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Sociodemographic determinants of larval control behaviors and their association with *Aedes aegypti* infestation in Banjarmasin, Indonesia

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ABSTRACT

Introduction. Dengue fever remains endemic in tropical urban areas, but the sociodemographic determinants of larval control behaviours are poorly understood, particularly in delta cities like Banjarmasin, Indonesia. This study examined how education level and age influence *Aedes aegypti* larval control practices in household water containers. The objective was to assess the socio-demographic determinants of behaviors against larvae and their relationship with *Aedes aegypti* infection.

Materials and methods. A cross-sectional study of 236 households (March – November 2024) used structured interviews and direct inspections. Data were analyzed using Chi-square tests and binary logistic regression.

Results. Higher education predicted proper drainage (OR=2.44, 95% CI: 1.33–4.49, $p=0.006$), while younger age was associated with frequent inspections (OR=1.91, 95% CI: 1.12–3.26, $p=0.017$). Larvicide use reduced larval presence by 54% (OR=0.46, $p=0.004$).

Limitations. The cross-sectional design limits the ability to establish causal relationships.

Conclusion. Targeted interventions addressing education and age-specific barriers could enhance urban dengue fever control programs.

Keywords: dengue fever; *Aedes aegypti*; larval control; behavior; Banjarmasin; Indonesia

Compliance with ethical standards. Health Research Ethics Committee of the National Research and Innovation Agency, with approval number No: 076/KE.03/SK/04/2024

For citation: Ridha M.R., Yahya Y., Hidayah N., Indriati L., Juhairiyah J., Marlinae L., Agustina N., Budidarma A. Sociodemographic determinants of larval control behaviors and their association with *Aedes aegypti* infestation in Banjarmasin, Indonesia. *Gigiena i Sanitariya / Hygiene and Sanitation, Russian journal*. 2026; 105(3): 230–240. <https://doi.org/10.47470/0016-9900-2026-105-3-230-240> <https://elibrary.ru/ejkgzn>

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Contribution: Ridha M.R. – concept of the study, carried out the experimental research in the field, summarized the research results, writing text; Yahya Y. – made draft the research proposal, performed the experimental research in the field, and created the research results; Hidayah N., Indriyati L., Juhairiyah J. – helped generate the research results, editing; Agustina N. – assisted in field data collection and summarized the research results; Budidarma A. – analyzed the research results and contributed to visualization. All authors are responsible for the integrity of all parts of the manuscript and the approval of the final version of the article.

Acknowledgment. The author would like to thank the leadership and enumerator team from the Kalimantan Leading Polytechnic: PoLanKa, who assisted with the use of the laboratory and helped collect data in the field.

Conflict of interest. The authors declare no conflict of interest.

Funding. National Research and Innovation Agency (BRIN), Republic of Indonesia.

Received: August 13, 2025 / Accepted: December 2, 2025 / Published: April 17, 2026

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Социодемографические детерминанты способов борьбы с личинками *Aedes aegypti* и их влияние на инфицирование в Банджармасине, Индонезия

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РЕЗЮМЕ

Введение. Лихорадка денге остаётся эндемичной в тропических городских районах, однако социально-демографические факторы, определяющие поведение в борьбе с личинками комаров *Aedes aegypti*, изучены недостаточно, особенно в городах в дельте рек, таких как Банджармасин (Индонезия). В данном исследовании изучалось, как уровень образования и возраст влияют на методы борьбы с личинками *Aedes aegypti* в бытовых ёмкостях для воды. **Цель исследования** состояла в оценке социально-демографических факторов, определяющих способы борьбы с личинками, и их влияния на частоту лихорадки денге, переносчиком возбудителя которой являются комары *Aedes aegypti*.

Материалы и методы. В рамках поперечного исследования 236 домохозяйств (с марта по ноябрь 2024 г.) получены структурированные интервью и проведены прямые осмотры. Данные проанализированы с применением критерия хи-квадрат и бинарной логистической регрессии.

Результаты. Жители с более высоким уровнем образования обеспечивали надлежащий дренаж (ОШ = 2,44; 95% ДИ: 1,33–4,49; $p = 0,006$), в то время как более молодые чаще проводили осмотры (ОШ = 1,91; 95% ДИ: 1,12–3,26; $p = 0,017$). Использование ларвицидов снижало присутствие личинок на 54% (ОР = 0,46; $p = 0,004$).

Ограничения исследования. Поперечное исследование ограничивает возможность установления причинно-следственных связей.

Заключение. Целенаправленные мероприятия, направленные на преодоление образовательных и возрастных барьеров, могут повысить эффективность городских программ борьбы с лихорадкой денге.

Ключевые слова: лихорадка денге; *Aedes aegypti*; борьба с личинками; способы борьбы; Банджармасин; Индонезия

Соответствие этическим стандартам. Комитет по этике медицинских исследований Национального агентства по исследованиям и инновациям, номер разрешения: 076/KE.03/SK/04/2024.

Для цитирования: Ридха М.Р., Яхья Ю., Хидайя Н., Индриати Л., Джухайрия Дж., Марлина Л., Агустина Н., Будидарма А. Социодемографические детерминанты способов борьбы с личинками *Aedes aegypti* и их влияние на инфицирование в Банджармасине, Индонезия. *Гигиена и санитария*. 2026; 105(3): 230–240. <https://doi.org/10.47470/0016-9900-2026-105-3-230-240> <https://elibrary.ru/ejkgzn>

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Вклад авторов: Ридха М.Р. — разработка концепции исследования, написание первоначального варианта, проведение экспериментального исследования в полевых условиях, обобщение результатов исследования и написание текста; Яхья Ю. — подготовка исследовательского проекта, проведение экспериментального исследования в полевых условиях и оформление результатов; Хидая Н., Индриати Л., Джухайрия Дж. — помощь в получении результатов исследования и редактирование рукописи; Агустина Н. — помощь в сборе полевых данных и обобщение результатов исследования; Будидарма А. — анализ результатов исследования. Все соавторы — утверждение окончательного варианта статьи, ответственность за целостность всех её частей.

