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REVIEW ARTICLE

Dominance of filariasis vector spread in endemic regions of Indonesia

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Abstract
The number of filariasis cases in Indonesia is increasing every year. This is especially true for people living in mosquito breeding areas, both artificial and natural, coupled with low knowledge and awareness of personal and environmental hygiene. The results of this review of various sources are expected to provide input for policy makers in mapping and determining filariasis vectors, so that vector control efforts can be carried out in an appropriate manner to break the chain of transmission and achieve the elimination target of this disease. This study used a systematic review method. The data used were secondary data in the form of research results published in electronic journals. Culex sp. has a wide distribution area and was found in every study, even dominating 8 out of 13 studies conducted. In general, the spread of filariasis disease in the tropics and subtropics, especially in countries with a middle to lower income index. Given this, it is important to map the distribution of filariasis vectors by geographical region, as it can help identify areas that require special treatment.

Keywords: Filariasis Cases, Culex sp., Filariasis Vector, Indonesia

INTRODUCTION

The number of filariasis cases in Indonesia is increasing every year. This is especially true for people living in mosquito breeding areas, both artificial and natural, coupled with low knowledge and awareness of personal and environmental hygiene. Filariasis cases in Indonesia fluctuated between 2010-2014, with a significant increase in 2014 reaching 14,932 cases. In 2014, three provinces had the highest prevalence, namely East Nusa Tenggara with 3,175 cases, Aceh with 2,375 cases, and West Papua with 1,765 cases (Ipa et al., 2016). In 2018, 236 out of a total of 514 districts in Indonesia were categorized as areas endemic to certain diseases (Aisyah et al., 2022). Two years later, more precisely in 2020, Filariasis disease attacked 38 people in Kolaka Regency (Southeast Sulawesi), with the majority of sufferers being male spread across 12 sub-district areas (Hapsir et al., 2022).

Understanding the epidemiology of the spread of filariasis agents, especially in endemic zones, is an important component in planning and implementing filariasis elimination programs. For this reason, it is necessary to review various references to identify the distribution of vectors that have been proven to transmit filariasis.

Identification of filariasis endemic areas through geographic mapping is a crucial early stage in vector elimination and control programs. This process involves recognizing key vector species and high transmission sites (Davis et al., 2021). This allows for targeted allocation of resources to those areas most in need of treatment (Srividya et al., 2019).

The results of this review of various sources are expected to provide input for policy makers in mapping and determining filariasis vectors, so that vector control efforts can be carried out in an appropriate manner to break the chain of transmission and achieve the elimination target of this disease.

MATERIALS AND METHODS

Study Method

This study uses a systematic review method. The data used were secondary data in the form of research results published in 13 electronic journals. The keywords used to obtain journals were "Filariasis vectors, Filariasis disease in endemic areas in Indonesia". The population in the study consisted of articles published on Google scholar, PubMed, and several other journal sites that have related topics.

RESULTS AND DISCUSSION

Filariasis Disease

Filariasis, also known as elephantiasis, is a parasitic and chronic disease. Filariasis is caused by infection with filarial worms, such as Wuchereria bancrofti, Brugia malayi, and Brugia timori, which are transmitted through the bites of mosquitoes of various species, including Culex, Anopheles, Mansonia, and Aedes (Ramadhani and Wahyudi, 2015). In general, filariasis disease spreads in tropical and subtropical areas, especially in countries with low to middle income indices (Jones et al., 2018).

The disease is transmitted to humans through mosquitoes as vectors. The main vectors of filariasis transmission have been reported as 457 species consisting of 125 species of Aedes aegypti, 82 species of Culex, 80 species of Anopheles and 8 species of Mansonia. In general, endemic areas have one mosquito species that acts as the main vector and other species act as potential vectors (Ramadhani and Wahyudi, 2015).

Mosquito Species in Filariasis Endemic Areas

Research results from 13 journals in filariasis endemic areas in Indonesia show that each region has different types of mosquitoes as vectors of disease transmission. The results showed that there are several mosquitoes that act as agents of filariasis transmission from four species groups, including Mansonia, Culex, Aedes, and Anopheles. Culex sp. has a wide distribution area and was found in every study, even dominating 8 out of 13 studies conducted. The areas that became inspection sites included Demak, Pekalongan, Mamasa, Tabalong, Barito Kuala, North Aceh, Balangan, and Bandung City (Wulandari, 2020).

In Indonesia, Culex mosquitoes are the main vector of filariasis transmission and are most commonly found. The presence of dominant mosquito species in an area needs serious attention because they are potential vectors of filariasis (Fitriyana et al., 2018). The discovery of Aedes mosquitoes in some studies requires special attention. Since microfilariae have a nocturnal periodicity, this vector actively seeks prey at night (Rahmawati et al., 2017). However, mosquito bite prevention efforts need not only be carried out at night, but also throughout the day, from morning to evening.

