

A Scopus-Based Bibliometric Analysis of *Wolbachia-Aedes* Innovation for Controlling Dengue Hemorrhagic Fever (DHF)

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Abstract. *Wolbachia* technology is an innovative strategy for controlling dengue hemorrhagic fever (DHF) and has been implemented in Indonesia. However, the community has pros and cons about its implementation. Some community's rejection was caused by limited socialization, community knowledge, and perception. They still doubt the safety, effectiveness, and efficiency of *Wolbachia-Aedes*'s innovation. This study aims to map global and Indonesian research on *Wolbachia-Aedes* innovation. The study used a quantitative descriptive method with a bibliometric approach. Data were obtained from publications indexed in the Scopus database from 2014 to 2024 complemented by VOSviewer analysis. The results revealed 568 publications related to *Wolbachia-Aedes* innovation, with varying annual publication rates. In Indonesia, 32 publications have been produced since 2014, with the majority of research concentrated in Yogyakarta. Australian researchers are the leading contributors. International collaboration on *Wolbachia-Aedes* innovation is apparent, particularly among countries such as Burkina Faso, Greece, Benin, Cameroon, the United States, and Panama. Based on the co-words map, three clusters have related keywords. Further systematic reviews are needed to evaluate the effectiveness of and strategies for implementing the *Wolbachia-Aedes* innovation, as well as potential risks, impacts, and benefits of implementing this innovation.

1 Introduction

Dengue hemorrhagic fever (DHF) is an infectious disease caused by the dengue virus and transmitted by the *Aedes aegypti* mosquito, especially in tropical and subtropical regions [1]. This vector-borne disease is a significant global public health issue, with the World Health Organization (WHO) identifying dengue fever as one of the ten global health problems in 2019 [2]. Climatic factors are crucial in transmitting dengue fever, which is influenced by temperature, rainfall, and relative humidity [3]. Research conducted in Semarang, Indonesia, found that the prevalence of dengue fever is higher during the rainy season compared to the dry season [4].

According to the Ministry of Health of the Republic of Indonesia, dengue fever cases have decreased. In 2022, there were 143,176 cases, which decreased to 98,071 cases

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in 2023 [5]. However, many areas in Indonesia continue to have higher incidence rates (IR) of more than ten, with 422 dengue fever-related deaths in 2023 [5].

To address this issue, the Ministry of Health of the Republic of Indonesia has introduced a new solution to reduce the transmission of dengue virus [6]. This involves injecting *Aedes aegypti* mosquitos with *Wolbachia* bacteria, which reduces the ability of the mosquitoes to spread the virus to humans. This innovative method was approved through the Decree of the Minister of Health Number HK.01.07/MENKES/1341/2022 and has been implemented as part of a dengue control pilot project in five regions, namely Semarang City, West Jakarta, Bandung City, Bontang City, and Kupang City. This method was previously implemented in Yogyakarta and successfully reduced the incidence of dengue fever [7]. Despite the implementation of the *Wolbachia-Aedes* innovation, regular inspections for mosquito larvae (PJN) and the eradication of mosquito breeding sites (PSN) should be carried out twice a week.

However, the policy has sparked pros and cons in Indonesia. The main concern is the limited research on the innovation in Indonesia. Therefore, this study aims to map global and Indonesian research on *Wolbachia-Aedes* innovation and evaluate its effectiveness in combating DHF.

2 Methods

2.1 Research Design and Procedure

This study used a quantitative descriptive method with a bibliometric approach. This study aims to map and assess the development of publications regarding the *Wolbachia-Aedes* innovation in combating DHF. The analysis focused on the annual number of publications, as well as details about the authors, their affiliations, and their countries of origin as indexed in the Scopus database. Additionally, a network map was created to visualize the connections between keywords and authors. The data were analyzed using Scopus's built-in analysis tools and VOSviewer software. This study was conducted between March and May 2024.

2.2 Data Collection

Data were collected by searching for articles in the Scopus database (www.scopus.com) using the keywords "*Wolbachia*," "*Aedes*," and "dengue." The search was restricted to articles published within the last ten years (2014 to 2024). The collected data included original research articles, reviews, editorials, and other relevant publications.

2.3 Scopus Analysis

The collected publications on the *Wolbachia-Aedes* innovation were analyzed using Scopus to examine their mapping and distribution. The analysis included the annual number of publications, as well as details about the authors, their affiliations, and their countries of origin.