Благодарность. Авторы выражают благодарность руководству и команде интервьюеров из ведущего политехнического института Калимантана: ПоЛанКа за содействие в проведении лабораторных исследований и сборе данных в полевых условиях.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов в связи с публикацией данной статьи.

Финансирование. Национальное агентство исследований и инноваций (BRIN), Республика Индонезия.

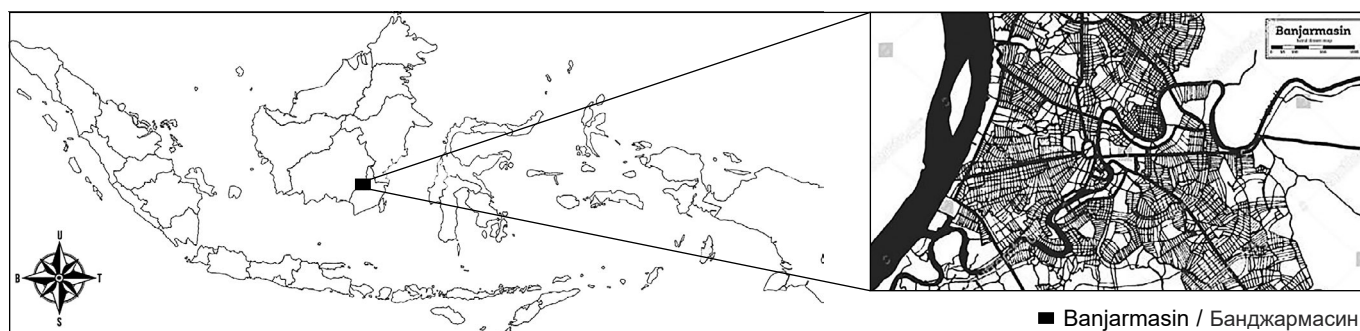
Поступила: 13.08.2025 / Принята к печати: 02.02.2025 / Опубликовано: 17.04.2026

Introduction

Dengue hemorrhagic fever (DHF), particularly in tropical and subtropical regions such as Indonesia, remains a major global public health threat. The World Health Organization (WHO) estimates approximately 390 million dengue infections annually, with around 96 million clinical DHF cases and periodic outbreaks in Indonesia. With almost 120,000 cases reported in 2022 and a mortality rate of 0.96%, Indonesia continues to experience fluctuating DHF incidence, remaining above the WHO target case fatality rate (CFR) of less than 1% [1]. In Banjarmasin City, the incidence rate (IR) increased from 5.79 per 100,000 population in 2019 to 12.10 in 2023, and the CFR rose from 2.4 in 2019 to 6.8 in 2023, indicating a persistent public health challenge. The WHO

has set a global target to reduce DHF incidence by 25% and CFR by 50% by 2030. Consistent with this, the Indonesian Ministry of Health aims to reduce the DHF incidence in Banjarmasin to fewer than 10 cases per 100,000 population.

Banjarmasin's unique geographical characteristics as a delta city with swamps, numerous rivers, and a humid tropical climate create an ideal environment for the proliferation of *Aedes aegypti*, the primary vector of DHF [2]. Abundant larval habitats are generated by high rainfall, dense population, urbanization, and household water storage practices, including bathtubs, drums, buckets, and flower vases. These conditions make Banjarmasin an endemic DHF area with consistently reported cases, often experiencing significant increases that require prompt response [3].



Research Location.

Расположение исследования.

Vector control at the larval stage is recognized in Integrated Vector Management (IVM) as a more effective, efficient, sustainable, and environmentally friendly strategy than adult mosquito control methods such as fogging [4,5]. Targeted interventions can be implemented because larval populations are concentrated in specific habitats, particularly water storage containers. Larval control relies on *pemberantasan sarang nyamuk* (PSN; mosquito breeding site eradication), involving regular inspection (searching for and identifying potential breeding sites) and cleaning (emptying water and brushing container walls to remove desiccation-resistant *Aedes* eggs) at least once a week, along with covering water storage containers and recycling or disposing of unused containers. National programs such as “One House, One Larvae Monitor” (*Gerakan 1 Rumah 1 Jumantik*; G1RIJ) prioritize these activities. However, the technical success of PSN entirely depends on consistent and routine implementation [6]. Studies have shown significant gaps between knowledge, attitudes, and actual practices (KAP), especially in thoroughly inspecting all types of containers (including hidden sites such as roof gutters or plant saucers) and proper cleaning [7, 8]. These behaviors determine the success or failure of community-based larval control.

Complex interactions of internal and external factors influence inspection and cleaning behaviors. Theories such as the Health Belief Model (HBM) and Theory of Planned Behavior (TPB) explain how intentions and behaviors are shaped by perceived susceptibility and severity of DHF, perceived benefits and barriers to PSN, subjective norms (social influence), and perceived behavioral control [9,10]. In Banjarmasin, these dynamics are further complicated by local conditions. Limited access to clean water in certain areas fosters a culture of storing rainwater in large drums, a necessity due to water scarcity and availability risks [11]. High-density settlements along riverbanks often generate numerous new breeding sites. Common behavioral barriers include complacency when no cases are reported, reliance on others or fogging (*free-rider problem*), the complexity and time required for proper PSN (particularly scrubbing large containers), and a lack of social support or supervision from *Jumantik* cadres [12,13]. Additionally, health system variables, such as sustainability and quality of cadre supervision and the presence of waste or unused items that can serve as passive breeding sites, influence behavior consistency [14].

