

Factors related to public support for the WINGKO (*Wolbachia* Ing Kota Semarang) program

Faktor-Faktor yang Berhubungan dengan Dukungan Masyarakat Terhadap Program Wingko (Wolbachia ing Kota Semarang)

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ABSTRACT

Background: Dengue fever (DF) remains a persistent public health threat in Semarang City, with 404 reported cases in 2023. To address this issue, the WINGKO Program (*Wolbachia* ing Kota Semarang) was launched in 2023 as a vector control initiative involving the release of *Aedes aegypti* mosquitoes inoculated with *Wolbachia* bacteria.

Objective: This study aimed to analyze the factors associated with public support for the WINGKO program.

Methods: A cross-sectional study was conducted among 80 residents of RW 2, Meteseh Village, Tembalang District, using a structured questionnaire and purposive sampling technique. Data were analyzed using the Chi-Square test and Pearson correlation to determine the factors influencing community support for the WINGKO Program.

Results: The results showed that residents who had lived in Semarang for more than five years were more likely to support the program (OR 3.590, 95% CI 1.247–10.330, $p = 0.015$). Participants with higher education levels were three times more likely to support the program (OR 3.626, $p = 0.006$). A history of dengue infection (OR 2.878, $p = 0.035$) and prior involvement as a *Wolbachia* Foster Parent (OTA) (OR 3.093, $p = 0.044$) were also significantly associated with higher program support. In contrast, variables such as gender and household size were not significantly related to support for the program.

Conclusion: This research highlights the importance of targeted community engagement strategies that consider educational and experiential factors to strengthen public acceptance.

Keywords: dengue, public support, vector control, *Wolbachia*

ABSTRAK

Latar Belakang: Demam berdarah dengue (DBD) masih menjadi ancaman kesehatan masyarakat yang berkelanjutan dengan 404 kasus pada tahun 2023 di Kota Semarang. Untuk mengatasi hal ini, Program WINGKO (*Wolbachia* ing Kota Semarang) diluncurkan pada tahun 2023 sebagai inisiatif pengendalian vektor dengan melepaskan nyamuk *Aedes aegypti* yang telah diinokulasi dengan bakteri *Wolbachia*.

Tujuan: Penelitian ini bertujuan untuk menganalisis faktor-faktor yang berhubungan dengan dukungan masyarakat terhadap Program WINGKO.

Metode: Studi cross sectional dilakukan terhadap 80 warga RW 2, Kelurahan Meteseh, Kecamatan Tembalang, dengan menggunakan kuesioner terstruktur dan menggunakan teknik purposive sampling. Data dianalisis menggunakan uji Chi-Square dan korelasi Pearson untuk mengetahui faktor-faktor yang mempengaruhi dukungan masyarakat terhadap Program WINGKO.

Hasil: Hasil menunjukkan bahwa warga yang tinggal di Semarang lebih dari lima tahun memiliki kemungkinan lebih besar untuk mendukung program (OR 3,590, 95% CI 1,247–10,330, $p = 0,015$). Partisipan dengan tingkat pendidikan tinggi memiliki kemungkinan tiga kali lebih besar untuk mendukung program (OR 3,626, $p = 0,006$). Pengalaman partisipan yang pernah terinfeksi dengue (OR 2,878, $p = 0,035$) dan pengalaman keterlibatan sebagai OTA *Wolbachia* (OR 3,093, $p = 0,044$) juga berhubungan signifikan dengan dukungan yang lebih tinggi terhadap program. Sebaliknya, variabel seperti jenis kelamin dan jumlah anggota rumah tangga tidak menunjukkan hubungan yang signifikan ($p > 0.05$).

Kesimpulan: Penelitian ini menggambarkan pentingnya keterlibatan masyarakat yang menjadi sasaran dengan mempertimbangkan faktor pendidikan dan pengalaman mereka untuk memperkuat penerimaan publik.

