily responsibilities. These practices included regularly draining and cleaning water containers, covering water storage areas, and managing waste to prevent water accumulation. Waste management practices were described as varied but generally proactive, with participants reporting activities such as collecting, burning, recycling, or selling recyclable materials to prevent them from becoming potential breeding sites. Waste management practices were described as varied but generally proactive, with participants reporting activities such as collecting, burning, recycling, or selling recyclable materials to prevent them from becoming potential breeding sites.

The findings indicate an alignment between sanitation workers' knowledge, attitudes, and reported practices. General awareness of mosquito breeding and vector-borne disease transmission was accompanied by positive preventive attitudes and routine implementation of basic control measures, such as draining and covering water containers (Ayettey et al., 2023; Ngingo et al., 2022; Saba et al., 2023). This descriptive consistency is in line with the entomological findings of this study, which demonstrated an absence of *Aedes* larvae across all inspected buildings and water containers, reflected by an *ABJ* of 100% and zero values for the House Index and Container Index.

Although gaps in specific knowledge were identified, particularly regarding the comprehensive components of the 3M Plus program, these limitations did not coincide

with the presence of *Aedes* breeding sites at the time of observation. Overall, the findings suggest that routine preventive practices carried out by sanitation workers contribute to maintaining a larva-free environment, while continued training and health education may further strengthen the sustainability of mosquito-breeding site control in public environments.

Compared to research conducted at the same location in 2018, there was an increase in all three aspects of knowledge, attitudes, and behavior. Previous research found that only behavior influenced larval numbers, while knowledge and attitudes did not (Yohana Sianipar et al., 2018). In this study, all three aspects showed consistent improvement, reflecting greater awareness and participation of officers in maintaining environmental cleanliness. This contributes to reducing larval habitats and reducing the risk of vector-borne disease transmission. These findings highlight the importance of routine sanitation management and staff engagement as key components of mosquito control strategies in tourism areas.

This study was conducted during the dry season, when most water-holding containers at the study site were dry, which likely reduced the number of larva-positive containers and limited the detection of mosquito larvae compared with conditions during the rainy season. In addition, unforeseen changes in sanitation management, including an increase in the number of cleaning staff and more intensive daily cleaning activities, altered environmental conditions between the initial survey and field data collection. These routine cleaning practices likely resulted in the prior removal or draining of potential breeding containers, thereby limiting opportunities to directly observe mosquito larvae during the study period. Future studies should include longitudinal surveys across different seasons and incorporate quantitative larval density measurements for both *Aedes* and non-*Aedes* genera.

CONCLUSIONS

This study found no *Aedes spp.* larvae in any inspected water-holding containers, with all detected larvae identified as *Culex* and confined to outdoor natural pools, resulting in an *ABJ* of 100% and zero HI and CI values. Sanitation workers demonstrated generally adequate knowledge, positive attitudes, and consistent preventive practices, which aligned with the observed absence of *Aedes* breeding sites. Although gaps in specific knowledge of the 3M Plus program remain, routine sanitation activities appear to play a key role in maintaining a larva-free public environment and reducing the risk of dengue transmission.

SUGGESTION

Future studies should consider sampling across different seasons to better capture variations in mosquito breeding patterns. Regular health education and training are recommended to strengthen sanitation workers' understanding of comprehensive vector control, including

the 3M Plus concept. Routine inspections should be managed by facility supervisors at least weekly, with success monitored by continued absence of *Aedes* larvae and proper implementation of preventive practices.

REFERENCE

Ayettey, J., Ablorde, A., Amlalo, G. K., Mensah, B. A., & Kudom, A. A. (2023). Entomological surveillance on aedes aegypti during covid 19 period in cape coast, ghana: Risk of arboviral outbreaks, multiple insecticide resistance and distribution of f1534c, v410l and v1016i kdr mutations. *PLoS Neglected Tropical Diseases*, *17*(5 May), 1–16. [Crossref] [Publisher]

Dinas Kesehatan Sumatera Selatan. (2023). *Profil Kesehatan Provinsi Sumatera Selatan Tahun 2023*. [Publisher]

Enslen, A. W., Lima Neto, A. S., & Castro, M. C. (2020). Infestation measured by Aedes aegypti larval surveys as an indication of future dengue epidemics: an evaluation for Brazil. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *114*(7), 506–512. [Crossref] [Publisher]

Gallichotte, E. N., Dobos, K. M., Ebel, G. D., Hagedorn, M., Rasgon, J. L., Richardson, J. H., Stedman, T. T., & Barfield, J. P. (2021). Towards a method for cryopreservation of mosquito vectors of human pathogens. In *Cryobiology* (Vol. 99, pp. 1–10). Academic Press Inc. [Crossref] [Publisher]

Ha, T. A., León, T. M., Lalangui, K., Ponce, P., Marshall, J. M., & Cevallos, V. (2021). Household-level risk factors for Aedes aegypti pupal density in Guayaquil, Ecuador. *Parasites and Vectors*, *14*(1), 1–10. [Crossref] [Publisher]

Hancock, C., & Camp, J. V. (2022). Habitat-Specific Host Selection Patterns of Culex Quinquefasciatus and Culex Nigripalpus in Florida. *Journal of the American Mosquito Control Association*, *38*(2), 89–91. [Crossref] [Publisher]

Hasanah, H., Widawati, I. A. P., Mahadewi, N. M. E., & Nurhayani. (2023). Pengaruh Aksesibilitas, Amenitas, dan Citra Destinasi terhadap Kunjungan ke Kawasan Taman Purbakala Bukit Siguntang di Kota Palembang. *Jurnal Bisnis Dan Manajemen*, *1*(3), 757–776. [Crossref] [Publisher]

