Advances in Health Sciences Research, volume 24
5th Universitas Ahmad Dahlan Public Health Conference (UPHEC 2019)

Receptivity Status of Malaria Transmission Toward Malaria Elimination in Indonesia

Wiwik Trapsilowati
Institute for Vector and Reservoir Control Research Development
Salatiga, Indonesia
trapsilowati@gmail.com

Riyani Setyaningsih
Institute for Vector and Reservoir Control Research Development
Salatiga, Indonesia
riyanisetia@gmail.com

Aryani Pujiyanti
Institute for Vector and Reservoir Control Research Development
Salatiga, Indonesia
yanie.litbang@gmail.com

Mega Tyas Prihatin
Institute for Vector and Reservoir Control Research Development
Salatiga, Indonesia
megatyas89@gmail.com

Triwibowo Ambar Garjito
Institute for Vector and Reservoir Control Research Development
Salatiga, Indonesia
triwibowoa@gmail.com

Arief Mulyono
Institute for Vector and Reservoir Control Research Development
Salatiga, Indonesia

***Abstract* — The re-emergence of malaria has become a major public health issue during national malaria elimination program in Indonesia. The receptivity status of Malaria is the key to its re-establishment. A cross-sectional entomological study was carried out to assess the potential of malaria re-introduction and evaluate the feasibility of malaria elimination in Indonesia by 2030. The aim of this study is to analyze the presence of receptivity to Malaria by using a large dataset in Indonesia. This study is based on the data from the National research of Vectors (Rikhus Vektora) obtained between 2015 to 2018 organized by the Institute for Vector and Reservoir Control Research and Development, National Institute of Health Research and Development, Ministry of Health Indonesia. The data used in this study include malaria elimination status from 27 study sites throughout 9 provinces in Indonesia. Mosquitoes caught were identified and examined for their plasmodium by using Polymerization Chain Reaction test. The results of this study reveal that Anopheles species, which os confirmed as a malaria vector, are found in all of the regencies. Only 2 (7.41%) of the 27 regencies in the last 2 years not report malaria cases, ignore both imports and indigenous. As many as 17 regencies (62.96%) of the 27 regencies are certified as malaria elimination areas. As many as 6 (22.22%) regencies are identified to have malaria plasmodium. There are still risks for malaria transmission due to the presence of malaria cases, vectors, and plasmodium. Sustained entomological surveillance and cases surveillance are strongly recommended for pre-elimination and elimination of malaria.**

Keywords: malaria, elimination, receptivity, Indonesia

I. INTRODUCTION

Malaria is still a global problem, including in Indonesia. Based on the data in 2011, 54% of 497 regencies in Indonesia are considered as malaria endemic areas. From 2005 to 2013, the incidence of malaria in Indonesia tended to decline, from 4.10 per 1,000 population in 2005 to 1.38 per 1,000 population in 2013 [1].

It was agreed in the World Health Assembly (WHA) meeting in May 2007 to eliminate malaria globally. The factors that influence the spreading of malaria include environmental changes, the number of *Anopheles sp* mosquitoes that have been confirmed as vectors (25 species) from various habitats, and high mobility population from endemic areas or to endemic areas [2][3].

The focus of malaria control program is to achieve malaria elimination and realize a healthy society that is free from malaria transmission gradually until 2030. The target area for eliminating malaria is all provinces in Indonesia that will be achieved through stages. The first stage was achieved in 2010 in Kepulauan Seribu (Jakarta Province), Bali Island, and Batam Island. The second stage was achieved in 2015 in Java Island, Nangroe Aceh Darussalam (NAD) Province, and Kepulauan Riau (Kepri) Province. The third stage will be achieved in 2020 in Sumatra Island, except NAD and Kepri, West Nusa Tenggara Province, Kalimantan Island and Sulawesi Island. The fourth stage will be achieved in 2030 in Papua, West Papua, East Nusa Tenggara, Maluku and North Maluku [2].

Malaria elimination is an effort to stop local malaria transmission in certain geographical areas. It does not mean that there are no cases in those areas since imported malaria cases are still possible to happen. Similarly, malaria vector can still possibly be found in the eliminated areas. Therefore, surveillance should be done to maintain the eliminated status. Variations in malaria endemicity in Indonesia need control strategies that are in line with specific local conditions in each region.