2.4 VOSviewer Analysis

The data collected from Scopus was further analyzed using the Visualization of Similarities-Viewer (VOSviewer). The visualization included a research network map based on keywords and a network map based on authors. The co-word map shows a network of publications where two keywords appear together in the title, abstract, and keywords. On the other hand, the co-authorship network visualizes the relationships between researchers working on the same topic.

3 Results and Discussion

3.1 The Number of Publications Related to Wolbachia-Aedes Innovation

According to the analysis of the Scopus database, 528 articles related to the *Wolbachia-Aedes* innovation were published between 2014 and 2024. Figure (1) shows that the number of publications fluctuated every year. There was an increase in the number of publications from 2014 to 2020, peaking in 2020 with 65 publications related to *Wolbachia-Aedes*. However, from 2020 to 2024, there was a decrease in the number of publications related to this topic. These findings suggest that research on *Wolbachia-Aedes* has been growing over the past decade. Research trend indicated that many countries have been focusing on this topic in recent years. For example, research in Malaysia has explored the sustainability and prevalence of *Wolbachia* in dengue-carrying mosquitoes [8]. Meanwhile, research in the Philippines has investigated the role of host sex and *Wolbachia* strain on *Wolbachia* density [9].

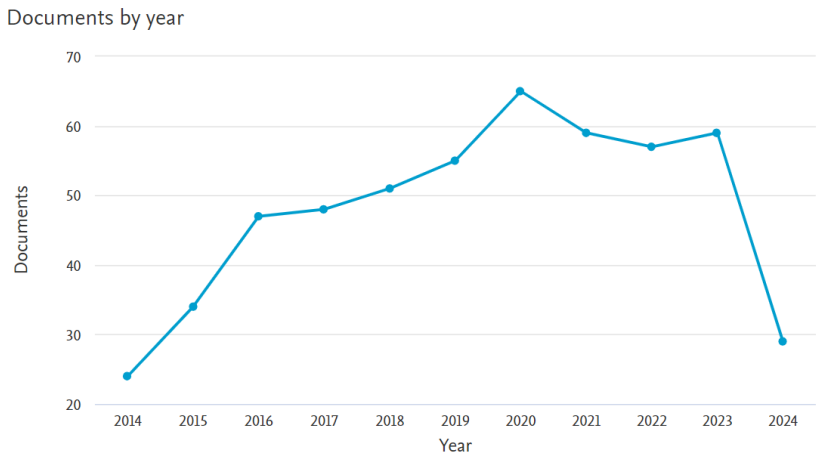


Figure (1). The number of publications related to *Wolbachia-Aedes* innovation (Scopus analysis on May 16, 2024)

3.2 Publication Types and Subject Area Related to Wolbachia-Aedes Innovation

Figure (2) shows the distribution of publication types, with the majority being research articles (406; 76.9%), followed by reviews (71; 13.4%), letters (12; 2.5%), book chapters (11; 2.1%), notes (11; 2.1%), short surveys (9; 1.7%), editorials (5; 0.9%), and conference papers (2; 0.4%). This indicated that publications related to *Wolbachia-Aedes* innovation varied, not limited only to original research, but also including reviews, letters, notes, and others.

In terms of subject areas, most publications were in the fields of medicine (30.1%), immunology and microbiology (22.5%), agricultural and biological sciences (12.9%), biochemistry, genetics, and molecular biology (12.8%), multidisciplinary studies (5.1%), mathematics (4.5%), environmental sciences (3.4%), veterinary sciences (3.2%), chemistry (0.8%), pharmacology, toxicology, and pharmaceuticals

(0.8%), and others (3.9%) (Figure 3). This indicated that research on *Wolbachia-Aedes* innovation is viewed from many perspectives, including medical and veterinary sciences.

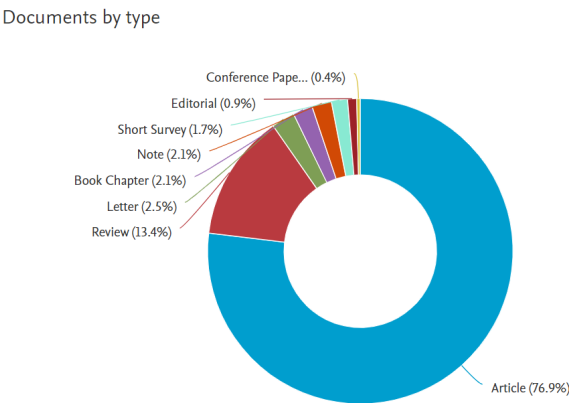


Figure (2). Publication types related to *Wolbachia-Aedes* innovation (Scopus analysis on May 16, 2024)

