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Public Knowledge about Wolbachia-Aedes Technology: A Survey among Cirebon City Residents, Indonesia

Herawati[1], Witri Pratiwi[2*], Muhammad Hussein Gasem[3,4]

1. Faculty of Medicine, Universitas Swadaya Gunung Jati, Cirebon, Indonesia (45132);
2. Department of Community Medicine and Public Health, Faculty of Medicine, Universitas Swadaya Gunung Jati, Cirebon, Indonesia (45132);
3. Department of Internal Medicine, Faculty of Medicine, Universitas Swadaya Gunung Jati, Cirebon, Indonesia (45132);
4. Division of Tropical Medicine and Infectious Disease, Dr. Kariadi Hospital, Semarang, Indonesia (45132);

***Corresponding author's e-mail: we3.borneo@gmail.com**

DOI: 10.35898/ghmj-831220

ABSTRACT

Background: Wolbachia-Aedes technology is one of the innovations in reducing dengue fever incidence in Indonesia. Its implementation may be limited by insufficient public knowledge, as low awareness can reduce community acceptance and participation in Wolbachia-Aedes technology, both of which are essential for the technology's effectiveness.

Aims: To determine the public knowledge about Wolbachia-Aedes technology and the associated factors in Cirebon City residents, Indonesia.

Methods: This is an observational study with a cross-sectional approach that was conducted in Cirebon City Health Centers (Puskesmas) between June and July 2024, using a cluster random sampling technique. Cirebon City residents who visited Puskesmas and met the inclusion and exclusion criteria were recruited as samples. Data were collected through self-administered validated questionnaires.

Results: There were 600 respondents, consisting of female (68%) who participated in the study. Most of the sample were senior high school graduates (68.2%). The results showed that 39.5% of respondents had poor knowledge, while 51.5% had moderate knowledge and 9% had good knowledge. Age [adjusted OR 1.86 (95%CI 1.32-2.63)] and education level [adjusted OR 2.12 (95%CI 1.38-3.27)] were the factors that related to public knowledge about Wolbachia-Aedes technology in Cirebon City, Indonesia.

Conclusion: Most Cirebon City residents had moderate knowledge, with a substantial proportion still having poor knowledge regarding Wolbachia-Aedes technology. Older age and lower education levels were associated with poorer knowledge. The government needs to improve public knowledge about Wolbachia-Aedes technology before implementation through targeted health promotion, particularly for older populations and those with lower education levels.

Keywords: *Aedes aegypti; Dengue; Dengue hemorrhagic fever; Knowledge; Wolbachia-Aedes technology*.
Received: 02 June 2025 **Reviewed:** 21 July 2025 **Revised:** 09 September 2025 **Accepted:** 30 October 2025.

1. Introduction

Dengue is a mosquito-borne disease with high burden, especially in tropical and subtropical countries, including Indonesia. Aedes aegypti is one of dengue vectors and daytime feeder whose females bite several people during the feeding period (Martina et al., 2018; Schaefer et al., 2024). The incidence of dengue has increased very rapidly in the last few decades. The World Health Organization (WHO) reported that more than 3.9 million people in 132 countries were at risk of being infected with dengue. It was estimated that 96 million people suffer from symptomatic dengue and 40,000 of them die every year. The highest incidence of dengue happened in 2023, experienced by more than 80 countries in all regions (World Health Organization, 2023, 2024).

Indonesia is one of the dengue endemic countries. Data from the Ministry of Health, Republic of Indonesia for April 2024 recorded 88,593 cases of dengue hemorrhagic fever (DHF) with 621 deaths in Indonesia (Kementerian Kesehatan Republik Indonesia, 2024). National data for 2022 reported that West Java was the province with the highest incidence of dengue in Indonesia. Data from the Cirebon City Health Office recorded 70 cases of DHF in Cirebon City during the period January to April 2023, increasing more than twofold to 164 cases in January to April 2024, with one reported death (Syahroni, 2024). Most dengue cases in Indonesia are experienced by the group aged 15-44 years (39%), with the highest mortality in the age group 5-14 years (45%) (Kementerian Kesehatan Republik Indonesia, 2023a).