An in-depth cognitive level of the nature and character of mosquito species is essential to understand their habits and behavioral patterns. Mosquito bionomics is region-specific, meaning that even if the species is the same, its behavior may vary between sites (Ridha, 2018). Knowledge of vector behavior patterns can be used to design effective prevention strategies to minimize interactions between humans and filariasis vectors.

Mosquito Biting Rate and Man Hour Density

Mosquito bite rates can be measured using two methods, namely Man Biting Rate (MBR) which calculates the number of bites per person per day, and Man Hour Density (MHD) which calculates the number of bites per person per hour (Juhairiyah et al., 2018). Meanwhile, Culex sp. mosquitoes were found to have the highest density in 8 studies, with the highest number recorded in Pekalongan City as well as Mamasa (Ridha and Sembiring, 2019).

Mosquito population density showed significant differences between regions. High mosquito population is one of the indicators that determine the potential of mosquitoes as filariasis vectors. High mosquito density is directly proportional to the possibility of contact with humans, which in turn increases the risk of transmission of filariasis parasites (Ramadhani and Wahyudi, 2015).

According to research Astuti et al. (2017), hourly fluctuation patterns of filariasis vector mosquito density provide important information in understanding the potential transmission of the disease.

Environmental factors in the study area have a significant influence on mosquito density. There is a negative correlation between altitude and mosquito population; the higher the altitude, the lower the mosquito population. This phenomenon is closely related to environmental temperature conditions (Kinansi et al., 2018). Based on a Wulandari et al., 2020, mosquitoes require specific conditions to breed optimally, namely at an altitude of 300-2000 meters above sea level with a temperature range of 20-30°C, both for the aquatic and adult phases.

Microfilariae Transmission Rate

Within the scope of two inspections, test results for microfilariae infection in mosquitoes were found. 39 L2 and L3 microfilariae were found in Culex quinquefasciatus mosquitoes in Bumirejo, Kertoharjo, and Jenggot villages, Pekalongan City (Nurjazuli, 2021). On the other hand, an L3 microfilariae infection rate of 8% was obtained in four out of 50 Anopheles barbirostris mosquitoes examined in Mamuju district (Wulandari, 2020).

The presence of microfilariae in mosquitoes is the main criterion for determining their status as filariasis vectors. There are two testing methods required to detect microfilariae in mosquitoes, namely by surgical techniques or by Polymerase Chain Reaction (PCR) analysis. Filarial worm density in humans is associated with the likelihood of microfilariae infection in mosquitoes. This factor correlates with the nocturnal nature of microfilariae and mosquito activity patterns that are more dominant at night (Rahmawati et al., 2017). Filariasis transmission reaches optimal effectiveness when the concentration of filarial parasites in the blood of patients is in the range of 1-3 mf/μl (Portunasari et al., 2016).

Birth Rate and Mosquito Lifespan

Mosquito dissection showed variation in results across different study sites. Some studies found mosquitoes that have completed the gonotropic cycle with adequate age to become filariasis vectors. In Tanah Bumbu, Mansonia uniformis mosquitoes had the highest parity rate with an estimated lifespan of 42.43 days, while Culex quinquefasciatus mosquitoes had an estimated lifespan of 47.96 days (Fadilly et al., 2019). Studies in Pekalongan City confirmed similar findings, where among the various mosquito species caught, Culex quinquefasciatus exhibited the highest parity and longer life span (Ramadhani and Wahyudi, 2015).

Parity status or parity level serves as an indicator to estimate the age of a mosquito and its daily survival rate. The daily survival probability gives an idea of the mosquito's ability to survive in the future. A very important factor is the mosquito's life duration, as it takes a long time for the parasite to complete its life cycle within the mosquito. Thus, the longer the mosquito's lifespan, the greater its potential to become a vector of filariasis (Ramadhani and Wahyudi, 2015).

Spatial Distribution of Filariasis Disease Vector

Based on the results of research in 13 endemic sites, four mosquito genera were captured, namely Aedes, Anopheles, Culex, and Mansonia. To determine the distribution pattern of mosquitoes in the study area, a mapping analysis was conducted. The mapping focused on the most abundant mosquito genus found in each study site. In analyzing the spatial pattern of filariasis vectors in endemic areas in Indonesia using the overlay method (Wulandari, 2020).