Kata kunci: dengue, dukungan masyarakat, pengendalian vektor, *Wolbachia*

INTRODUCTION

Dengue fever is a mosquito-borne viral infection caused by four distinct serotypes of the *dengue virus* (DENV-1 to DENV-4).¹ It is transmitted primarily by the *Aedes aegypti* mosquito and manifests clinically as an acute febrile illness that can progress to severe dengue, characterized by plasma leakage, hemorrhage, and organ impairment.² Dengue remains a major global health concern, with over 14.3 million cases and 10,576 deaths reported in 2024 across 112 countries, more than double the incidence recorded in 2023.³ In Indonesia, dengue remains endemic, including in Semarang City, where recurrent outbreaks have been reported. According to data from the Semarang City Health Office, dengue fever remains a persistent public health challenge, with 865 cases reported in 2022, 404 cases in 2023, and decreased to 231 cases in June 2024.⁴ These figures highlight ongoing transmission risks in the region, particularly in densely populated subdistricts such as Tembalang, Pedurungan, and Banyumanik, where case concentrations have been consistently high.

In response to this ongoing threat, innovative vector control strategies have been explored to complement existing measures. One promising innovation in dengue vector control is the use of *Wolbachia* technology.⁵ However, despite its potential, this method has several limitations, including its non-instant effectiveness, dependence on the stability of local mosquito populations, and challenges in public acceptance.⁵ *Wolbachia* are intracellular endosymbiotic bacteria naturally found in many arthropod species, including insects and some nematodes.⁶ In *Aedes aegypti*, transinfection with specific *Wolbachia* strains, such as *wMel* can inhibit the replication of dengue, Zika, and chikungunya viruses, thereby reducing the mosquito's ability to transmit pathogens.⁷ The release strategy of *Wolbachia*-infected mosquitoes involves the repeated introduction of laboratory-reared *Aedes aegypti* carrying *Wolbachia* into local populations, where the bacteria spread through natural mating.⁸ Over time, *Wolbachia* can become stably established in the wild mosquito population.⁸ Field trials in Australia, Vietnam, and Brazil have demonstrated the feasibility of this approach.⁹⁻¹¹ For example, a large-scale study in Yogyakarta, Indonesia, showed that areas with sustained *Wolbachia* deployment experienced a 77% reduction in dengue incidence and an 86% reduction in hospitalizations compared to untreated areas.¹²

Multiple studies have confirmed that *Wolbachia* does not infect vertebrates, including humans, and does not pose direct environmental or ecological risks.^{13,14} These characteristics have supported regulatory approvals and community engagement efforts in several countries. Community acceptance is recognized as a cornerstone of successful *Wolbachia* deployment. Prior research has shown that clear communication

about benefits, safety, and implementation methods significantly increases community trust and participation.^{15,16} Community perception includes knowledge, attitudes, beliefs, and concerns about potential risks and benefits of the program. Positive perceptions can support the sustainability of the program, while negative perceptions or doubts can be serious obstacles to implementation in the field.¹⁷

In Semarang City, the implementation of *Wolbachia*-based vector control has been formalized through the WINGKO (*Wolbachia ing Kota Semarang*) program, which was initiated in 2023 as part of a pilot project led by the Indonesian Ministry of Health. This program represents a coordinated effort among public health authorities, research institutions, and local communities to reduce dengue transmission in a sustainable manner. Given the community-based nature of the intervention, public support plays a vital role in ensuring its long-term success. Community acceptance and participation are therefore essential for the effective implementation and sustainability of *Wolbachia* biocontrol strategies. To better understand the determinants of public support, it is important to consider various influencing factors, including educational level, duration of residence, prior personal or household experience with dengue infection, and participation as an *Orang Tua Asuh Wolbachia* (OTA *Wolbachia* foster parent). These factors may shape perceptions, acceptance, and engagement with the WINGKO program, a novel vector control initiative launched in Semarang in 2023.

Although previous research has demonstrated that higher educational attainment and direct involvement in community-based vector control efforts are positively associated with program acceptance,¹⁸ specific studies evaluating these associations within the context of the WINGKO program remain limited due to its recent implementation in Semarang City. Therefore, this study aimed to analyze the factors associated with public support for the WINGKO Program in the Meteseh Subdistrict, Tembalang District, Semarang. The findings are expected to provide valuable insights for local health authorities and stakeholders to optimize community involvement and improve the program's effectiveness in controlling dengue transmission.

METHODS

Study design

This study employed a cross sectional design to assess public perceptions of the WINGKO program at a specific point in time, with public support as the dependent variable and demographic characteristics (such as gender, education, length of stay, household size, experience with dengue and experience as an OTA *Wolbachia*) as the independent variables. The research was conducted at RW 2, Meteseh Subdistrict, Tembalang District, Semarang City, during October to December 2024.