Until now, there is no specific treatment for dengue, so prevention and control of dengue depend on vector control (World Health Organization, 2023). It aims to reduce dengue transmission, thereby reducing the incidence of dengue cases and preventing outbreaks. The Indonesian government has formulated 6 national strategies to tackle dengue in 2021-2025, one of which is linking effective, safe and sustainable vector management. This strategy involves community participation and the use of locally specific, appropriate technology. Fogging which was often carried out previously, was ineffective because its implementation did not comply with procedures, thereby triggering vector resistance to insecticides. In contrast, Wolbachia-Aedes technology is more effective because it involves releasing *Aedes aegypti* mosquitoes infected with *Wolbachia* bacteria, which reduce the mosquitoes' ability to transmit dengue virus. Unlike chemical fogging, Wolbachia-based vector control does not rely on insecticides, thereby avoiding issues of resistance. Additionally, once established in local mosquito populations, Wolbachia can sustainably maintain itself over time, reducing dengue transmission with minimal ongoing intervention. For this reason, the Indonesian government has launched the implementation of Wolbachia-Aedes technology which has proven its effectiveness as vector management in Indonesia (Kementerian Kesehatan Republik Indonesia, 2023a; Martina et al., 2018; Utarini et al., 2021).

Wolbachia-aedes technology is an innovative technology that utilizes the natural Wolbachia bacteria which are naturally found in >50% of insects. The Wolbachia bacteria is inserted into the body of the Aedes aegypti mosquito so that the dengue virus's replication is inhibited. Aedes aegypti with Wolbachia will produce offspring that also have Wolbachia, so the incidence of dengue can be reduced. The Wolbachia-Aedes technology trial project was carried out in Yogyakarta City and Bantul Regency in 2022. It succeeded in reducing 77% of dengue fever cases and reducing the proportion of hospitalizations due to dengue by 86%. Furthermore, this innovation will be implemented in 5 cities in Indonesia, namely Semarang, West Jakarta, Bandung, Kupang and Bontang (Kementerian Kesehatan Republik Indonesia, 2023c; Utarini et al., 2021).

If successful, perhaps the government will immediately implement it in other areas, including Cirebon City. The implementation of Wolbachia-Aedes technology in Indonesia faces obstacles, including the public's unpreparedness to accept the policy (Fakultas Kedokteran, Kesehatan Masyarakat dan Keperawatan UGM, 2024). This may be due to several factors, including concerns about the safety of releasing Wolbachia-infected mosquitoes, doubts about the effectiveness of this technology, and misunderstandings about its impact on human health and the environment. To gain public acceptance, communities need accurate information about how Wolbachia reduces mosquitoes' ability to transmit dengue virus, its long-term safety for humans and ecosystems, and the expected benefits for public health. Without this knowledge, residents may be hesitant or unwilling to support the implementation of this technology. Based on previous research in Singapore, general knowledge influenced public acceptance of the Wolbachia program (Lwin et al., 2022). Therefore, we are interested in researching public knowledge about Wolbachia-Aedes technology, through a public survey in Cirebon City, West

Java Province, Indonesia. To the best of researchers' knowledge, no previous study has been conducted in Cirebon to examine public knowledge about Wolbachia-Aedes technology. To address this research gap, this study was conducted to determine the description of public knowledge about Wolbachia-Aedes technology and the factors that influence it, which are gender, age, marital status, education level, and monthly income.

2. Methods

Study design and sampling technique

A cross-sectional study through a public survey regarding knowledge about Wolbachia-Aedes technology was conducted in Cirebon City, Indonesia. The sampling technique used in this study was cluster random sampling. It was done by randomly selecting 1 Public Health Center (Puskesmas) to represent each District in Cirebon City. Five Puskesmas were selected, namely Puskesmas Perumnas Utara, Jagasatru, Gunung Sari, Kejaksan and Kesunean. The samples were taken in equal numbers from each Puskesmas.

Study sample

The study sample were Cirebon city residents who visited five selected Puskesmas between June and July 2024. Within each Puskesmas, participants were randomly selected from all visitors meeting the inclusion criteria during the study period. We included Cirebon city residents aged ≥18 years. Exclusion criteria were Cirebon city residents who had been involved in validity and reliability of the questionnaire test. Samples that met the criteria and agreed to participate were recruited as sample.