An overlay method was conducted by combining maps of endemic areas with mosquito finding sites, focusing on the dominant genus and microfilariae-positive mosquitoes. Spatial distribution analysis showed that mosquito concentration correlated with high filariasis cases. In terms of distribution, the genus Culex and Mansonia have a wide distribution area. Specifically, the dominance of Culex mosquitoes was seen in five regions in Indonesia, namely South Kalimantan, Aceh, Central Java, West Java and West Sulawesi. Meanwhile, Mansonia dominance was found in South Kalimantan and South Sumatra. On the other hand, Anopheles and Aedes showed a narrower distribution. Anopheles is the dominant species in three regions, namely Papua, NTT, and South Sumatra. Two mosquito species act as vectors of disease transmission, namely Culex quinquefasciatus in Pekalongan and Anopheles barbirostris in Mamuju District, West Sulawesi (Wulandari, 2020).

The spread of filariasis spreading agents will always be closely related to the emergence of several filariasis cases in an area. In the vicinity of filariasis patients, mosquitoes infected with filarial worms are found. The presence of mosquitoes that have been proven to be carriers of this disease in an area can increase the risk of filariasis transmission. This puts people who live near the habitat of filarial worm-carrying mosquitoes at high risk of contracting the disease. The Culex quinquefasciatus mosquito, which is a domestic species, can fly as far as 900 meters. This ability to fly greatly influences how widely the mosquito spreads (Dida et al., 2018).

Mosquito population density is influenced by several factors, including vector species distribution, habitat preference, and susceptibility to microfilariae. In addition, filariasis transmission is also influenced by geographical location, where Anopheles mosquitoes are more commonly found in rural areas, while Culex mosquitoes are more commonly found in urban areas. Urban areas, especially slums with high population density and poor drainage systems, are ideal habitats for Culex quinquefasciatus mosquitoes that act as vectors of filariasis transmission (Tallan and Mau, 2016).

Knowledge of the distribution pattern of filariasis vectors plays an important role in the implementation of elimination programs. Special attention needs to be given to areas that share the same filariasis and malaria vector species, as mass treatment programs risk worsening the malaria disease situation. To overcome this, the implementation of mass treatment or Mass Drug Administration (MDA) in these areas needs to be integrated with vector control efforts (Wulandari et al., 2020).

Vector control efforts can be carried out through two main methods. First, the use of Long-Lasting Insecticide-Treated Bed Nets (LLINs). Second, indoor residual spraying of insecticides. Both methods are highly effective for controlling mosquitoes that have a habit of staying or resting inside the house (Tananchai et al., 2019). For urban areas with dense populations and poor drainage systems that harbor Culex mosquitoes, one control strategy is to modify the environment to reduce potential breeding sites. Meanwhile, to control Mansonia mosquitoes, which are mostly found in humid and watery areas, it can be done by destroying swamp vegetation and utilizing larval fish to reduce the number of larvae. As for the Aedes mosquito, which is widely spread in rural areas and breeds in places or containers containing clean water, control can be done through the mosquito nest eradication program and the installation of wire mesh in the gaps of the house (home screen) to prevent mosquitoes from entering (Wulandari et al., 2020).

The strategy of controlling filariasis through mass treatment and vector control aims to minimize transmission by reducing the prevalence of filaria in humans and reducing interactions between vectors and humans. This strategy is reinforced by research findings on the vector-parasite system, which show that vectors can effectively transmit infection even under conditions of low microfilariae levels. The relationship between vectors and parasites can be understood through two processes that are interrelated with population density, namely facilitation and limitation (Wulandari, 2020). Facilitation is a process that occurs when the number of microfilariae is below a certain minimum limit, thus interfering with the ability of Anopheles vectors. On the other hand, limitation is a process that occurs when microfilariae numbers are low, but disease transmission continues, as occurs in Culicinae mosquitoes (Wulandari et al., 2020)

The success of filariasis control depends on the ability to reach a breakpoint, where the prevalence of filarial worms in humans decreases below the minimum threshold of transmission. Therefore, filariasis elimination programs must be adapted to local geographical conditions and characteristics to ensure program success.

CONCLUSIONS

The distribution of filariasis vectors has a pattern in line with the emergence of filariasis cases, with the range of spread extended by the flight capabilities of mosquitoes. Given this, it is important to map the distribution of filariasis vectors by geographical area, as it can help identify areas that require special handling. This mapping approach can optimize the use of resources and manpower, especially in areas facing endemic problems from a number of diseases spread by intermediate agents such as malaria, dengue fever and filariasis simultaneously. Furthermore, data on the distribution pattern of filariasis vectors can provide a clear picture of the potential transmission of this disease in an area.

Author contributions

Zhakia Rahma Ghani: Conceptualization, analysis, draft writing, and editing; Yauwan Tobing Lukiyono: Conceptualization and analysis.

Conflict of Interest

There is no conflict of interest in this study.

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Data availability

Data related to the findings of this study are available at the corresponding author.

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