

Sequential Neighborhood Filariasis Transmission in Coastal Areas of Demak Regency, Indonesia

1st Arum Siwiendrayanti
*Environmental Health Division,
 Public Health Science
 Department,
 Universitas Negeri Semarang
 Semarang, Indonesia
 a_shiwi@mail.unnes.ac.id*

2nd Eram Tunggul Pawenang
*Environmental Health Division,
 Public Health Science
 Department,
 Universitas Negeri Semarang
 Semarang, Indonesia
 eramtepe@mail.unnes.ac.id*

3rd Rudatin Windraswara
*Environmental Health Division,
 Public Health Science
 Department,
 Universitas Negeri Semarang
 Semarang, Indonesia
 rudatin@mail.unnes.ac.id*

4th Yuni Wijayanti
*Environmental Health Division,
 Public Health Science
 Department,
 Universitas Negeri Semarang
 Semarang, Indonesia
 yuniwija@mail.unnes.ac.id*

Abstract— Filariasis endemic area in Central Java, Indonesia, became wider from 2 regencies/cities to 9 regencies/cities. Most of the new filariasis regencies are coastal areas which have suitable sites for mosquito's breeding and resting places. This study aimed to analyze neighborhood filariasis transmission in 2016-2018 in 4 coastal districts in Demak Regency, Central Java, Indonesia. It was observational study with spatiotemporal approach. Filariasis case documentation, observation and spatial mapping with ArchGIS and GPS were used to collect the data. The result showed that the location of 2017-filariasis-cases were within 1.5-2.6 km from 2016-filariasis-cases. The location of 2018-filariasis-cases were within 1.4-2.6 km from 2017-filariasis-cases. The closest filariasis case from coastline were within 1 km radius. The distances between nearest cases were 1.2 km in 2016, 0.2 km in 2017, and 6.4 km in 2018. Those are in the range of *Culex sp.* and *Anopheles sp.* flight distance. It was concluded that environmental condition in filariasis cases surroundings were suitable for mosquitoes' breeding and resting places. The environmental condition has not been changed in years and expedited filariasis transmission for the next year. Environmental condition had important role as filariasis transmission media.

Keywords—*filariasis, coastal area, Demak Regency*

I. INTRODUCTION

Filariasis is an infection caused by filarial worms human or animal body. Its presence in blood and lymph gland can result in enlargement of some body parts which will grow to disability and unproductivity. Filarial worms are transmitted through various mosquitoes (i.e. *Anopheles sp.*, *Culex sp.*, *Aedes sp.*, *Mansonia* and *Armigeres*) [1]–[3].

Mf-rate or Microfilaria rate is the percentage of microfilarial positive blood sample in an area. Area with Mf-rate >1% is stated as filariasis endemic area. WHO instructs areas with Mf-rate >1% to hold Mass Drug Administration (MDA) for minimally 5 years. It is adopted by Indonesia government that all the society of cities and regencies with Mf-rate >1% should take MDA for 5 years. The 5-year period will be evaluated and should be continued with the next MDA period when the evaluation still results in Mf-rate >1% [1], [4].

Indonesia's MDA coverage increased from 37.7% in 2011 to 73.9% in 2014, but in the contrary, the number of

Indonesia's filariasis case increased from 11,902 in 2012 to 14,932 in 2014. It could occur when filariasis elimination efforts only prior MDA without strengthening environmental control. Environmental control is very important in filariasis elimination because mosquitoes need specific environmental condition as their breeding and resting places. Climate change also contributes to expand suitable areas for mosquitoes breeding and resting. Some studies indicated mosquitoes' adaptation (*Aedes*, *Anopheles* and *Culex*) that they can breed in brackish water and being survived in inappropriate conditions [5]–[9]. Mosquitoes' insecticide resistance was also reported [10].