Special Research on Vector and Reservoir Disease (Rikhus Vektora) is a national research center with the aims to: obtain vector and reservoir disease distribution maps, confirm vector and reservoir of disease, as well as obtain secondary data related to vector-borne diseases and reservoirs. The Eastern parts of Indonesia are mostly areas with high malaria endemicity. The highest Annual Parasite Incidence (API) is in Papua Province, followed by West Papua Province. Provincial areas with zero API are DKI Jakarta and Bali [4].

Malaria receptivity is a measure of the intrinsic vector transmission potential of an area. Receptivity is not static; this can change with the implementation of a vector control. Malaria receptivity is closely related to the vulnerability of a region, such as the closeness to malaria endemic areas or

high population migration [5][6][7]. Malaria receptivity mapping is a follow-up to malaria elimination which aims to prevent malaria reintroduction. Efforts to measure malaria receptivity in an area are carried out by vector surveillance.

The aim of the study is to describe the achievement of malaria elimination in targeted 2015 and receptivity status in Indonesia. This study is expected to provide plans for the surveillance activities to achieve and maintain malaria elimination status.

II. METHOD

Special Research of Vector and Reservoir Disease (Rikhus Vektora) conducted a cross sectional study which was carried out in stages from 2015 to 2018. The research sites were located in 9 provinces in which three regencies were selected in each province. The detailed locations of the research are presented in Table I.

TABLE I. STUDY SITE

Island	Province	Number of Regencies
Sumatera	Nangroe Aceh Darussalam (NAD) Kepulauan Riau (Kepri)	3 3
Java	Central Java East Java West Java DKI Jakarta Banten DI Yogyakarta	3 3 3 3 3 3
Bali	Bali	3
Total	9 Provincies	27 Regencies

The mosquitoes was caught by using several methods such as human landing inside and outside collection, Animal Baited Trap net, light trap, and resting morning. The catches were done 2 times in 6 ecosystems. The ecosystems were forests, non-forests, and beaches with the categories of being near and far from settlements from 18:00 pm to 6:00 am. The collected mosquitoes were immediately identified, and the collected larvae were maintained until they became adults to identify their species.[8][9][10][11]. Plasmodium was detected by using nested Polymerase Chain Reaction (PCR).[12][8].

The data on malaria cases were obtained from secondary data from the regency health offices. A province/regency area was declared as eliminated if there was no local transmission for three consecutive years and the data was supported through surveillance, both migration surveillance and vector surveillance, especially in areas with high receptivity. The data analysis was carried out descriptively.

III. RESULTS

A. Malaria Vectors

In all areas where the study is carried out, Anopheles mosquitos are found in which some of them are confirmed to be malaria vectors (Table II).

TABLE II. MALARIA VECTOR SPECIES FOUND IN THE RESEARCH AREAS

Province	*Anopheles* Species Caught	Vector Species Confirmed
NAD	9 species	6 species
Central Java	10 species	6 species
West Java	6 species	6 species
East Java	11 species	7 species
Kepulauan Riau	17 species	7 species
Bali	9 species	4 species
Banten	9 species	6 species
DKI Jakarta	2 species	1 species
DI Yogyakarta	10 species	5 species

B. Malaria Cases

All provinces report malaria cases, for both imported and indigenous malaria. Imported Malaria are cases from outside the region and occurs in areas with elimination status. In detail, it is presented in Table III.

TABLE III. MALARIA CASES BY REGENCY

Prov/Regency	No. of Cases	No. of Cases	Prov/Regency	No. of Cases	No. of Cases
NAD	2014	2015	Central Java	2014	2015
Aceh Timur*	6	3	Purworejo*	610	359
Aceh Barat*	39	5	Pati	118	20
Pidie	25	5	Kab. Pekalongan	4	0
West Java	2014	2015	East Java	2014	2015
Garut*	317	32	Malang	40	23
Subang	1	3	Banyuwangi	58	30
Pangandaran*	10	15	Pasuruan	21	23
Banten	2014	2015	Bali	2015	2016
Pandeglang*	48	19	Jembrana	2	3
Lebak*	42	18	Badung	1	0
Kab. Serang	3	2	Karangasem	1	2
DI Yogyakarta	2015	2016	DKI Jakata	2016	2017
Kulon Progo*	122	94	Kep. Seribu	0	0
Bantul	3	2	Jakarta Timur	17	25
Gunung Kidul	0	0	Jakarta Barat	13	10
Kepulauan Riau	2016	2017			
Bintan*	1	141			
Lingga*	459	458			
Batam	9	1			