Previous studies have often measured mosquito breeding site eradication (*pemberantasan sarang nyamuk*, PSN) frequency in general terms (“ever/never”) without examining specific larval control behaviors, such as the thoroughness of water storage container inspection, frequency of cleaning, or methods used to eliminate *Aedes aegypti* eggs. These behavioral nuances are critical for effective larval control but remain understudied, particularly in urban dengue-endemic areas like Banjarmasin, Indonesia. Additionally, while sociodemographic factors — such as age, gender, education level, and occupation — are known to influence health behaviors, limited research has comprehensively analyzed their impact on *Aedes aegypti* larval control practices.

Understanding these determinants is essential for designing targeted interventions that address gaps in community participation and improve the sustainability of vector control programs.

This study examines the sociodemographic determinants of larval control behaviors—including inspection frequency, cleaning methods, and larvicide use—and assesses their association with *Aedes aegypti* infestation in household water storage containers. By focusing on Banjarmasin, a high risk urban setting, the findings aim to provide context-specific insights for refining local vector control strategies, strengthening community based programs, and reducing dengue fever transmission. The results will contribute to global efforts to combat Vector borne diseases by highlighting the role of behavioral and sociodemographic factors in larval control effectiveness.

Objective To assess the socio-demographic determinants of larval control behavior and their association with *Aedes aegypti* infection

Materials and methods

Research Design and Location

This study employed a quantitative research design with an observational analytic approach using a cross-sectional study design. The research was conducted in Banjarmasin City, South Kalimantan, a region known to be endemic for dengue hemorrhagic fever (DHF). Banjarmasin, often referred to as the “City of a Thousand Rivers,” serves as the economic center of South Kalimantan. Geographically, it is located between 3° 16' 46" to 3° 22' 54" South Latitude and 114° 31' 40" to 114° 39' 55" East Longitude (Figure). The area lies at an average elevation of 0.16 meters below sea level, with relatively flat and swampy terrain. During high tide, most parts of the city are inundated with water. The study location was selected purposively based on the number of DHF cases and the presence of water storage containers that could potentially serve as breeding sites for mosquito larvae. Households were then selected using simple random sampling. The study was conducted from March to November 2024.

Population and Data Collection Techniques. The study population consisted of all household heads or family members responsible for household cleanliness in Banjarmasin City. Sampling was performed using purposive sampling with the following inclusion criteria: Residing in the study location for at least 6 months, Willing to participate by signing an informed consent form, and Aged ≥16 years and capable of understanding the questionnaire.

The sample size for this study was 236 respondents, deemed sufficient to represent the population for bivariate and multivariate analyses. The variables collected included: Behavior of inspecting water storage containers, Behavior of cleaning water storage containers, Use of larvicides, Cleaning method (with or without scrubbing the container walls), Presence of mosquito larvae (yes or no), The research instrument used was a structured questionnaire that had been tested for validity and reliability. The questionnaire

Table 1 / Таблица 1

Respondent Characteristics
Характеристики респондентов

Respondent Characteristics Характеристика респондентов	Frequency / Частота	
	abs. абс.	%
Age group, years: / Возрастная группа, лет:		
16–49	127	53.8
50–82	109	46.2
Gender: / Пол:		
Male / Мужской	71	30.1
Female / Женский	165	69.9
Educational category: / Образование:		
Junior high school and below Неполное среднее образование и ниже	124	52.5
Senior high school and above Законченное среднее образование и выше	112	47.5
Occupation category: / Профессия:		
Unemployed / Безработный	176	74.6
Employed / Работающий	60	25.4
Total / Всего	236	100

included sections on respondent identity, sociodemographic characteristics, and questions related to larval control behaviors, such as the frequency of inspecting and cleaning water storage containers, as well as larvicide use. Data collection was conducted by trained enumerators who underwent prior training to ensure uniform understanding. Direct interviews were carried out with respondents using the prepared questionnaire. Data on the presence of larvae were collected by directly inspecting water storage containers and recording whether larvae were found.

Data Analysis. Data analysis was conducted in stages using IBM SPSS Statistics version 27. Univariate analysis was used to describe respondent characteristics and larval control behaviors in the form of frequency distributions and percentages. This step aimed to provide an overview of respondent profiles and their behavioral tendencies regarding the inspection and cleaning of water storage containers.

Bivariate analysis was performed to examine the relationship between respondent characteristics and variables related to larval control behaviors. The Chi-Square (χ^2) test was used for this analysis. To identify dominant factors influencing larval control behaviors and the presence of larvae in household environments, multivariate analysis was conducted using binary logistic regression. Variables with a p -value <0.25 from the bivariate analysis were included in the regression model using a stepwise method. The logistic regression model's goodness-of-fit was assessed using the Hosmer and Lemeshow test, while the strength of the association between independent and dependent variables was expressed as an Odds Ratio (OR) with a 95% Confidence Interval (CI). This approach helped identify key factors contributing to community behavior in larval control and the risk of larvae presence in household water storage containers.

Results

Respondent Characteristics. A total of 236 respondents participated in the study. The majority were aged 16–49 years ($n = 127$; 53.8%), female ($n = 165$; 69.9%), had a junior high school education or lower ($n = 124$; 52.5%), and were unemployed ($n = 176$; 74.6%). This indicates that most respondents were women of productive age with relatively low educational attainment (Table 1).