Indonesia has more than 17,000 islands. Filariasis usually occurs in non-Java Islands because they have suitable wide spaces for mosquitoes' breeding and resting, such as swamp, forest, and shrub. Java Island is one of the biggest islands in Indonesia. It is the center of development, but filariasis still occurs. Central Java Province in 2010 had Pekalongan City and Pekalongan Regency as filariasis endemic areas. They had held MDA for 5 years (2011-2015), but it could not decrease the Mf-rate and the filariasis case number. They were asked for continuing holding MDA. It seems not works optimally that filariasis endemic area in Central Java Province become wider. It is reported in Central Java Health Profile that Central Java Province in 2017 had Pekalongan City, Pekalongan Regency, Demak Regency, Pati Regency, Brebes Regency, Semarang Regency, Grobogan Regency, Blora Regency, and Wonosobo Regency.

Most of the 9 filariasis endemic areas in Central Java Province are coastal areas (Pekalongan City, Pekalongan Regency, Demak Regency, Pati Regency, Brebes Regency) and areas which bordered with coastal areas (Semarang Regency, Grobogan Regency, Blora Regency). Settlement in coastal areas mostly have sanitary problem because of the limitation in socioeconomics and tidal flood. Tidal flood will fill little spaces on stone basins, wood pieces, wreckages, and others then become mosquitoes' breeding places. The society of coastal settlement commonly cannot do enough efforts for solving this problem because of their limitation in socioeconomics. The same condition also occurs to uncontrolled shrubs, unseparated cattle from house, and others which become mosquitoes' resting places [11]–[13]. Those

neglected conditions predicted to be media of filariasis transmission in their neighborhood in years.

Demak Regency is one of filariasis endemic area in Central Java. It is bordered with Java Sea in north side. Its number of filariasis cases in 2017 was 35. Most of the cases were located on coastal areas. Sayung District, Bonang District, Wedung District, and Karangtengah District are located on coastal area. They had greatest number of filariasis case in Demak Regency. This study aimed to analyze neighborhood filariasis transmission in 2016-2018 in the 4 coastal districts in Demak Regency, Central Java, Indonesia.

II. MATERIALS AND METHODS

It was observational study with spatiotemporal approach. Filariasis case documentation, observation and spatial mapping with ArchGIS and GPS were used to collect the data. This study was set in 4 coastal districts of Demak Regency, i.e: Sayung District, Karangtengah District, Bonang District, and Wedung District. Total sampling was performed and had 15 filariasis patients as samples. They were filariasis patients of year 2016, 2017, and 2018 in the 4 studied districts. Information about name and address of filariasis patients were collected from Demak Regency Health Office. The patient’s address coordinates were marked spatially with GPS. The coordinate data were transferred and processed with ArchGIS. Data of 2016 filariasis cases were figured as red dots, the 2017 ones were figured as green dots, and the 2018 ones were figured as black dots. Black lines were drawn to describe the distances between later cases and previous cases. Blue lines were drawn to describe the distances between cases in the same year.

III. RESULTS AND DISCUSSIONS

There were 15 filariasis patients as samples in this study. Wedung District had 2 cases only in 2016. Those cases were separated with 5.5 km distance (Fig.1). Wedung District had no filariasis case in 2017 and 2018. Karangtengah District had 1 case only in 2017, and the patient had been passed away in 2018. It might be the reason that no filariasis case in the next year in Karangtengah District. Sayung District had the greater number of filariasis cases in 2016 (4 cases), had 1 case in 2017, and had none in 2018. Bonang District had filariasis cases in 2016-2018. It had the greatest number of total filariasis case in 2017-2018. It also had annual cases in every year of 2016-2018. It had 3 cases in 2016, 2 cases in 2017, and 2 cases in 2018. These conditions were simply concluded that the greater number of filariasis cases, the higher probability to have new filariasis case in the next year. Previous patient is the source of agent (microfilariae worm) for the next patient [14]. Mosquitos will bite the previous patient and take the microfilariae with. Then they will bite other people and insert the microfilariae in. Interaction among some risk factors will allowed the bitted people to be the next filariasis patients. The more one get bitted, the higher risk of filariasis infection [15]. The distribution of district, and the year of case are provided in Table I.

TABLE I. DISTRIBUTION OF FILARIASIS CASES BY DISTRICT AND YEAR

District	2016	2017	2018	Total
Sayung	4	1	0	5
Karangtengah	0	1	0	1
Bonang	3	2	2	7
Wedung	2	0	0	2
Total	9	4	2	15

The distances between nearest cases were 1.2 km in 2016, 0.2 km in 2017, and 6.4 km in 2018. The nearest distance between 2016 case and 2017 case was 1.5 km. The nearest distance between 2017 case and 2018 case was 2.6. The nearest distance between 2016 case and 2018 case was 1.4. The details of distances between nearest cases are delivered in Table II.