Data source and sampling procedures

A total of 80 households were selected as respondents using a non-probabilistic sampling technique, specifically purposive sampling. The sample size was determined based on considerations of time constraints, available resources, and the need to focus the research on subjects who met predefined inclusion criteria and were deemed most relevant to the study objectives. The sample was drawn from residents of RW 2, Meteseh Subdistrict, Tembalang District, as monitoring data results indicated that out of 109 inspected houses, 22 were found to contain mosquito larvae, resulting in a larva-free index (LFI) of only 79%, which is well below the minimum acceptable threshold of 95%. Inclusion criteria for respondents included being registered as a resident with a Semarang City ID card, living in Neighborhood Unit (RW) 2, Meteseh Subdistrict for more than one year, and expressing willingness to participate in the study. Exclusion criteria

included individuals who were not registered with a KTP Semarang, lived in RW 2 for less than one year, or were unwilling to provide informed consent as study participants.

Variables of the study

The variables in this study consisted of independent and dependent variables. The independent variables included demographic characteristics such as gender, education, length of stay, household size, experience with dengue infection, and experience as an OTA Wolbachia. The dependent variable was public support for the WINGKO program. Public support was defined based on respondents' scores from the questionnaire, categorized into 'supporting' and 'not supporting' the program.

Measurement and instruments

A questionnaire was developed to assess public support for the WINGKO program and to identify factors potentially associated with that support. The development of this questionnaire was informed and inspired by the survey instrument used in the study by Rosyad et al. (2022).¹⁹ Respondents were asked a series of questions covering sociodemographic characteristics such as sex, age, education level, and household size. Additionally, the questionnaire included items regarding their length of stay in Semarang, previous experience with dengue infection, and whether they had participated as an OTA (Orang Tua Asuh) *Wolbachia*. The primary outcome or dependent variable in this study was public support for the WINGKO program. Support was evaluated using a scoring system based on responses to the 10 questions of the questionnaire. Participants who achieved a score of ≥ 60 were categorized as 'supporting' the program, whereas those who scored < 60 were classified as 'not supporting'. The data were collected through face-to-face interviews with selected respondents who met the inclusion criteria and agreed to participate in the study.

The questionnaire was tested for validity and reliability using SPSS version 16.0. The questionnaire was first tested on 30 residents of Tembalang Sub-district to assess its validity and reliability, in accordance with the widely accepted guideline that a minimum of 30 respondents is adequate for preliminary instrument testing.²⁰ The validity test, conducted using Pearson's correlation, yielded an *r-value* of 0.535, which exceeds the threshold of 0.3, indicating that the questionnaire is valid. The reliability test using Cronbach's Alpha produced a value of 0.625, which is above the acceptable limit of 0.6, confirming that the instrument is reliable.

Data Collection

Data were collected using a structured questionnaire administered to respondents who met the inclusion criteria and agreed to participate in the study. The questionnaire included items related to sociodemographic characteristics, length of stay, experience with dengue infection, and participation as an OTA *Wolbachia*, as well as questions to assess public support for the WINGKO program.

Ethical consideration

Data collection was conducted following ethical approval from the Human Research Ethics Committee of Universitas Ngudi Waluyo (No: 57/KEP/EC/UNW/2024). Informed consent was obtained from all participants to ensure voluntary participation and maintain the confidentiality of the data.

Data analysis

Data analysis consisted of univariate analysis to describe the frequency distribution of respondents' characteristics. To examine the relationship between variables, bivariate analysis was performed using the Chi-Square test. A *p-value* of less than 0.05 was considered statistically significant.

RESULTS

Respondent characteristics in table 1 shows a total of 80 respondents participated in this study. The majority were male (60%), aged 18–59 years (91.2%), and had lived in Semarang for more than 5 years (67.5%). Most participants had a household size of 1 to 4 people (75%) and were covered by BPJS insurance (87.5%). In terms of education, 58.8% had less than 12 years of formal education. Regarding prior experience with dengue, 71.2% reported no experience with the disease. These demographic characteristics were analyzed to explore their association with public support for the WINGKO program, focusing on variables such as sex, length of stay, education level, household size, prior experience with dengue, and prior experience as an OTA.