Table 2 / Таблица 2

Respondents' Behavior in Inspecting and Draining Water Reservoirs in Mosquito Larvae Control

Поведение респондентов при осмотре и осушении резервуаров с водой в рамках борьбы с личинками комаров

Respondent Behaviors Поведение респондентов	Frequency / Частота	
	abs. абс.	%
Frequency of checking places water reservoirs: Частота проверки резервуаров с водой:		
1 time/week / 1 раз в неделю	144	61.0
2 times/week / 2 раза в неделю	3	1.3
1 time/2 weeks / 1 раз в 2 недели	7	3.0
1 time/3 weeks / 1 раз в 3 недели	3	1.3
1 time/month / 1 раз в месяц	35	14.8
> 1 time/month / > 1 раза в месяц	44	18.6
Use of Larvicide Powder: Применение порошковых лаврицидов:		
1 time/week / 1 раз в неделю	24	10.2
1 time/month / 1 раз в месяц	27	11.4
1 time/3 months / 1 раз в 3 мес	61	25.8
Do not use / Не использую	124	52.5
Frequency Drain Place Water reservoir: Частота дренирования места с расположением резервуара с водой:		
1 time/week / раз в неделю	163	69.1
2 times/week / 2 раза в неделю	7	3.0
1 time/2 weeks / раз в 2 недели	8	3.4
1 time/3 weeks / раз в 3 недели	2	0.8
1 time/month / раз в месяц	40	16.9
> 1 time/month / > 1 раза в месяц	16	6.8
How to Drain Place Water reservoirs: Как сливается вода из резервуаров:		
Just drain the water without brushing wall Вода просто сливается без очистки стенки щёткой	63	26.7
Drain the water and brush wall После слива воды стенка резервуара очищается щёткой	173	73.3
Total Bcero	236	100

Larval Control Behaviors. Table 2 shows that the majority of respondents ($n = 144$; 61%) inspected water storage containers (WSCs) once a week. However, 18.6% ($n = 44$) inspected them less frequently than once a month, indicating a high risk of larval presence. More than half of the respondents ($n = 124$; 52.5%) did not use larvicides. Only 10.2% ($n = 24$) applied larvicides weekly, reflecting low adoption of this simple vector control method.

Most respondents ($n = 169$; 69.1%) cleaned WSCs once a week, but 6.8% ($n = 16$) did so less frequently than once a month. Regarding cleaning methods, 73.3% ($n = 173$) scrubbed the container walls while draining, an effective technique for removing mosquito eggs.

Association Between Respondent Characteristics and Larval Control Behaviors. Table 3 presents the relationship between respondent characteristics and the frequency of WSC inspection across six time categories. Statistical analysis revealed that among the four tested variables — age, sex, education, and employment — only education level showed a significant

Table 3 / Таблица 3

Relationship between Respondent Characteristics and the Frequency of Checking Water Reservoirs**Взаимосвязь между характеристиками респондентов и частотой проверки резервуаров с водой**

Respondent Characteristics Характеристика респондентов	Frequency of Checking Places Water reservoirs, abs. (%) Частота проверки мест расположения резервуаров с водой, абс. (%)						Total, abs. (%) Всего, абс. (%)	p
	1 time/week 1 раз в неделю	2 times/week 2 раза в неделю	1 time/2 weeks 1 раз в 2 недели	1 time/3 weeks 1 раз в 3 недели	1 time/month 1 раз в месяц	> 1 time/month > 1 раза в месяц		
Age group, years: Возрастная группа, лет:								
16–49	86 (67.7)	2 (1.6)	5 (3.9)	1 (0.8)	16 (12.6)	17 (13.4)	127 (100)	0.126
50–82	58 (53.2)	1 (0.9)	2 (1.8)	2 (1.8)	19 (17.4)	27 (24.8)	109 (100)	0.126
Gender: / Пол:								
Male / Мужской	40 (56.3)	1 (1.4)	3 (4.2)	0 (0.0)	11 (15.5)	16 (22.5)	71 (100)	0.690
Female / Женский	104 (63.0)	2 (1.2)	4 (2.4)	3 (1.8)	24 (14.5)	28 (16.9)	165 (100)	0.690
Educational category: Образование:								
Junior high school and below Неполное среднее образование и ниже	74 (59.7)	2 (1.6)	0 (0.0)	3 (2.4)	19 (15.3)	26 (20.9)	124 (100)	0.041*
Senior high school and above Среднее среднее образование и выше	70 (62.5)	1 (0.9)	7 (6.3)	0 (0.0)	16 (14.3)	18 (16.1)	112 (100)	0.041*
Occupation category: Профессия:								
Unemployed / Безработный	108 (61.4)	3 (1.7)	4 (2.3)	3 (1.7)	26 (14.8)	32 (18.2)	176 (100)	0.660
Employed / Работающий	36 (60.0)	0 (0.0)	3 (5.0)	0 (0.0)	9 (15.0)	12 (20.0)	60 (100)	0.660
Total / Всего	144 (61.0)	3 (1.3)	7 (3.0)	3 (1.3)	35 (14.8)	44 (18.6)	236 (100)	—

Note: * Influential.

Примечание. * — влияет.

association ($p = 0.041$). Respondents with a senior high school education or higher were more likely to inspect WSCs regularly than those with junior high school education or lower.

Although respondents aged 16–49 years inspected WSCs weekly more often ($n = 86$; 67.7%) than those aged ≥ 50 years ($n = 58$; 53.2%), this difference was not statistically significant ($p = 0.126$). Similarly, no significant associations were found for sex ($p = 0.690$) or employment status ($p = 0.660$).

Table 4 displays the relationship between respondent characteristics and WSC inspection frequency, dichotomized into ≤ 1 time per week and > 1 time per week. Bivariate analysis showed a significant association with age ($p = 0.017$), where respondents aged 16–49 years inspected WSCs more frequently ($n = 88$; 69.3%) than those aged 50–82 years ($n = 59$; 54.1%). Multivariate logistic regression confirmed age as a significant influencing factor ($p = 0.017$; OR = 1.912; 95% CI: 1.122–3.258). Education, sex, and employment were not significant in the regression model.

Table 5 examines the association between respondent characteristics and larvicide use across four frequency categories (weekly, monthly, every 3 months, and never). Only age showed a statistically significant relationship ($p = 0.028$), with respondents aged 50–82 years using larvicides more often ($n = 62$; 56.9%) than those aged 16–49 years ($n = 50$; 39.4%). Sex, education, and employment were not significantly associated ($p = 0.304$, 0.772, and 0.147, respectively).