The minimum sample size was calculated using Open Source Epidemiologic Statistics for Public Health which can be accessed through: https://www.openepi.com/SampleSize/SSPropor.htm. The calculation of the sample size used a population of 112,100 and 95% confidence level, resulting in minimum sample size of 575 (Dinas Kependudukan dan Pencatatan Sipil Kota Cirebon, 2024; Sullivan & Dean, 2024).

Measurement and data collection

Primary data were collected through a questionnaire that contained questions about the respondents' socio-demographic characteristics and knowledge regarding Wolbachia-Aedes technology. The questionnaire items were developed through a literature review and discussed with experts. A pilot test was conducted on 30 respondents to assess the validity and reliability of the 10-item questionnaire designed to evaluate public knowledge of Wolbachia-Aedes technology. The instrument demonstrated acceptable internal consistency, with a Cronbach's alpha value of 0.783. All items showed corrected item-total correlation coefficients above the acceptable threshold of 0.3, ranging from 0.313 to 0.672, indicating satisfactory construct validity.

The paper-based questionnaire was filled out by respondents who were given prior information regarding the filling procedure. Questionnaires about knowledge consist of 10 questions with true and false answer choices. The score ranges from 0 to 10. The total score was categorized as poor knowledge if the score was 0-3, moderate 4-7 and good 8-10. This classification was based on a proportional scoring method commonly used in knowledge, attitude, and practice (KAP) studies, in which less than 40% of correct answers is considered poor, 40–70% is considered moderate, and more than 70% is considered good.

Data analysis

Incomplete questionnaire responses were excluded from the analysis. Data descriptions are displayed based on frequency and percentage values. Bivariate analysis to determine the relationship between socio-demographic characteristics and knowledge was carried out using Chi-square test. Variables with p value <0.2 were continued into multivariate analysis using logistic regression to obtain final model and adjusted OR (95%CI). Multivariate analysis was carried out using the backward method. The value of $p<0.05$ was considered as statistically significant. The analysis was performed using SPSS Version 26 software.

Ethical approval

All samples that met the inclusion and exclusion criteria were given an explanation of aims, benefits and procedures of the study. If agree, the sample was asked to sign an informed consent form. Those who disagree were not included in the study. This study has obtained ethical approval from the Ethics Commission of the Faculty of Medicine, Universitas Swadaya Gunung Jati, Indonesia No. 60/EC/FKUGJ/V/2024.

3. Results

A total of 625 participants were approached, with 600 completing the questionnaire, resulting in a 96% response rate. The socio-demographic characteristics of the respondents were summarized in Table 1. Most of the respondents were female (68%). The proportion of respondents based on age category was almost the same between those aged 21-30, 31-40, 41-50 and >50 years. The majority were married (81.7%) and senior high school graduates (68,2%). About 12.3% of respondents were elementary school graduates or below, and only 13.2% who graduated from university.

Most of the samples worked as private employees and housewives. The majority of the sample came from low socio-economic backgrounds, as indicated by 68.8% having a monthly income below the regional minimum wage (RMW) for Cirebon City (<2,500,000 IDR).

Table 1. Socio-demographic characteristics of respondents and knowledge about Wolbachia-Aedes technology