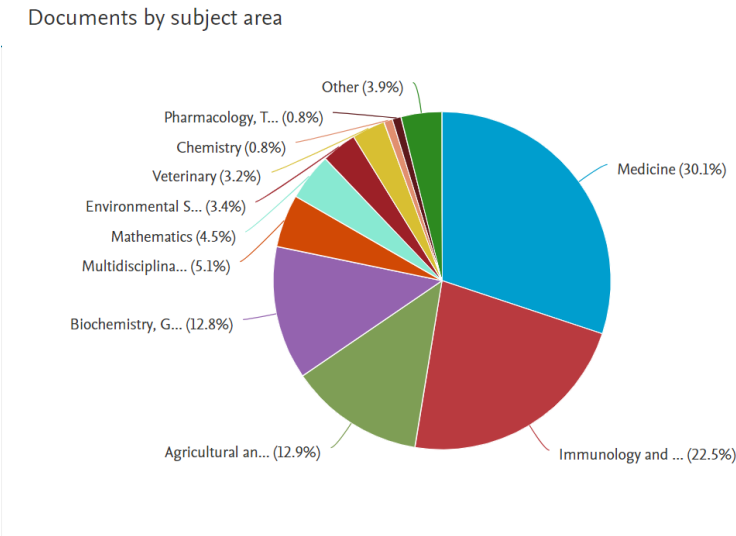


Figure (3). Subject areas related to *Wolbachia-Aedes* innovation (Scopus analysis on May 16, 2024)

The majority of articles in the field of medicine (285) were published in journals such as PLOS Neglected Tropical Diseases (60), Parasites and Vectors (31), Viruses (14), Frontiers in Microbiology (13), Journal of Medical Entomology (10), Frontiers in Cellular and Infection Microbiology (10), Acta Tropica (10), the American Journal of Tropical Medicine and Hygiene (8). This suggested that many journals publish

research on *Wolbachia-Aedes* innovation, which covers not only the effectiveness of the technology, but also the risks, genetic interactions, and other aspects [10].

3.3 Authors, Affiliations, and Countries Related to Publications on *Wolbachia-Aedes* Innovation

As shown in Figure (4), the countries with the highest number of publications related to *Wolbachia-Aedes* innovation were Australia (188), the United States (152), the United Kingdom (92), Brazil (62), China (48), Indonesia (32), Vietnam (30), France (29), Colombia (25), India (22), Malaysia (22), Singapore (19), Germany (15), Italy (15), and Austria (12). Other countries such as Saudi Arabia, Thailand, Portugal, Spain, Japan, Mexico, Canada, Pakistan, Philippines, Sri Lanka, Switzerland, Burkina Faso, Cambodia, Netherlands, Taiwan, Cameroon, Chile, Greece, Israel, New Caledonia, Panama, and also contributed to research on this topic. These results suggested that research and publications on *Wolbachia-Aedes* innovation were not only carried out in Asia, but also in Australia, Europe, Africa, and America. This further suggested that *Wolbachia-Aedes* is a global concern, with research efforts being pursued in many countries worldwide [11].

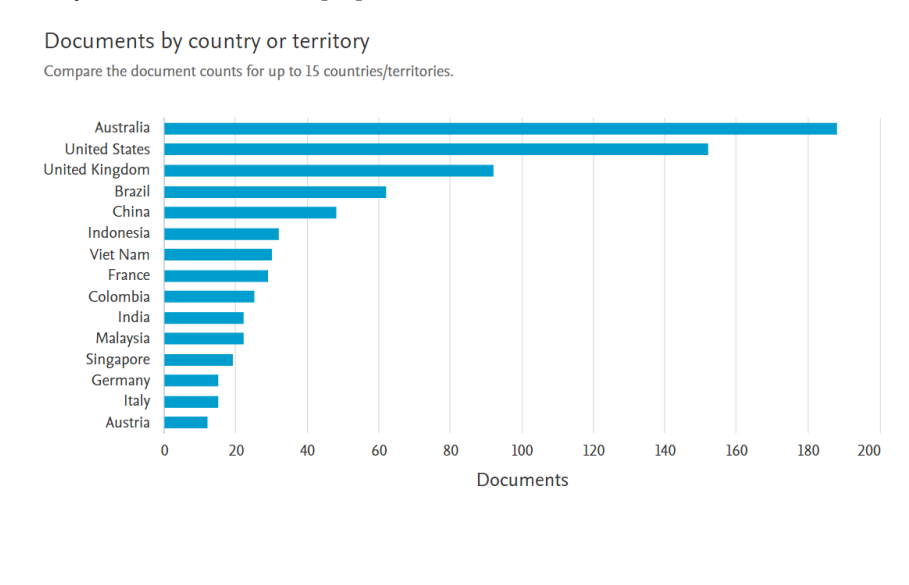


Figure (4). Countries related to publications on *Wolbachia-Aedes* innovation (Scopus analysis on May 16, 2024)