Table 6 presents larvicide use dichotomized into “used” and “not used.” Bivariate analysis confirmed a significant association with age ($p = 0.011$), with older respondents more likely to use larvicides. Multivariate analysis reinforced this finding ($p = 0.007$;

OR = 0.481; 95% CI: 0.283–0.818), indicating that younger individuals had lower odds of larvicide use.

Table 7 analyzes the relationship between respondent characteristics and WSC cleaning frequency across six categories. Only education level was significantly associated ($p = 0.043$), with higher-educated respondents cleaning WSCs more regularly. Age, sex, and employment were not significant ($p = 0.153$, 0.326, and 0.263, respectively).

Table 8 dichotomizes cleaning frequency into ≤ 1 time per week and > 1 time per week. Although age, sex, education, and employment had p -values < 0.25 in bivariate analysis, only age approached significance in multivariate regression ($p = 0.089$; OR = 1.673), suggesting a trend toward younger respondents cleaning WSCs more frequently.

Table 9 examines the association between respondent characteristics and cleaning method (draining only vs. draining with scrubbing). Education was the only significant factor ($p = 0.006$), remaining significant in multivariate analysis ($p = 0.004$; OR = 2.442; 95% CI: 1.328–4.489). Respondents with senior high school education or higher were twice as likely to scrub WSCs during cleaning.

Table 10 evaluates the relationship between larval control behaviors and larval presence in households. Larvicide use showed the strongest and most significant association ($p = 0.004$; OR = 0.461), indicating lower odds of larval presence with larvicide application. Weekly WSC inspection was significant in bivariate analysis ($p = 0.041$) and marginally significant in regression ($p = 0.077$). Cleaning frequency and method were not significantly associated, though protective trends were observed.

Table 4 / Таблица 4

Relationship between Respondent Characteristics and Frequency of Checking Water Reservoirs

Взаимосвязь между характеристиками респондентов и частотой проверки резервуаров с водой

Respondent Characteristics Характеристика респондентов	Bivariate Analysis / Двухфакторный анализ				Multivariate Analysis / Многофакторный анализ	
	Frequency of Checking Places Water reservoirs, abs. (%) Частота проверки резервуаров с водой, абс. (%)		Frequency, abs. (%) Частота, абс. (%)	p (χ^2)	p Logistic Regression Логистическая регрессия	Odds Ratio (95% CI) ^b Отношение шансов (95% ДИ) ^b
	≤ 1 week very Гораздо ≤ 1 раза в неделю	≥ 1 week very Гораздо ≥ 1 раза в неделю				
Age group, years: Возрастная группа, лет:						
16–49	88 (69.3)	39 (30.7)	127 (100)	0.017 ^a	0.017***	1.912 (1.122–3.258)
50–82	59 (54.1)	50 (45.9)	109 (100)	0.017 ^a	0.017***	1.912 (1.122–3.258)
Gender: / Пол:						
Male / Мужской	41 (57.7)	30 (42.3)	71 (100)	0.425	—	—
Female / Женский	106 (64.2)	59 (35.8)	165 (100)	0.425	—	—
Educational category: Категория образования:						
Junior high school and below Незаконченное среднее и ниже	76 (61.3)	48 (38.7)	124 (100)	0.039 ^a	0.779**	1.082 (0.623–1.881)
Senior high school and above Законченное среднее и выше	71 (63.4)	41 (36.6)	112 (100)	0.039 ^a	0.779**	1.082 (0.623–1.881)
Occupation category: / Профессия:						
Unemployed / Безработный	111 (63.1)	65 (36.9)	176 (100)	0.072 ^a	0.932*	1.027 (0.552–1.912)
Employed / Работающий	36 (60.0)	24 (40.0)	60 (100)	0.072 ^a	0.932*	1.027 (0.552–1.912)

Note: * — Results of Logistic Regression Step 1 analysis; ** — Results of Logistic Regression Step 2 analysis; *** — Results of Logistic Regression Step 3 analysis; ^a value p -value < 0.25 was entered into the Logistic Regression Step 1 analysis; ^b Hosmer & Lemeshow test, χ^2 : 2.066, p -value: 0.356.

Примечание. * — результаты логистического регрессионного анализа на первом этапе; ** — результаты логистического регрессионного анализа на втором этапе; *** — результаты логистического регрессионного анализа на третьем этапе; ^a — p < 0.25 введено на первом этапе логистического регрессионного анализа; ^b — критерий Хосмера — Лемешова, χ^2 : 2.066, значение p : 0.356.

Table 5 / Таблица 5

Relationship between Respondent Characteristics and Behavior Use Larvicide (1 week, 1 month, 3 months and No Use)

Зависимость между характеристиками респондентов и практикой использования порошкового лаврицида

Respondent Characteristics Характеристики респондентов	Use Larvicide, abs. (%) / Применение лаврицида, абс. (%)				Total, abs. (%) Всего, абс. (%)	p
	1 time/week 1 раз в неделю	1 time/month 1 раз в месяц	1 time/3 months 1 раз в 3 мес	Do not use Не используют		
Age group, years: Возрастная группа, лет:						
16–49	11 (8.7)	9 (7.1)	30 (23.6)	77 (60.6)	127 (100)	0.028*
50–82	13 (11.9)	18 (16.5)	31 (28.4)	47 (43.1)	109 (100)	0.028*
Gender: / Пол:						
Male / Мужской	10 (14.1)	10 (14.1)	14 (19.7)	37 (52.1)	71 (100)	0.304
Female / Женский	14 (8.5)	17 (10.3)	47 (28.5)	87 (52.7)	165 (100)	0.304
Educational category: Образование:						
Junior high school and below Незаконченное среднее или ниже	12 (9.7)	16 (12.9)	34 (27.4)	62 (55.4)	124 (100)	0.772
Senior high school and above Законченное среднее и выше	12 (10.7)	11 (9.8)	27 (24.1)	62 (50.0)	112 (100)	0.772
Occupation category: Профессия:						
Unemployed / Безработный	14 (8.0)	19 (10.8)	50 (28.4)	93 (52.8)	176 (100)	0.147
Employed / Работающий	10 (16.7)	8 (13.3)	11 (18.3)	31 (51.7)	60 (100)	0.147