* Not eliminated yet

C. Achievement on Malaria Elimination Targeted in 2015

The target of malaria elimination in 2015 was achieved in Bali, Riau Archipelago (Kepri), Nangroe Aceh Darussalam Province (NAD), and Java Island with the total of 158 regencies and there were elimination status in 136 regencies [13]. The achievement of malaria elimination areas targeted in 2015 is presented in Table 4.

TABLE IV. ACHIEVEMENT ON MALARIA ELIMINATION TARGETED IN 2015

Island	Number of Provinces	Number of Regencies	Number of Regencies Elimination of Malaria	%
NAD	1	23	19	82.61
Kepulauan Riau	1	7	3	42.86
Bali Island	1	9	9	100
Java Island	6	119	105	88.24
Total	9	158	136	86.08

The achievement of elimination status at the study site is 62.96%. The achievement of malaria elimination at study site in 2018 is presented in Table V.

TABLE V. ACHIEVEMENT ON MALARIA ELIMINATION AT STUDY SITE IN 2018

Island	Number of Provinces	Number of Regencies	Number of Regencies Elimination of Malaria	%
NAD	1	3	1	33.33
Kepulauan Riau	1	3	1	33.33
Bali Island	1	3	3	100
Java Island	6	18	12	66.67
Total	9	27	17	62.96

D. Laboratory Results of Plasmodium

The results of laboratory tests reveal that in 34 (40%) of the 85 regencies of the study sites plasmodium parasites in vector mosquitoes are found. The results of the laboratory test in the target elimination regencies in 2015 find Rikhus Vektora locus in 6 regencies (22.22%) out of 27 regencies. The results of laboratory tests in 2015 elimination target are presented in Table VI.

TABLE VI. LABORATORY TEST RESULTS IN TARGETED ELIMINATION AREA 2015-2018

Province	Number of Regencies	Positive	%
NAD Province	3	0	0
Kepulauan Riau	3	0	0
Bali Island	3	1	33.33
Java Island	18	5	27.78
Total	27	6	22.22

IV. DISCUSSION

The malaria vector (*Anopheles sp*) was still found in all research locations from 2015 to 2018. Those mosquito vector species have previously been confirmed as vectors. According to the Ministry of Health, there are 25 species of mosquitoes considered as malaria vectors in Indonesia. Those confirmed mosquito vectors spread throughout Indonesian territory. The species confirmed as malaria vector in Java and Bali are *Anopheles sundaicus*, *An. subpictus, An. aconitus, An. kochi and An. maculatus* [3]. Other studies indicate that *An. barbirostris* is also a malaria vector in Java and *An. Vagus* is a potential vector in Banten Province [14][15]. Epidemiologically, malaria transmission is influenced by the existence of hosts, agents, and environment. The malaria agent is plasmodium carried by the *Anopheles* mosquito. Therefore, malaria transmission is influenced by one of the existed vector mosquitoes [16][17].

As presented in Table II, malaria vectors are found in all areas of study. It indicates that there is a possibility of malaria transmission. The presence of malaria vectors and bionomics should be monitored routinely and mapping should also be carried out to measure potential transmission [5][6]. In order to achieve or maintain malaria elimination in areas with high vector density, vector control is needed to prevent re-transmission [18][19]. Malaria vulnerability is defined as the probability of importing malaria parasites into a country or a region. Measurements are easy to use by looking at the frequency of entry of individuals or groups infected with malaria [7]. This study reveals that only 2 (7.41%) of the 27 regencies in the last 2 years that not report malaria cases, ignore both imported and indigenous one. Vulnerability can be caused by population mobility, both at national and international levels. Vulnerability is closely related to receptivity. It is because if a malaria vector is found in an area, at the same time there are sufferers entering from outside the region. Then, local transmission can occur. Migration surveillance is an attempt to break the chain of transmission again, especially in areas eliminated from malaria [18][19].