In Indonesia, research on *Wolbachia-Aedes* has been carried out extensively, with 32 publications since 2015. Most of the research was concentrated in Yogyakarta, with Universitas Gadjah Mada being the leading affiliation, contributing to 21 publications. Five recent articles related to *Wolbachia-Aedes* innovation in Indonesia are shown in Table (1) below [12,13,14,15,16].

Table 1. Five recent articles related to *Wolbachia-Aedes* innovation in Indonesia

| No | Title | Author(s) | Publication Type | Year | Journal |
|----|--|---|------------------|------|--|
| 1 | <i>Wolbachia</i> : New Hopes for the Prevention of Dengue Hemorrhagic Fever in Indonesia | Nindrea, R.D. | Letter | 2024 | Asia-Pacific Journal of Public Health |
| 2 | Lessons from the Mass Production of <i>Wolbachia</i> -infected <i>Aedes aegypti</i> for Egg Release in the Sleman and Bantul Districts of Yogyakarta | Fitriana, I., Nurhayati, I., Arianto, B., ..., Arguni, E., Tantowijoyo, W. | Article | 2024 | Journal of Tropical Biodiversity and Biotechnology |
| 3 | Utility of Surveillance Data for Planning for Dengue Elimination in Yogyakarta, Indonesia: A Scenario-Tree Modelling Approach | Bannister-Tyrrell, M., Hillman, A., Indriani, C., ..., Anders, K.L., Sergeant, E. | Article | 2024 | BMJ Global Health |
| 4 | Control Methods for Invasive Mosquitoes of <i>Aedes aegypti</i> and <i>Aedes Albopictus</i> (Diptera: Culicidae) in Indonesia | Ridha, M.R., Marlinae, L., Zubaidah, T., ..., Desimal, I., Sofyandi, A. | Review | 2023 | Veterinary World |
| 5 | Qualitative Behavioral Analysis in Mosquito | Suandi, D., Ilahi, | Article | 2023 | Communication in Biomathematics |

| | | | | | |
|--|--------------------------------------|---------------------------------------|--|--|--------------------------|
| | Dynamics Model with <i>Wolbachia</i> | F., Ramdhani, R., Nugraha, E.S. | | | mathematical Sciences |
|--|--------------------------------------|---------------------------------------|--|--|--------------------------|

Figure (5) shows a network map based on co-author collaboration, with 20 authors collaborating in *Wolbachia-Aedes* research. Figure (6) shows the collaboration among six countries in *Wolbachia-Aedes* publications, namely Burkina Faso, Greece, Benin, Cameroon, the United States, and Panama.

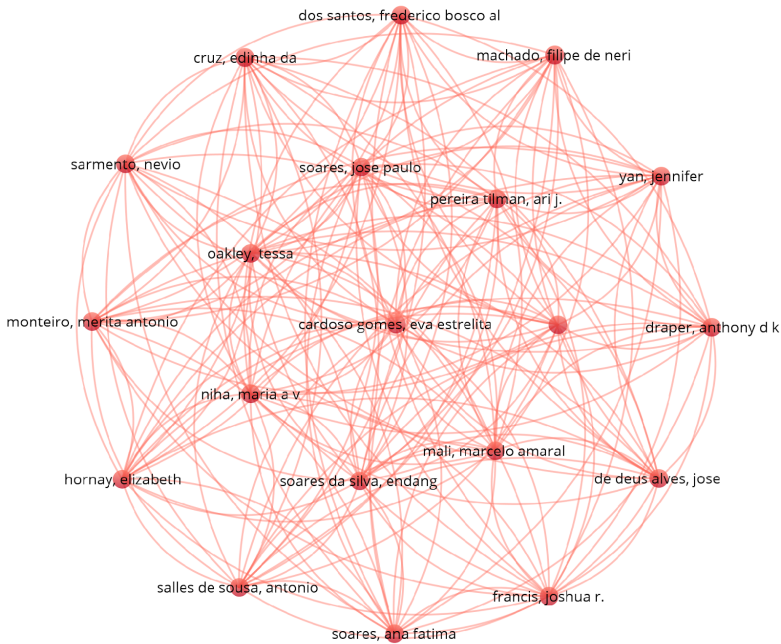


Figure 5. Network map based on authors (*VOSViewer analysis*)