Table 6 / Таблица 6

Relationship Respondent Characteristics with Behavior Use Larvicides (Use and Not Use)

Зависимость между характеристиками респондентов и практикой использования порошкового лаврицида (применяется / не применяется)

Respondent Characteristics Характеристики респондентов	Bivariate Analysis Двухфакторный анализ			Multivariate Analysis Многофакторный анализ		
	Use Larvicide, abs. (%) Применение лаврицида, абс. (%)		Frequency, abs. (%) Частота, абс. (%)	p (χ^2)	p Logistic Regression Логистическая регрессия	Odds Ratio (95% CI) ^b Отношение шансов (95% ДИ) ^b
	Yes / Да	No / нет				
Age group, years: Возрастная группа, лет:						
16—49	50 (39.4)	77 (60.6)	127 (100)			
50—82	62 (56.9)	47 (43.1)	109 (100)	0.011 ^a	0.007**	0.481 (0.283—0.818)
Gender: / Пол:						
Male / Мужской	34 (47.9)	37 (52.1)	71 (100)			
Female / Женский	78 (47.3)	87 (52.7)	165 (100)	<0.0888888888888801 ^a	0.663**	0.880 (0.494—1.567)
Educational category: Образование:						
Junior high school and below Незаконченное среднее или ниже	62 (50.0)	62 (50.0)	124 (100)			
Senior high school and above Законченное среднее и выше	50 (44.6)	62 (55.4)	112 (100)	0.489		
Occupation category: Профессия:						
Unemployed / Безработный	83 (47.2)	93 (52.8)	60 (100)			
Employed / Работающий	29 (48.3)	31 (51.7)	176 (100)	< 0.001 ^a	0.943*	0.974 (0.477—1.991)

Note: * Results of Logistic Regression Step 1 analysis; ** Results of Logistic Regression Step 2 analysis; ^a value p -value <0.25 was entered into the Logistic Regression Step 1 analysis; ^b Hosmer & Lemeshow test, χ^2 : 1.123, p -value: 0.570.

Примечание. * — результаты логистического регрессионного анализа на первом этапе; ** — результаты логистического регрессионного анализа на втором этапе; ^a — значение p < 0.25 введено на первом этапе логистического регрессионного анализа; ^b — критерий Хосмера — Лемешова, χ^2 : 1.123, значение p : 0.570.

Table 7 / Таблица 7

Relationships Respondent Characteristics with Behavior Frequency Draining the landfill

Взаимосвязь характеристик респондентов с частотой дренирования места расположения источника водоснабжения

Respondent Characteristics Характеристика респондентов	Frequency Drain Place Water reservoirs, abs. (%) Частота слива воды из резервуаров, абс. (%)						Total, abs. (%) Всего, абс. (%)	p
	1 time/week 1 раз в неделю	2 times/week 2 раза в неделю	1 time/2 weeks 1 раз в 2 недели	1 time/3 weeks 1 раз в 3 недели	1 time/month 1 раз в месяц	> 1 time/month > 1 раза в месяц		
Age group, years: Возрастная группа, лет:								
16–49	93 (73.2)	4 (3.1)	5 (3.9)	0 (0.0)	15 (11.8)	10 (7.9)	127 (100)	0.153
50–82	70 (64.2)	3 (2.8)	3 (2.8)	2 (1.8)	25 (22.9)	6 (5.5)	109 (100)	0.153
Gender: / Пол:								
Male / Мужской	48 (67.6)	2 (2.8)	4 (5.6)	0 (0.0)	15 (21.1)	2 (2.8)	71 (100)	0.326
Female / Женский	115 (69.7)	5 (3.0)	4 (2.4)	2 (1.2)	25 (15.2)	14 (8.5)	165 (100)	0.326
Educational category: Образование:								
Junior high school and below Неполное среднее образование и ниже	87 (70.2)	3 (2.4)	0 (0.0)	2 (1.6)	23 (18.5)	9 (7.3)	124 (100)	0.043
Senior high school and above Среднее среднее образование и выше	76 (77.4)	4 (3.6)	8 (8.0)	0 (0.0)	17 (15.2)	7 (6.3)	112 (100)	0.043
Occupation category: / Профессия:								
Unemployed / Безработный	121 (68.8)	5 (2.8)	4 (2.3)	2 (1.1)	29 (16.5)	15 (8.5)	176 (100)	0.263
Employed / Работающий	42 (70.0)	2 (3.3)	4 (6.7)	0 (0.0)	11 (18.3)	1 (1.7)	60 (100)	0.263

Table 8 / Таблица 8

Relationship between Respondent Characteristics and Behavior Frequency Draining the landfill

Взаимосвязь характеристик респондентов с частотой дренирования места расположения источника водоснабжения

Respondent Characteristics Характеристика респондентов	Bivariate Analysis / Двухфакторный анализ				Multivariate Analysis / Многофакторный анализ	
	Frequency Drain Place Water reservoirs, abs. (%) Частота слива воды из резервуаров, абс. (%)		Frequency, abs. (%) Частота, абс. (%)	p (χ^2)	p Logistic Regression Логистическая регрессия	Odds Ratio (95% CI) ^b Отношение шансов (95% ДИ) ^b
	≤ 1 week very Гораздо ≤ 1 раза в неделю	≥ 1 week very Гораздо ≥ 1 раза в неделю				
Age group, years: Возрастная группа, лет:						
16–49	97 (76.4)	30 (23.6)	127 (100)	0.144 ^a	0.089***	1,673 (0.925–3.028)
50–82	73 (67.0)	36 (33.0)	109 (100)	0.144 ^a	0.089***	1,673 (0.925–3.028)
Gender: / Пол:						
Male / Мужской	50 (70.4)	21 (29.6)	71 (100)	0.041 ^a	0.777*	0.896 (0.421–1.909)
Female / Женский	120 (72.7)	45 (27.3)	165 (100)	0.041 ^a	0.777*	0.896 (0.421–1.909)
Educational category: Категория образования:						
Junior high school and below Незаконченное среднее и ниже	90 (72.6)	34 (27.4)	124 (100)	0.003 ^a	0.533***	1.208 (0.667–2.185)
Senior high school and above Законченное среднее и выше	80 (71.4)	32 (28.6)	112 (100)	0.003 ^a	0.533***	1.208 (0.667–2.185)
Occupation category: / Профессия:						
Unemployed / Безработный	126 (71.6)	50 (28.4)	176 (100)	0.009 ^a	0.567**	0.820 (0.415–1.618)
Employed / Работающий	44 (73.3)	16 (26.7)	60 (100)	0.009 ^a	0.567**	0.820 (0.415–1.618)