The elimination of malaria is a global commitment that will be achieved in 2030. The achievement of malaria elimination in Indonesia is carried out in stages. Malaria elimination targets in 2015 were in Java Island, Bali, Kepulauan Riau, and NAD Province. The region that achieved malaria elimination in 2015 was only Bali while the other regions did not reach 100%, yet. Until 2017, in the four target provinces, there were 136 (86.08%) regencies from 158 regencies that reached the target. Nevertheless, by 2017 there were a total of 262 (98.86%) out of 265 regencies recorded in Indonesian Strategic Plan (Renstra) [13]. In 2015, Indonesia's population living in high endemic areas was 2.2%, 8.5% was in moderate endemic areas, 15.3%, was in low endemic areas, and 74% was in malaria-free areas[20]. Malaria elimination is not merely the responsibility of the health sector. There should be collaboration and commitment among all sectors and community[20]. The efforts to achieve malaria elimination in Bukit Menoreh region can be seen in the establishment of an integrated malaria control team which involve cross-sectors, experts, and community [16].

Among the target areas in 2015, there were still 6 (22.22%) regencies from the 27 regencies that were surveyed with positive malaria plasmodium. The positive detection of malaria plasmodium in the malaria elimination area indicated that the regions were vulnerable to indigenous malaria transmission. Therefore, a commitment to prevent local transmission by monitoring the entry of parasite carriers and vector control was highly needed [21][16].

In the regions that have been declared as malaria elimination areas, the implementation of malaria control program has not finished yet. The regions ought to maintain their status so that there will not be indigenous transmission. These efforts can be carried out by implementing active surveillance including migration surveillance. Primary Health Care (PHC) and the Public Health Offices in the Regency and Municipality levels have to immediately follow up on cases of imports found to avoid local transmission, especially in malaria vector focus areas [22][20][23]. The government’s commitment to mobilize cross-sectoral cooperation including Non-Governmental Organizations (NGOs), professional organizations, private sectors, and the communities is needed in forming the malaria elimination strategy [2][24]. Various efforts to achieve and maintain malaria elimination have been conducted in various regions, including policies of regional governments. Private sector involvements are shown in Corporate Social Responsibility (CSR) programs and community empowerment in malaria elimination activities [2][25][26][27].

V. CONCLUSION

The regions targeted for malaria elimination in 2015 reached 62.96% in 2018. The reported cases indicate that the study site is regarded as vulnerable areas. Anopheles sp. mosquitoes, which are previously identified as malaria vector, are still found in all study sites. This indicates that the regions are receptive areas. The risks of malaria transmissions still exist due to the presence of malaria vectors and malaria plasmodium. Sustained entomological and case surveillance are strongly recommended for pre-elimination and elimination phases of malaria.

ACKNOWLEDGMENT

The researchers would like to thank the chief of the Institute for Vector and Reservoir Control Research and Development (IVRCRD) of the National Health Research and Development who has provided the opportunities and the team who are in charge in technical and enumerator office to help collect the data in the field.

REFERENCES

[1]. Indonesian Ministry of Health,"The current situation of malaria control in Indonesia 2014." Indonesia; 2015.

[2]. Indonesian Ministry of Health,"Minister of health decree no. 293/MENKES/SK/IV/2009 concerning elimination of malaria in Indonesia." Jakarta, Indonesia; 2009.

[3]. Indonesian Ministry of Health,"Guidelines for control of malaria vector." Jakarta: Indonesian Ministry of Health; 2014.

[4]. Indonesian Ministry of Health,"Report on the malaria program in Indonesia." Jakarta; 2014.

[5]. Noor AM, Alegana VA, Patil AP, Moloney G, Borle M, Yusuf F, et al.,"Mapping the receptivity of malaria risk to plan the future of control in Somalia." BMJ Open. 2012;2(4):1–10.

[6]. Burkot TR, Bugoro H, Apairamo A, Cooper RD, Echeverry DF, Odabasi D, et al.,"Spatial-temporal heterogeneity in malaria receptivity is best estimated by vector biting rates in areas nearing elimination." Parasites and Vectors. 2018;11(1):1–12.