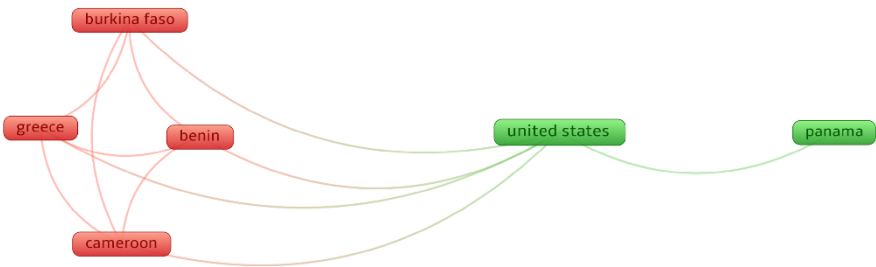


Figure 6. Network map based on countries (*VOSViewer analysis*)

3.4 Network Map Based on Keywords

The co-occurrence maps in Figure (6) and Table (2) identified three clusters with correlated keywords and different themes. The first theme was *Aedes-Wolbachia*, the second was Zika-*Wolbachia*, and the third was dengue virus and humans.

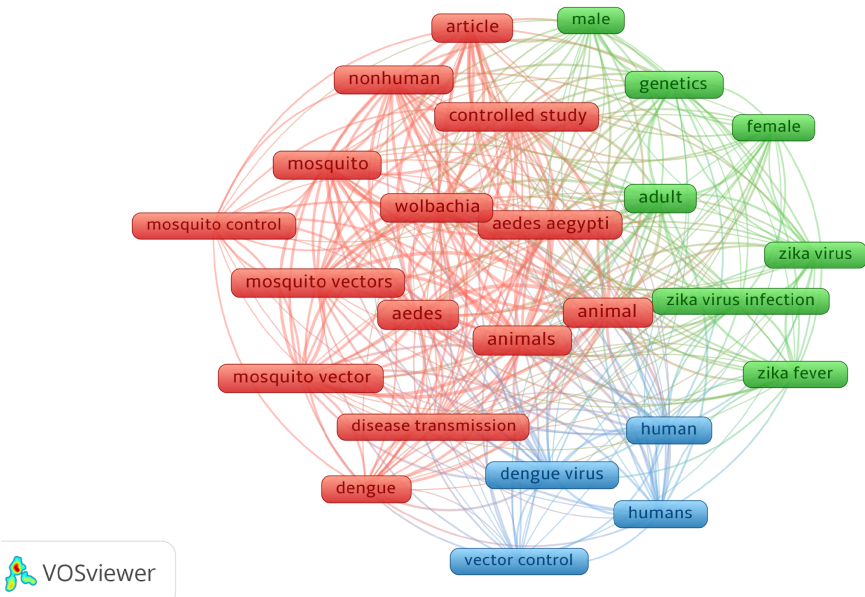


Figure 7. Network map based on keywords (VOSViewer analysis)

The results of the mapping revealed that *Wolbachia-Aedes* is not only associated with the dengue virus but also with the Zika virus. Previous research demonstrated that the *w*Mel strain of *Wolbachia* can reduce the transmission of Zika virus by *Aedes aegypti* [17].

Table 2. Three clusters of keywords related to *Wolbachia-Aedes* innovation

| Cluster | Color | Keywords |
|--------------------------------------|-------|---|
| <i>Aedes-Wolbachia</i> (14 keywords) | Red | <i>Aedes</i> , <i>Aedes aegypti</i> , animal, animals, article, controlled study, dengue, disease transmission, mosquito, mosquito control, mosquito vector, mosquito vectors, nonhuman, <i>Wolbachia</i> |
| Zika- <i>Wolbachia</i> (7 keywords) | Green | Adult, female, genetics, male, zika virus, zika fever, zika virus infection |
| Dengue virus and humans (3 keywords) | Blue | Dengue virus, human, human control, vector |

4 Conclusion

The results of this study revealed 568 published documents related to *Wolbachia-Aedes* innovation globally, with 32 publications from Indonesia between 2014 and 2024. Research on this topic covers a wide range of subjects and is carried out by various countries worldwide. Further research using a systematic review approach is needed to evaluate the effectiveness of and strategies for implementing the *Wolbachia-Aedes* innovation, as well as to assess potential risks, impacts, and benefits of implementing this innovation.

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7 Conflict of Interest

The authors declare no conflict of interest in this study.

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