Table 1. Analysis of Variables Associated with Public Support for The WINGKO Program

Variables	Public Support for The Wingko Program				Total	P-Value	OR (95% CI)
	Support		Not Support				
	N	Percentage	N	Percentage			
Sex							
Male	21	43.8%	27	56.5%	48	0.782	0.88 (0.355 - 2.179)
Female	13	40.6%	19	59.4%	32		
Length of Stay in Semarang							
1-5 years	6	23.1%	20	76.9%	26	0.015	3.590 (1.247 – 10.330)
> 5 years	28	51.9%	26	48.1%	54		
Education Level							
< 12 years	14	29.8%	33	70.2%	47	0.006	3.626 (1.421 – 9.258)
> 12 years	20	60.6%	13	39.4%	33		
Household size							
1 to 4 persons	22	36.7%	38	63.3%	60	0.068	2.591 (0.918 – 7.311)
≥ 5 persons	12	60%	8	40%	20		
Experience of Dengue							
Experienced	14	60.9%	9	39.1%	23	0.035	2.878 (1.060 – 7.811)
Unexperienced	20	35.1%	37	64.9%	57		
Experience as an OTA <i>Wolbachia</i>							
Experienced	30	85.7%	5	14.3%	35	0.044	3.093 (1.003 – 9.542)
Unexperienced	16	35.6%	29	64.4%	45		

The analysis of variables associated with public support for the WINGKO program is presented in Table 1. Of the 80 respondents, 42.5% supported the program, while 57.5% did not. No significant association was found between sex and program support ($p=0.782$). Support was reported by 43.8% of male and 40.6% of female respondents (OR=0.868; 95% CI: 0.355–2.179). Length of stay in Semarang was significantly associated with support ($p=0.015$), with higher support among those residing for >5 years (51.9%) compared to 1–5 years (23.1%) (OR=3.590; 95% CI: 1.247–10.330). Educational attainment was also significantly associated with support ($p=0.006$), with higher support among respondents with >12 years of education (60.6%) compared to those with lower education (23.3%) (OR=3.626; 95% CI: 1.421–9.258).

Household size showed a marginal association ($p=0.068$), with higher support among larger households (≥ 5 members: 60%) compared to smaller households (36.7%) (OR=2.591; 95% CI: 0.918–7.311). A significant relationship was found between experience of dengue infection and public support for the WINGKO program ($p=0.035$).

Among respondents who had experienced dengue, 60.9% supported the WINGKO program, compared to only 35.1% of those without such experience. The odds of supporting the program were 2.878 times higher among those who had direct experience with dengue (OR=2.878; 95% CI: 1.060–7.811), reflecting the influence of personal or familial health experiences on support for prevention measures. Importantly, experience as an OTA *Wolbachia* was also significantly associated with support for the WINGKO program ($p=0.044$). Respondents with OTA experience overwhelmingly supported the program (85.7%), in stark contrast to the 35.6% support among those without this experience. The OR of supporting the program were three times higher among those involved in OTA activities (OR=3.093; 95% CI: 1.003–9.542).

DISCUSSION

The results presented several factors significantly associated with public support for the WINGKO Program. Among the variables analyzed, length of residence in Semarang showed a strong association with WINGKO program support, with residents living in the area for more than five years significantly more likely to express support (OR 3.590, 95% CI 1.247–10.330, $p = 0.015$). This may be attributed to the fact that individuals who lived in Tembalang for more than five years are more likely to be familiar with the WINGKO program, which has been implemented since 2023. They have also had more time to receive information about *Wolbachia* and understand its potential benefits compared to recent residents. This finding is consistent with studies in Yogyakarta and Brazil, which found that residents with longer community ties were more likely to engage with and trust local public health initiatives.^{21,22}

Similarly, education level emerged as a significant predictor of public support for the WINGKO program. Participants with more than 12 years of education were over three times more likely to support the program (OR 3.626, 95% CI 1.421–9.258, $p = 0.006$). Participants with 12 years of education are those who have completed elementary, junior high, and high school, while those with more than 12 years of education are pursuing or have completed higher education at the university level. This is likely because individuals with higher educational attainment tend to be more receptive to new health information and emerging health technologies compared to those with lower levels of education. This finding aligns with previous literature indicating that higher education often correlates with greater understanding and acceptance of biomedical innovations.¹⁵