[7]. Chen TM, Zhang S Sen, Feng J, Xia ZG, Luo CH, Zeng XC, et al.,"Mobile population dynamics and malaria vulnerability: A modelling study in the China-Myanmar border region of Yunnan Province, China." Infect Dis Poverty. 2018;7(1):1–11.

[8]. Institute for Vector and Reservoir Control Research Development,"Guidelines for vector (mosquito) collection in the field." Salatiga: National Health Research Development; 2017.

[9]. Panthusiri, Rattanarithikul R, Prachong,"Illustrated Keys to the Medically Important Mosquitoes of Thailand." Thailand; 1994. 1-66 p.

[10]. Rattanarithikul R, Harbach RE, Harrison BA, Panthusiri P, Jones JW, Coleman RE,"Illustrated Keys to the mosquitoes of Thailand II Genera Culex and Lutzia." Thailand; 2005. 1-97 p.

[11]. Rattanarithikul R, Harbach RE, Harrison BA, Panthusari P, Coleman RE, Richardson JH,"Illustrated Keys to The Mosquitoes of Thailand VI. Tribe Aedini." Thailand; 2010. 1-128 p.

[12]. WHO,"Manual on practical entomology in malaria." Geneva; 1975. 1-186 p.

[13]. Indonesian Ministry of Health,"Achievement of malaria elimination status in Indonesia 2017." Jakarta; 2018.

[14]. Ndoen E, Wild C, Dale P, Sipe N, Dale M,"Relationships between anopheline mosquitoes and topography in West Timor and Java, Indonesia." Malar J. 2010;9(1):1–9.

[15]. Astuti EP, Ipa M, Prasetyowati H, Fuadzy H, Dhewantara PW,"Vector capacity and entomological inoculation rate of Anopheles vagus from endemic malaria in Banten Province." Vektora J Vektor dan Reserv Penyakit. 2017;8(1):23–30.

[16]. Indonesian Ministry of Health,"Minister of Health decree no. HK.01.07/MENKES/498/2017 concerning the Menoreh Hill integrated malaria management team." Jakarta; 2017. p. 1–7.

[17]. Mendis K, Rietveld A, Warsame M, Bosman A, Greenwood B, Wernsdorfer WH,"From malaria control to eradication: The WHO perspective." Trop Med Int Heal. 2009;14(7):802–9.

[18]. South African Department of Health (SA DoH),"Surveillance Guidelines for Malaria Elimination and Prevention of Re- Introduction for South Africa." 2012;(May):1–39.

[19]. World Health Organisation,"WHO | Eliminating malaria." Who. 2016;

[20]. Indonesian Ministry of Health Data and Information Center,"Malaria." Jakarta; 2016.

[21]. Bridges DJ, Winters AM, Hamer DH,"Malaria elimination: surveillance and response." Pathog Glob Health. 2012;106(4):224–31.

[22]. Dharmawardena P, Premaratne RG, De Aw Gunasekera WKT, Hewawitarane M, Mendis K, Fernando D,"Characterization of imported malaria, the largest threat to sustained malaria elimination from Sri Lanka." Malar J [Internet]. 2015;14(1):1–8. Available from: ???

[23]. World Health Organisation (WHO),"A framework for malaria elimination." Genewa: WHO; 2017.

[24]. Smith Gueye C, Newby G, Tulloch J, Slutsker L, Tanner M, Gosling RD,"The central role of national programme management for the achievement of malaria elimination: a cross case-study analysis of nine malaria programmes." Malar J. 2016;15(1):1–21.

[25]. Hutagalung J, Kusnanto H, Sa H, Aw S, Novijanti R, Ag T, et al.,"Scientific study of malaria pre-elimination in Eastern Indonesia." Outbreak Surveill Investig Rep. 2016;9(1):1–7.

[26]. Roosihermiatie B, Pratiwi NL, Rukmini R, P WJ,"Analysis of Implementation The Policy on Malaria Elimination in Indonesia." Bul Penelit Sist Kesehat. 2017;18(3):277–84.

[27]. Sitohang V, Sariwati E, Fajariyani SB, Hwang D, Kurnia B, Hapsari RK, et al.,"Malaria elimination in Indonesia: halfway there." Lancet Glob Heal. 2018;6(6):e604–6.