TABLE II. DISTANCES BETWEEN NEAREST CASES

Distance (km)	2016	2017	2018
2016	1.2	1.5	1.4
2017		0.2	2.6
2018			6.4

Fig. 1 showed the coordinate position of each patient houses in 2016-2018 of Sayung District, Wedung District, Bonang District, and Karangtengah District. Data of 2016 filariasis cases were figured as red dots, the 2017 ones were figured as green dots, and the 2018 ones were figured as black dots. Black lines were drawn to describe the distances between later cases and previous cases. Blue lines were drawn to describe the distances between cases in the same year.

Sayung District had 4 filariasis cases in 2016. Three of them were clustered with distance of 1.2-4.7 km between cases. They were located 1-2 km from coastline. The other one was separated more than 6 km. Sayung District had 1 filariasis case in 2017. It was surrounded by the three 2016 clustered cases with distance of 2.6-4.0 km between later and previous cases. *Culex sp.* and *Anopheles sp.* probably had contribution in filariasis transmission in Sayung District referred to the flight distance of them. The flight distance of *Anopheles sp.* was reported as 0.5-2.0 km by Okorie et al. (2014) and reported as 1.0-3.0 km by World Health Organization (2013) [15], [16]. The flight distance of *Culex sp.* was reported as 0-200 m by World Health Organization (2013) and reported as 0.42-1,2 km by Tsuda et al (2008) [15], [17]. Another study by Verdonschot & Anna (2014) reported that the average flight distance of *Culex sp.* is 0.5-5.0 km and 6.2-19.2 km especially for *Culex annulirostris* [18]. The 2017 case which was surrounded by three 2016 cases indicated the constancy between years of microfilariae worm presence in human blood. Mosquito will transmitted the microfilariae worm from previous patient to the later patient [15]. It might be supported by environmental condition which suitable for mosquito’s breeding and resting places [12], [19]. Sayung District was reported annually suffered from tidal flood. Many people had already moved to other area [20]. In other hand, there were two probability about the separated 2016 case. The first probability was that it probably in clustered with other cases in the bordered district. The second probability was that it was still in the range of *Culex sp.* maximum flight distance [18].