Previous experience with dengue was another significant factor associated with public support for the WINGKO program (OR 2.878, 95% CI 1.060–7.811, $p = 0.035$). This finding is consistent with studies from Malaysia and Australia, which showed that individuals who had previously contracted dengue, or had household members affected by it, demonstrated greater openness to vector control interventions.^{23,24} Previous experience with dengue may heighten awareness of the disease's severity and increase perceived vulnerability, which in turn can lead to stronger support for novel prevention strategies such as *Wolbachia*. In a study conducted in Yogyakarta, Indonesia, community members who had experienced repeated dengue infections were more likely to approve the release of *Wolbachia*-infected mosquitoes as a preventive measure.²¹ Similarly, in Brazil, personal or family history of arboviral infection played a key role in motivating active community engagement with vector control programs.²⁵ These findings highlight the importance of leveraging personal disease experiences in risk communication strategies, especially in endemic areas where community participation is critical for intervention success.

Importantly, participation as an OTA *Wolbachia* showed a strong association with public support for the WINGKO program (OR 3.093, 95% CI 1.003–9.542, $p = 0.044$).

This finding highlights the critical role of direct community involvement in building acceptance and ownership of public health interventions. Individuals who participate in the OTA *Wolbachia* not only receive more information and ongoing communication about the program but are also actively engaged in the process, which may foster a sense of responsibility and trust. This reinforces the value of participatory approaches and local stakeholder engagement in promoting the long-term sustainability of vector control efforts.

Previous studies have shown that community engagement increases both awareness and willingness to participate in innovative health strategies. For example, in the Eliminate Dengue Program in Australia, public forums and community ambassador roles led to higher acceptance rates of *Wolbachia* mosquito releases.²⁶ Similarly, in Indonesia, active community involvement, including local volunteers and household-level participation, was essential to the success of *Wolbachia* trials.²¹ Therefore, strengthening the role of OTA *Wolbachia* and similar community-based initiatives could be a key strategy in increasing public support and ensuring program success.

While household size did not reach statistical significance ($p = 0.068$), and sex was also not associated with public support ($p = 0.782$), these findings underscore the importance of directing public health communication and community engagement efforts toward more influential predictors such as education level, length of residence in the community, and prior dengue experience. The lack of association for sex may reflect that both men and women share similar levels of exposure to health information and risk perception regarding dengue in urban communities, especially when public messaging is uniformly delivered.²⁷

Similarly, household size may not directly influence attitudes toward programs like *Wolbachia* unless it interacts with caregiving responsibilities or dengue-related experiences within the household.²⁸ In some settings, larger household size may increase awareness due to caregiving demands, while in others, it may dilute individual responsibility or engagement, leading to inconsistent associations.²⁹ Thus, focusing on psychosocial and contextual factors, such as education, community attachment, and disease experience, offers a more reliable pathway to increase support and participation.

This study highlights the value of community attachment, higher educational attainment, and personal experience in fostering acceptance of *Wolbachia*-based vector control, while also highlighting the critical role of participatory approaches. These results are particularly relevant to the Semarang context, because the program was relatively new (starting in early 2024) and the findings contributed to the existing global literature showing that community engagement was essential for the success of innovative public health initiatives.

Despite these contributions, several limitations should be noted. The cross-sectional design precludes causal inference, and reliance on self-reported data may introduce bias. The findings are also specific to Semarang and may not be generalizable to other regions. Nevertheless, the implications are clear: program implementers should prioritize outreach to newer residents and less-educated groups, strengthen participatory mechanisms such as OTA *Wolbachia*, and leverage digital platforms to enhance communication and counter misinformation. By aligning scientific innovation with community trust and engagement, WINGKO program has the potential to ensure long-term sustainability and effectiveness in dengue control.

CONCLUSION

This study identified several key factors associated with public support for the WINGKO program, including length of residence, education level, prior experience with

dengue, and participation as an OTA *Wolbachia*. Residents who had lived in Semarang for more than five years and those with more than 12 years of education were significantly more likely to support the program. Similarly, individuals who had personal experience with dengue or who were directly involved in program activities demonstrated greater acceptance. These results suggest that long-term community attachment, health literacy, and participatory engagement can enhance the effectiveness of biocontrol initiatives.

While factors like gender and household size were not significantly associated with program support, future research should explore the underlying reasons through qualitative methods such as interviews or focus group discussions. Additionally, studies could examine how trust in government, exposure to misinformation, and social networks influence public attitudes. Longitudinal research is also recommended to evaluate how perceptions evolve over time as the *Wolbachia* program expands and matures in Semarang and other cities.

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