Characteristics	Total n(%)	Knowledge		
		Poor	Moderate	Good
Gender				
Male	192 (32.0)	74 (38.5)	99 (51.6)	19 (9.9)
Female	408 (68.0)	163 (40.0)	210 (51.5)	35 (8.6)
Age (years)				
18-30	144 (24.0)	42 (29.2)	89 (61.8)	13 (9.0)
31-40	167 (27.8)	54 (32.3)	105 (62.9)	8 (4.8)
41-50	160 (26.7)	61 (38.1)	78 (48.8)	21 (13.1)
51-60	85 (14.2)	50 (58.8)	25 (29.4)	10 (11.8)
>60	44 (7.3)	30 (68.2)	12 (27.3)	2 (4.5)
Married				
Yes	490 (81.7)	206 (42.0)	240 (49.0)	44 (9.0)
No	110 (18.3)	31 (28.2)	69 (62.7)	10 (9.1)
Education level				
Elementary school or below	74 (12.3)	55 (74.3)	18 (24.3)	1 (1.4)
Junior high school	38 (6.3)	10 (26.3)	21 (55.3)	7 (18.4)
Senior high school	409 (68.2)	139 (34.0)	231 (56.5)	39 (9.5)
University	79 (13.2)	33 (41.8)	39 (49.4)	7 (8.9)
Occupation				
Private employee	286 (47.7)	107 (37.4)	160 (55.9)	19 (6.6)
Housewife	224 (37.3)	96 (42.9)	102 (45.5)	26 (11.6)
Laborer	12 (2.0)	8 (66.7)	4 (33.3)	0
Teacher	7 (1.2)	1 (14.3)	4 (57.1)	2 (28.6)
University student	19 (3.2)	3 (15.8)	14 (73.7)	2 (10.5)
Unemployed or retired	38 (6.3)	15 (39.5)	18 (47.4)	5 (13.2)
Others	14 (2.3)	7 (50.0)	7 (50.0)	0
Income (IDR per month)				
<2,500,000	413 (68.8)	175 (42.4)	207 (50.1)	31 (7.5)
2,500,000 – <5,000,000	152 (25.7)	58 (37.7)	80 (51.9)	16 (10.4)
5,000,000 – <10,000,000	22 (3.7)	2 (9.1)	13 (59.1)	7 (31.8)
≥10,000,000	11 (1.8)	2 (18.2)	9 (81.8)	0

As described in Figure 1, about 39.5% of respondents had poor knowledge and only 9% had good knowledge. Table 1 shows a description of knowledge based on socio-demographic characteristics. Among male respondents, 38.5% had poor knowledge, while among female it was 40%. Among the age group 18-50, mostly had moderate knowledge, while the majority of >50 years old respondents had poor knowledge. Among elementary school or below graduated respondents, most had poor knowledge (74.3%). Based on occupation, most laborers had poor knowledge. Meanwhile, those who worked as teachers (14.3%) and university students (15.8%) had the least of poor knowledge. Respondents with a monthly income of IDR <5,000,000 mostly had poor knowledge.

Based on information sources that are presented in Figure 2, most respondents got information from social media (21.3%), followed by television (16,8%). There were 8.7% and 3.3% of respondents who received information from Puskesmas and health cadres, respectively. There were 3.2% of respondents who got information from websites.