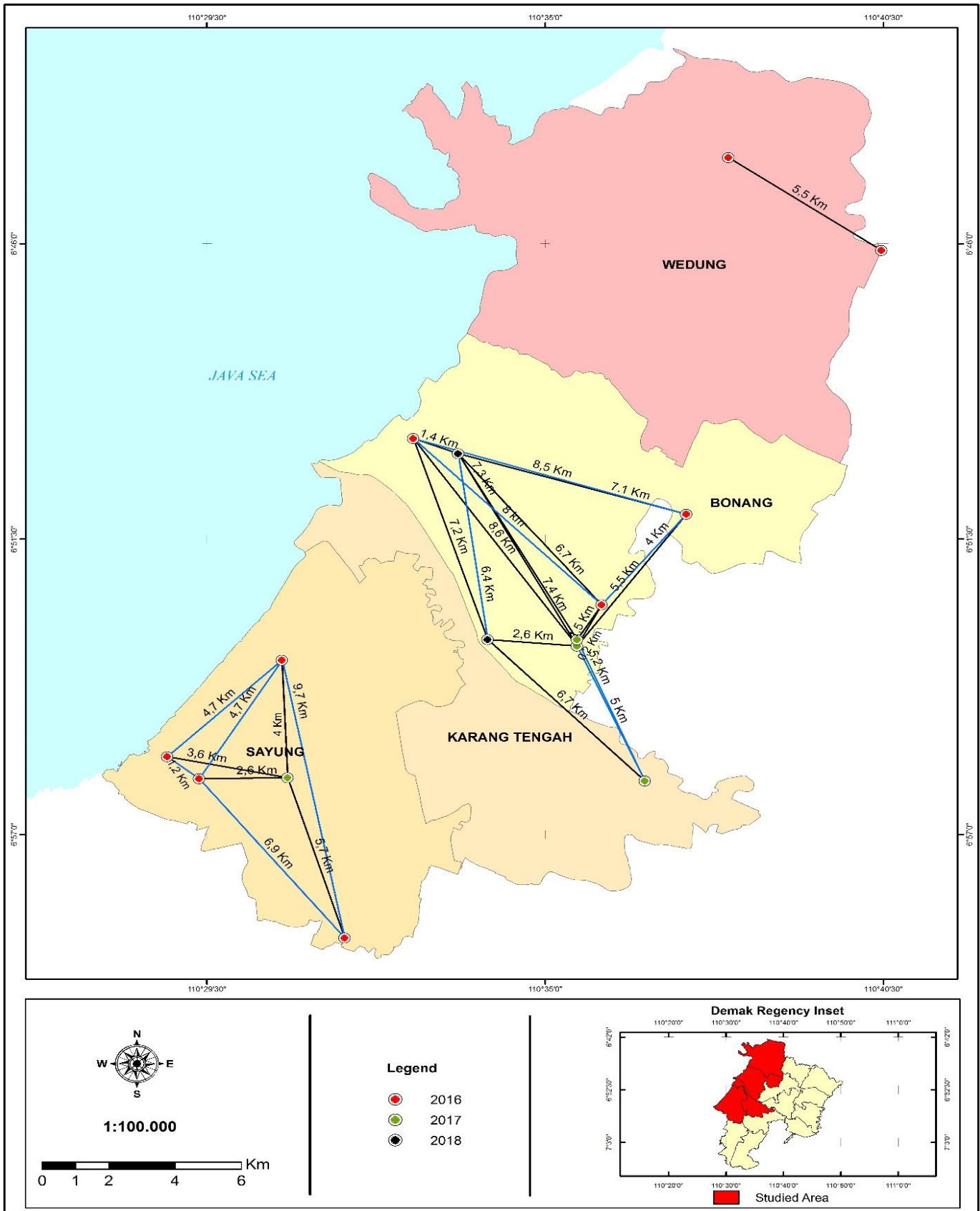


Fig. 1. Sequential neighborhood filariasis transmission.

Bonang District had 3 sporadic filariasis cases in 2016. One of them was located less than 1 km from coastline, and the other two were located 6.7 km and 7.1 km from the first case. They were near the border with Demak District. That distance was in the range of *Culex sp* [18]. It also could be indicated that the transmission source of the two 2016 filariasis case in Bonang District was from Demak District. Bonang District had 2 filariasis cases which located near the border with Demak District and in 1.5 km radius from the 2016 cases. The two 2017 cases were also only separated 0.2 km. It was in the range of *Culex sp.* and *Anopheles sp.* flight distance and it seemed that they were clustered in a suitable environment for mosquito breeding and resting place. Bonang District had 2 filariasis cases in 2018. One of them was located about 2 km from coastline and 1.4 km from a 2016 filariasis case. The 2018 another case was located 2.6 km from 2017 cases. Those were in the range of *Culex sp.* and *Anopheles sp.* flight distance. Those patterns showed that in Bonang District, there were 2 clusters of filariasis cases. One cluster was near coastline and the another was near the border with Demak District.

Karangtengah District only had one filariasis case in 2017. The patient then passed away in 2018. It could be the reason of no new filariasis case in 2018. Mosquito with no microfilariae worm in it will not transmit filariasis through its bite [15]. The case coordinate position was close to district border and in 5 km radius from 2017 filariasis case of Bonang District. That distance was in the range of *Culex sp* [18]. It also could be indicated that the transmission source of filariasis case in Karangtengah District was from other districts (Bonang District, Demak District, Guntur District, and Wonosalam District). The case coordinate position was far enough from coastline. It was a different pattern from Sayung District and Bonang District which some of the filariasis cases were in 1-2 km radius from coastline.