Note: * Results of Logistic Regression Step 1 analysis; ** Results of Logistic Regression Step 2 analysis; *** Results of Logistic Regression Step 3 analysis; ^a value p -value < 0.25 was entered into the Logistic Regression Step 1 analysis; b Hosmer & Lemeshow test, χ^2 : 1.123, p -value: 0.570.

Примечание. * — результаты логистического регрессионного анализа на первом этапе; ** — результаты логистического регрессионного анализа на втором этапе; *** — результаты логистического регрессионного анализа на третьем этапе; ^a — p < 0.25 введено на первом этапе логистического регрессионного анализа; ^b — критерий Хосмера — Лемешева, χ^2 : 1,123, значение p : 0,570.

Table 9 / Таблица 9

Relationship Respondent Characteristics and Behavior on How to Drain Landfills

Взаимосвязь характеристик респондентов и применяемых ими способов осушения полигонов твёрдых бытовых отходов

Respondent Characteristics Характеристика респондентов	Bivariate Analysis / Двухфакторный анализ				Multivariate Analysis / Многофакторный анализ	
	Behavior How to Drain Landfills, abs. (%) Способы дренирования свалок, абс. (%)		Frequency, abs. (%) Частота, абс. (%)	p (χ^2)	p Logistic Regression Логистическая регрессия	Odds Ratio (95% CI) ^b Отношение шансов (95% ДИ) ^b
	Drain дренаж	Drain and brush дренаж и очищение				
Age group, years: Возрастная группа, лет:						
16–49	37 (29.1)	90 (70.9)	127 (100)	0.443	—	—
50–82	26 (23.9)	83 (76.1)	109 (100)	0.443	—	—
Gender: / Пол:						
Male / Мужской	18 (25.4)	53 (74.6)	71 (100)	0.021 ^a	0.927*	1.031 (0.537–1.981)
Female / Женский	45 (27.3)	120 (72.7)	165 (100)	0.021 ^a	0.927*	1.031 (0.537–1.981)
Educational category: Категория образования:						
Junior high school and below Незаконченное среднее и ниже	43 (34.7)	81 (65.3)	124 (100)	0.006 ^a	0.004**	2.442 (1.328–4.489)
Senior high school and above Законченное среднее и выше	20 (17.9)	92 (82.1)	112 (100)	0.006 ^a	0.004**	2.442 (1.328–4.489)
Occupation category: / Профессия:						
Unemployed / Безработный	45 (25.6)	131 (74.4)	176 (100)	0.251	—	—
Employed / Работающий	18 (30.0)	42 (70.0)	60 (100)	0.251	—	—

Note: * Results of Logistic Regression Step 1 analysis; ** Results of Logistic Regression Step 2 analysis; *** Results of Logistic Regression Step 3 analysis; ^a value p -value < 0.25 was entered into the Logistic Regression Step 1 analysis; b Hosmer & Lemeshow test, χ^2 : 5.370, p -value: 0.068.

Примечание. * — результаты логистического регрессионного анализа на первом этапе; ** — результаты логистического регрессионного анализа на втором этапе; *** — результаты логистического регрессионного анализа на третьем этапе; ^a — p < 0.25 введено на первом этапе логистического регрессионного анализа; ^b — критерий Хосмера — Лемешева, χ^2 : 5,370, значение p : 0,068.

Table 10 / Таблица 10

Relationship between Mosquito Larva Control Behavior and the Presence of Larvae
Взаимосвязь между способами ликвидации личинок комаров и наличием личинок

Mosquito Larval Control Behavior Способы уничтожения личинок	Bivariate Analysis / Двухфакторный анализ				Multivariate Analysis / Многофакторный анализ	
	Larval Presence, abs. (%) Наличие личинок, абс. (%)		Frequency, abs. (%) Частота, абс. (%)	<i>p</i> (<i>χ</i> ²)	<i>p</i> Logistic Regression Логистическая регрессия	Odds Ratio (95% CI) ^b Отношение шансов (95% ДИ) ^b
	Present Есть	absent нет				
Frequency of Landfill Inspection: Частота проверок свалки:						
≤ 1 week once / реже 1 раза в нед	56 (38.1)	91 (61.9)	147 (100)	0.041 ^a	0.077***	1.634 (0.949—2.813)
once a week / чаще 1 раза в нед	46 (51.7)	43 (48.3)	89 (100)	0.041 ^a	0.077***	1.634 (0.949—2.813)
Use Larvicide: / Применение лаврицидов:						
Use / Применяются	60 (53.6)	52 (46.4)	112 (100)	0.004 ^a	0.004***	0.461 (0.271—0.783)
Do not use / Не применяются	42 (33.9)	82 (66.1)	124 (100)	0.004 ^a	0.004***	0.461 (0.271—0.783)
Frequency of Draining Landfills: Периодичность осушения свалок:						
≤ 1 week once / реже 1 раза в нед	72 (42.4)	98 (57.6)	170 (100)	0.081 ^a	0.109**	0.447 (0.167—1.197)
once a week / чаще 1 раза в нед	30 (45.5)	36 (54.5)	66 (100)	0.081 ^a	0.109**	0.447 (0.167—1.197)
How to Drain a Landfill: / Способы дренирования:						
Just draining without brushing wall Только дренирование без очистки стенок	21 (33.3)	42 (66.7)	63 (100)	0.089 ^a	0.238*	1.474 (0.774—2.808)
Draining and brushing wall Дренирование и очистка стенок	81 (46.8)	92 (53.2)	173 (100)	0.089 ^a	0.238*	1.474 (0.774—2.808)