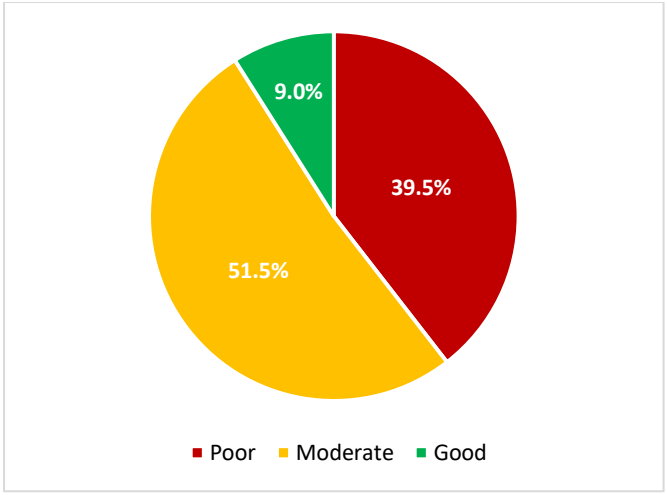

Figure 1. Public knowledge about Wolbachia-Aedes Technology

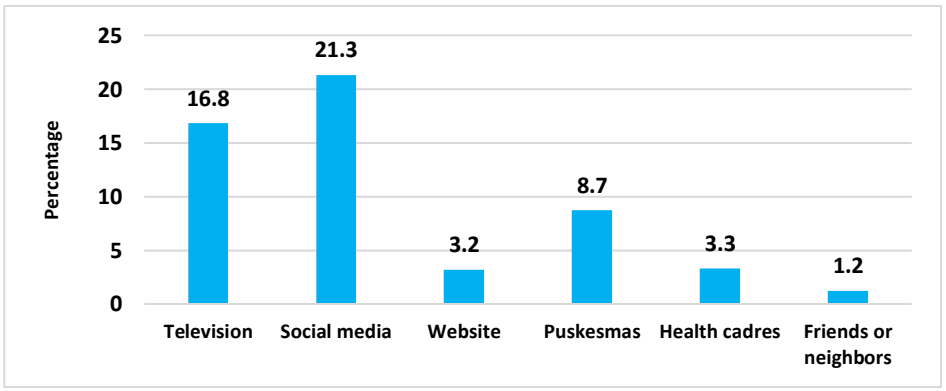

Figure 2. Sources of information about Wolbachia-Aedes Technology

Respondents' responses to the knowledge question are presented in Figure 3. Overall, many respondents did not know about Wolbachia-Aedes technology. Most respondents answered incorrectly on questions: Wolbachia can't infect humans and Wolbachia-infected Aedes aegypti mosquitoes do not transmit dengue fever.

Table 2 displays the results of bivariate and multivariate analyses of factors associated with knowledge of Wolbachia-Aedes technology. In bivariate analysis, respondents aged >40 years [cOR 2.13 (95%CI 1.53-2.98)], those who were married [cOR 1.85 (95%CI 1.18-2.91)], had education level of junior high school or below [cOR 2.54 (95%CI 1.67-3.86)], and those with monthly income below regional minimum wage (RMW) [cOR 1.48 (95%CI 1.03-2.13)] were significantly associated with poor knowledge. In multivariate analysis, age >40 years [aOR (95%CI 1.86 (1.32-2.63)] and junior high school or below graduated [aOR 2.12 (1.38-3.27)] remained as independent predictors of poor knowledge. The model demonstrated a good fit as indicated by the Hosmer–Lemeshow test ($p > 0.05$), and no multicollinearity was detected (VIF < 10 for all variables).

Figure 3. Responses to questions regarding knowledge about Wolbachia-Aedes Technology (%)

Table 2. Factors related to knowledge of Wolbachia-Aedes technology

Variables	Knowledge		Bivariate Analysis		Multivariate Analysis (Final Model)	
	Poor	Moderate + good	p-value	Crude OR (95%CI)	p-value	Adjusted OR (95%CI)
Gender						
Male	74 (38.5)	118 (61.5)	0.742	-	-	-
Female	163 (40.0)	245 (60.0)				
Age (years)						
≤40	96 (30.9)	215 (69.1)	<0.001	Reff.	<0.001	Reff.
>40	141 (48.8)	148 (51.2)		2.13 (1.53-2.98)		1.86 (1.32-2.63)
Married						
Yes	206 (42.0)	284 (58.0)	0.007	1.85 (1.18-2.91)	-	-
No	31 (28.2)	79 (71.8)		Reff.		
Education level						
Junior high school or below	65 (58.0)	47 (42.0)	<0.001	2.54 (1.67-3.86)	0.001	2.12 (1.38-3.27)
Senior high school or above	172 (35.2)	316 (64.8)		Reff.		Reff.
Monthly income						
<RMW	175 (42.2)	238 (57.6)	0.032	1.48 (1.03-2.13)	-	-
≥RMW	62 (33.2)	125 (66.8		Reff.		

Abbreviation: RMW, regional minimum wage

4. Discussion

The findings revealed that knowledge about Wolbachia-Aedes technology was predominantly moderate (51.5%), with 39.5% having poor knowledge and merely 9% exhibiting good knowledge. Poor knowledge was especially was found on questions regarding Wolbachia which can infect humans and Wolbachia-infected Aedes aegypti mosquitoes which can transmit dengue fever. Research conducted in Singapore found that 38.4% of the population had good perceived knowledge about Wolbachia-Aedes technology in their country. Meanwhile, those with poor and moderate knowledge amounted to 41% and 20.6%, respectively (Soh et al., 2021). In addition, a study in Malaysia also highlighted that public attitudes towards Wolbachia-infected Aedes mosquitoes were generally positive, with perceived benefits, trust in authorities, and religiosity being important predictors of acceptance, although moderate perceived risks indicated cautious optimism (Arham et al., 2020). Based on our research, the Indonesian government must conduct outreach regarding Wolbachia-Aedes technology to increase public knowledge. With increasing public knowledge, it hoped that the implementation of this technology will get a positive response from the public.