Wedung District had 2 sporadic filariasis cases only in 2016. They were separated 5.5 km. Their locations were far from coastline. One of them was exactly on the border with Mijen District and Jepara Regency. Another case was about 5 km from the first case, Jepara Regency, and the coastline. Although it was still in the range of *Culex sp.* flight distance, but it seemed not supported by suitable environment for mosquitos breeding and resting place. It was proved with no later cases in 2017 and 2018 [11], [18], [21]. A crosscheck was needed to confirm if they were immigrant cases from other areas.

This study only analyzed filariasis transmission from patients' house position in 4 coastal districts of Demak Regency in 2016-2018. This study will be continued with project which analyze the presence of breeding and resting places of *Culex sp.* and *Anopheles sp.* on patients' surrounding, the society behavior, the presence of filarial worm in mosquitos collected from patients' surrounding, and the specific coastal characteristics which related to filariasis transmission.

IV. CONCLUSIONS AND SUGGESTION

The filariasis sequential transmission of the 4 coastal districts in 2016-2018 were in the range of *Culex sp.* and

Anopheles sp. flight distance. Some of filariasis cases in Bonang District and Sayung District were 1-2 km from coastline. It was concluded that environmental condition in filariasis cases surroundings were suitable for mosquitoes' breeding and resting places. The environmental condition has not been changed in years and expedited filariasis transmission for the next year. The greater number of filariasis cases, the higher probability to have new filariasis case in the next year. Environmental condition had important role as filariasis transmission media. Environmental control is needed to minimize the site number and vastness of *Culex sp.* breeding and resting places.

REFERENCES

- [1] World Health Organization, *Global Programme to Eliminate Lymphatic Filariasis: Managing Morbidity and Preventing Disability*. Geneva-Switzerland: Department of Control of Neglected Tropical Diseases (NTD) World Health Organization, 2013.
- [2] B. V. Babu, A. N. Nayak, K. Dhal, A. S. Acharya, P. K. Jangid, and G. Mallick, "The economic loss due to treatment costs and work loss to individuals with chronic lymphatic filariasis in rural communities of Orissa, India," *Acta Trop.*, vol. 82, no. 1, pp. 31–38, 2002.
- [3] B. V. Babu, B. K. Swain, and K. Rath, "Impact of chronic lymphatic filariasis on quantity and quality of productive work among weavers in an endemic village from India," *Trop. Med. Int. Heal.*, vol. 11, no. 5, pp. 712–717, 2006.
- [4] Kementerian Kesehatan RI, *Rencana Nasional Program Eliminasi Filariasis 2010 - 2014 (National Plan Filariasis 2010-2014-Indonesia)*, Jakarta: Subdit Filariasis dan Schistosomiasis. Direktorat P2B2. Ditjen PP&PL. Kemenkes RI, 2010.
- [5] T. Mariappan, V. Thenmozhi, P. Udayakumar, and V. Bhavaniamadevi, "An observation on breeding behaviour of three different vector species (*Aedes aegypti* Linnaeus 1762, *Anopheles stephensi* Liston 1901 and *Culex quinquefasciatus* Say 1823) in wells in the coastal region of Ramanathapuram district, Tamil Nadu, India," *Int. J. Mosq. Res.*, vol. 2, no. 2, pp. 42–44, 2015.
- [6] P. J. Jude *et al.*, "Salinity-tolerant larvae of mosquito vectors in the tropical coast of Jaffna, Sri Lanka and the effect of salinity on the toxicity of *Bacillus thuringiensis* to *Aedes aegypti* larvae," *Parasites and Vectors*, vol. 5, no. 1, pp. 2–9, 2012.
- [7] M. De Brito Arduino, L. F. Mucci, L. L. N. Serpa, and M. De Moura Rodrigues, "Effect of salinity on the behavior of *Aedes aegypti* populations from the coast and plateau of southeastern Brazil," *J. Vector Borne Dis.*, vol. 52, no. 1, pp. 79–87, 2015.
- [8] R. Ramasamy and S. N. Surendran, "Global climate change and its potential impact on disease transmission by salinity-tolerant mosquito vectors in coastal zones," *Frontiers in Physiology*. 2012.
- [9] M. C. I. Medeiros, E. C. Boothe, E. B. Roark, and G. L. Hamer, "Dispersal of male and female *Culex quinquefasciatus* and *Aedes albopictus* mosquitoes using stable isotope enrichment," *PLoS Negl. Trop. Dis.*, 2017.
- [10] Y. Li *et al.*, "Evidence for multiple-insecticide resistance in urban