Ilyas, M., Setyaningrum, E., Mumtazah, D. F., & Busman, H. (2025). Tempat Perindukan dan Kepadatan Larva Aedes spp. sebagai Indikator Risiko Penularan Demam Berdarah di Tempat Wisata Bandar Lampung. *Bioma : Jurnal Biologi Dan Pembelajaran Biologi*, *10*(1), 39–50. [Crossref] [Publisher]

Kaura, T., Mewara, A., Zaman, K., & Sehgal, R. (2023). Comparative efficacy of natural aquatic predators for biological control of mosquito larvae: A neglected tool for vector control. *Journal of Vector Borne Diseases*, *60*(4), 435–438. [Crossref] [Publisher]

Kemenkes. (2024). *Profil Kesehatan Indonesia* (F. Sibuea & B. Hardhana (eds.); Profil kes). Kementerian Kesehatan RI. [Publisher]

Kemenkes RI. (2017). *Peraturan Menteri Kesehatan Nomor 50 Tahun 2017*. Kementerian Kesehatan Republik Indonesia. [Publisher]

Kemenkes RI. (2024). *Profil Kesehatan Indonesia Tahun 2024* (Buku (ed.)). [Publisher]

Krol, L., Langezaal, M., Budidarma, L., Wassenaar, D., Didaskalou, E. A., Trimbos, K., Dellar, M., Bodegom, P. M., Geerling, G. W., & Schrama, M. (2024). Distribution of Culex pipiens life stages across urban green and grey spaces in Leiden, The Netherlands. *Parasites and Vectors*, *17*(1), 1–12. [Crossref] [Publisher]

Kularatne, S. A., & Dalugama, C. (2022). Dengue infection: Global importance, immunopathology and management. *Clinical Medicine, Journal of the Royal College of Physicians of London*, *22*(1), 9–13. [Crossref] [Publisher]

Ngingo, B. L., Mboera, L. E. G., Chengula, A., Machelle, I., Makange, M. R., Msolla, M., Mwanyika, G. O., Rugarabamu, S., & Misinzo, G. (2022). Aedes aegypti abundance, larval indices and risk for dengue virus transmission in Kinondoni district, Tanzania. *Tropical Medicine and Health*, *50*(1), 1–8. [Crossref] [Publisher]

Nursanti, A. D., Kusariana, N., Wurjanto, M. A., & Martini, M. (2024). Kepadatan Larva dan Karakteristik Kontainer Kasus Demam Berdarah di Wilayah Pesisir Kota Tegal. *JRKM Jurnal Riset Kesehatan Masyarakat*, *4*(3), 79–90. [Crossref] [Publisher]

Permana Putri, M., Dwi Prasasty, G., Anwar, C., & Handayani, D. (2023). pH Air Berkorelasi dengan Jumlah Larva Nyamuk di Taman Wisata Alam Kota Palembang Water pH Correlates with The Number of Mosquito Larvae in Nature Tourism Park, Palembang City. *Journal of Agromedicine and Medical Sciences*, *9*(1), 2714–5654. [Crossref] [Publisher]

Prodyanatasari, A., Ronald, A., O., L., Anggraeni, Y. M., Gustin, R. K., Tan, H. T., Sari, A. I., Rahayu, N., Rita, R. S., Salim, N. A., Faisal, D. R., & Sudayasa, I. P. (2024). *Epidemiologi penyakit tropis* (Mubarak & Irma (eds.); 1st ed.). Eureka Medika Aksara. [Publisher]

Ravenia, A. H., Anwar, C., Aulia, H., & Ghiffari, A. (2018). *Hubungan Pengetahuan Sikap dan Perilaku Petugas Kebersihan Dengan Jumlah Larva Nyamuk Pada Tempat Penampungan Air Di Wisma Atlet Jakabaring Kota Palembang. Prosiding Seminar Nasional PEI Cabang*. [Publisher]

Saba, S., Naeem-Ullah, U., Saeed, S., Rajwana, I. A., & Khan, A. A. (2023). Outreach Vector Control Worker's Knowledge, Attitude and Practices Towards Mosquito Control and Associated Diseases. *Journal of Arthropod-Borne Diseases*, *17*(2), 138–151. [Crossref] [Publisher]

Sunaryanti, S. S. H., & Iswahyuni, S. (2020). Hubungan antara pengetahuan dan sikap terhadap perilaku dalam pengendalian vektor demam berdarah dengue (dbd) di desa jelok cepogo boyolali. *Avicenna : Journal of Health Research*, *3*(1), 92–104. [Crossref] [Publisher]

Tewari, P., Guo, P., Dickens, B., Ma, P., Bansal, S., & Lim, J. T. (2023). Associations between Dengue Incidence, Ecological Factors, and Anthropogenic Factors in Singapore. *Viruses*, *15*(9). [Crossref] [Publisher]

World Health Organization. (2023). *Menengok masa lalu untuk merencanakan masa depan bebas malaria di Indonesia*. [Publisher]

Xavier, A., Bonfim, C., Cantalice, P., Júnior, W. B., Silva, F. S. d., Régis, V., Sá, A., & Medeiros, Z. (2024). Culex quinquefasciatus Density Associated with Socioenvironmental Conditions in a Municipality with Indeterminate Transmission of Lymphatic Filariasis in Northeastern Brazil. *Pathogens*, *13*(11). [Crossref] [Publisher]

Yohana Sianipar, M., Anwar, C., Handayani, D., Km, M. A. K. R. S. M. H., & J. (2018). Identifikasi larva nyamuk di tempat penampungan air serta pengetahuan, sikap dan tindakan petugas kebersihan tentang perkembangbiakan nyamuk di taman wisata sejarah bukit siguntang palembang. *JKK*, *5*(2), 78–88. [Publisher]