Research in Singapore regarding Wolbachia-aedes technology in that country showed that 32-54% of the population got information through print and broadcast media, and 23-33% from publicity materials (Liew et al., 2021). We also got almost the same results in this study. Based on overall information sources that the public accesses to get information about Wolbachia-Aedes technology, it was known that most get information from television and social media. Some information from social media provides disinformation so the government must also provide clarification to the public about it. So far, the government has provided a lot of information about Wolbachia-Aedes technology through the official website of the Ministry of Health, Republic of Indonesia. However, based on our research results, only 3.2% of public accessed information about this technology from websites. Besides that, only 8.7% of information was obtained from Puskesmas and 3.3% from health cadres. Therefore, the government needs to expand information media, not only through websites, but also by optimizing Puskesmas and health cadres. Puskesmas as primary health-care play an important role in educating the community through promotion and prevention programs. Moreover the Ministry of Health, Republic of Indonesia stated that Puskemas are the spearhead in public health efforts in Indonesia (Kementerian Kesehatan Republik Indonesia, 2023b; Luthfia & Alkhajar, 2019). Besides that, puskesmas is also assisted by health cadres who are part of community empowerment in health efforts. By optimizing the role of puskesmas and health cadres, socialization regarding Wolbachia-Aedes technology can be maximized and effective.

People with low socio-economic and educational levels are a group that is vulnerable to poor health knowledge. Previous research showed low health information literacy among those with low education and socio-economic status (Li & Guo, 2021). This is in accordance with our results. Bivariate analysis found that those with low socio-economic status (monthly income <RMW), were 1.48 times more likely to have poor knowledge. Besides that, multivariate analysis showed that those with low education (junior high school and below) had 2.12 times higher risk of having poor knowledge [aOR 2.12 (95%CI 1.38-3.27)].

The results of the multivariate analysis also found that those aged >40 years were almost 2 times more likely to had poor knowledge [aOR (95%CI 1.86 (1.32-2.63)], compared to those aged ≤40 years This can be explained by the fact that older individuals are less likely to use digital platforms and social media as their primary sources of information, resulting in lower exposure to new health innovations. Younger individuals are more familiar with technology and social media, enabling faster access to updated health information. Similarly, those with lower educational backgrounds often face difficulties in interpreting scientific concepts, reflecting limited health literacy (Goodyear et al., 2019; Turner et al., 2018).

These findings suggest several implications for program design. Targeted health promotion should be implemented to reach vulnerable groups, particularly older adults and those with low education. Community-based interventions through Puskesmas and health cadres can deliver information in simple, visual, and culturally appropriate formats. At the same time, media-based strategies such as television and social media should be optimized to engage younger groups, while also countering misinformation about Wolbachia-Aedes technology.

The limitation of this study is that we only took samples from Puskesmas visitors. Therefore, it is possible that the knowledge we get about Wolbachia-Aedes technology is different from those who do not come to Puskesmas. Additionally, the use of self-administered questionnaires may introduce bias due to potential misinterpretation or social desirability in responses. Future research should therefore expand to include wider community-based sampling beyond Puskesmas visitors to provide more representative data. Randomized controlled trials or community intervention studies would also be useful to evaluate the effectiveness of tailored educational campaigns and media strategies in improving knowledge and acceptance of Wolbachia-Aedes technology.

5. Conclusion

Based on this study, most residents of Cirebon City, Indonesia, had moderate knowledge regarding Wolbachia-Aedes technology, although a substantial proportion still had poor knowledge. Older age and lower education levels were associated with poorer knowledge. The government needs to improve the delivery of information to the public regarding Wolbachia-Aedes technology, especially by optimizing the role of puskesmas and health cadres. Further research with recruiting a larger sample size and taking from a more diverse population is needed to obtain a more complete picture of knowledge and influencing factors among Indonesian population.

Conflict of Interest

There is no conflict of interest to declare.

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Cite this article as:

Herawati, H., Pratiwi, W., & Gasem, M. H. (2025). Public Knowledge about Wolbachia-Aedes Technology: A Survey among Cirebon City Residents, Indonesia. *GHMJ (Global Health Management Journal)*, *8*(3), 403–411. https://doi.org/10.35898/ghmj-831220