- Aedes albopictus* populations in southern China,” *Parasites and Vectors*, vol. 11, no. 1, pp. 1–10, 2018.
- [11] A. Siwiendrayanti, E. T. Pawenang, and S. Indarjo, “Spatial analysis and behavior evaluation to identify differentiating factors of Filariasis endemic status,” *Adv. Sci. Lett.*, vol. 23, no. 4, pp. 3349–3354, 2017.
- [12] N. Khikmah and E. T. Pawenang, “Review of environmental aspects and community behavior in the determination of Filariasis risk vulnerability zone,” *Unnes J. Public Heal.*, vol. 7, no. 1, pp. 38–49, 2018.
- [13] N. Nurjazuli, O. Setiani, and R. Lubis, “Analysis of Lymphatic Filariasis transmission potential in Pekalongan City , Central Java , Indonesia,” *Asian J. Epidemiol.*, vol. 11, no. 1, pp. 20–25, 2018.
- [14] N. A. Ike Ani Windiastuti, Suhartono, “Hubungan Kondisi Lingkungan Rumah , Sosial Ekonomi , dan Perilaku Masyarakat dengan Kejadian Filariasis di Kecamatan Pekalongan Selatan Kota Pekalongan (The Association between Environmental House Condition , Socio-economic , and Behaviour Factors with Filariasis in the South Pekalongan District of Pekalongan City),” *J. Kesehat. Lingkung. Indones.*, vol. 12, no. 1, pp. 51–57, 2013.
- [15] World Health Organization, *Lymphatic filariasis: A handbook of Practical Entomology for National Lymphatic Filariasis Elimination Programmes*, Geneva-Switzerland: WHO Press, 2013.
- [16] P. N. Okorie, K. O. K. Popoola, O. M. Awobifa, K. T. Ibrahim, and G. O. Ademowo, “Species composition and temporal distribution of mosquito populations in Ibadan, Southwestern Nigeria,” *J Entomol Zool Stud*, vol. 2, no. 4, pp. 164–169, 2014.
- [17] Y. Tsuda *et al.*, “A Mark–Release–Recapture Study on Dispersal and Flight Distance of *Culex pipiens pallens* in an Urban Area of Japan,” *J. Am. Mosq. Control Assoc.*, vol. 24, no. 3, pp. 339–343, Sep. 2008.
- [18] P. F. M. Verdonchot and A. A. Besse-lototskaya, “Flight distance of mosquitoes (Culicidae): A metadata analysis to support the management of barrier zones around rewetted and newly constructed wetlands,” *Limnologica*, vol. 45, pp. 69–79, 2014.
- [19] S. A. Wulandhari and E. T. Pawenang, “Analisis Spasial Aspek Kesehatan Lingkungan Dengan Kejadian Filariasis Di Kota Pekalongan (Spatial Analysis of Environmental Health Aspects with Filariasis in Pekalongan City),” *Unnes J. Public Heal.*, vol. 6, no. 1, pp. 59–67, 2017.
- [20] A. Siwiendrayanti, E. T. Pawenang, S. Indarjo, R. Windraswara, and U. N. Semarang, “Edukasi Pencegahan Filariasis dengan Buku Saku Mandiri di Wilayah Endemis Filariasis Kabupaten Demak (Education of Filariasis Prevention with the Independent Pocket Book in the Filariasis Endemic Region of Demak),” *ABDIMAS J. Pengabd. Kpd. Masy.*, vol. 23, no. 2, pp. 107–111, 2019.
- [21] Y. Syuhada, Nurjazuli, and N. E. W, “Studi Kondisi Lingkungan Rumah dan Perilaku Masyarakat Sebagai Faktor Risiko Kejadian Filariasis di Kecamatan Buaran dan Tirto Kabupaten Pekalongan (Study Of Environmental And Behavioral As Risk Factor Of Filariasis In District Of Buaran And Tirto Pekalongan),” *Kesehat. Lingkung. Indones.*, vol. 11, no. 1, pp. 95–101, 2012.