Note: * Results of Logistic Regression Step 1 analysis; ** Results of Logistic Regression Step 2 analysis; *** Results of Logistic Regression Step 3 analysis; ^a value *p*-value <0.25 was entered into the Logistic Regression Step 1 analysis; b Hosmer & Lemeshow test, χ^2 : 1.185, *p*-value: 0.553.

Примечание. * – результаты логистического регрессионного анализа на первом этапе; ** – результаты логистического регрессионного анализа на втором этапе; *** – результаты логистического регрессионного анализа на третьем этапе; ^a – *p* < 0.25 введено на первом этапе логистического регрессионного анализа; ^b – критерий Хосмера – Лемешова, χ^2 : 1,185, значение *p*: 0,553.

Discussion

Larval control behavior represents a fundamental component in vector management and dengue fever prevention efforts. Various national programs worldwide have incorporated larval control as a central element of their dengue fever control strategies. In Guatemala, social and behavioral change campaigns emphasize weekly cleaning and proper covering of water storage containers [15]. The Philippines implements the 4S Campaign, which includes searching for and eliminating breeding sites, using personal protective measures, seeking early medical consultation for persistent fever, and avoiding indiscriminate fogging [16]. In Indonesia, the program initially known as 3M Plus has evolved into 4M Plus, incorporating physical larval control methods: draining and scrubbing water tanks, covering household water containers, burying discarded items that may collect water, and monitoring for larval presence – supplemented by additional measures such as larvicide application, insecticide use, and biological control methods [17].

The comprehensive implementation of 4M Plus in Bali Province, known as the SIGAP strategy, has successfully reduced dengue fever cases through regional policies that promote awareness of 4M Plus principles, integrated dengue fever information services, use of natural insecticides and larvicides, vector surveillance reporting, and weekly monitoring Adnyana & Surya, 2023). However, larval control efforts, particularly regular monitoring of water storage containers, face significant challenges due to the need for sustained behavioral change and broad community participation. Given the global increase in dengue fever incidence, some researchers recommend focusing control efforts on the most productive breeding sites rather than all water-holding containers, potentially offering a more time- and cost-effective strategy [18]. In the Indonesian context, bathroom water tanks represent particularly high-risk breeding

sites due to common practices of maintaining standing water for extended periods and inadequate cleaning methods that often omit scrubbing the container surfaces [19].

The current study found persistently high risks of larval presence in water storage containers, with many respondents inspecting containers less frequently than the recommended weekly interval – crucial for interrupting the mosquito life cycle [17,20]. While knowledge about proper cleaning methods appears adequate, as evidenced by widespread scrubbing practices, adoption of larvicides remains low (only 10.2% weekly users), indicating poor uptake of this simple vector control technology. Chemical control methods, particularly temephos-based larvicides (“Abate”), remain important for suppressing larval populations and reducing disease transmission [17].

The study revealed significant associations between demographic factors and larval control behaviors. Higher education levels correlated with better container inspection practices, while adults aged 16–49 demonstrated more frequent weekly inspections compared to those ≥50 years old – findings that contrast with some previous studies [21, 22]. Older adults (50–82 years) showed greater larvicide use (56.9%), likely due to physical limitations that make this method more practical than manual cleaning (39.4% in younger adults). However, larvicide use requires careful consideration of water usage purposes and potential insecticide resistance, necessitating rotation strategies like those implemented in Rio de Janeiro combining chemical and biological (*Bacillus thuringiensis*) larvicides [18]. Resistance issues, such as temephos-resistant strains identified in Laos, highlight the need for alternative agents like Bti and diflubenzuron [23]. Local solutions like Bali’s Legiayu incense, derived from natural materials, demonstrate promising larvicidal effects against *Aedes aegypti* with no observed mammalian toxicity [24].

Comprehensive larval control requires integrated approaches combining multiple methods. Monte Verde’s success in eliminating

Aedes aegypti production through biological control (copepods, turtles, tilapia), physical methods (container scrubbing/covering), and limited but strategic use of environmentally-friendly larvicides demonstrates the effectiveness of community-led, 100% coverage monitoring systems [25]. Sustainable control depends on continuous health promotion, local leadership engagement, and interventions adapted to community contexts while addressing social barriers [26].

Conclusion

This study reveals critical insights into dengue fever vector control in Banjarmasin, Indonesia, demonstrating that sociodemographic factors significantly influence larval control behaviors. While 61% of respondents inspected water containers weekly and 69.1% practiced weekly drainage, only 10.2% used larvicides regularly. Higher education levels were strongly

associated with proper drainage methods ($OR=2.442$, $p=0.006$), while younger individuals (16–49 years) conducted more frequent inspections ($OR=1.912$, $p=0.017$). Crucially, larvicide use showed a protective effect against larval presence ($OR=0.461$, $p=0.004$), underscoring its importance despite low adoption rates (52.5% non-users). These findings highlight the need for targeted interventions: education campaigns to improve proper container management, age-specific approaches promoting larvicides among older adults and regular inspections among youth, and community-based programs to increase larvicide accessibility and acceptance. The study emphasizes that integrating these sociodemographic considerations into dengue fever control strategies could significantly enhance their effectiveness in urban endemic areas, potentially reducing *Aedes aegypti* infestation rates and dengue fever transmission. Future efforts should focus on overcoming behavioral barriers and sustaining community engagement in vector control practices.

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