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SPATIO-TEMPORAL ANALYSIS OF MALARIA INCIDENCE ALONG HLAINGBWE TOWNSHIP IN MYANMAR AND THA SONG YANG DISTRICT IN THAILAND

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ABSTRACT

***Background**: Malaria stays a serious public health problem in many countries of the world. The border regions are difficult to control for the malaria elimination due to the importation or reintroduction of malaria. A key to address such problem is reinforcing of surveillance activities with rapid identification. The objective of the study was to describe the malaria incidence rate and analyze the space and time distribution of malaria incidence rate in the high endemic border areas between Myanmar and Thailand, the Hlaingbwe Township and Tha Song Yang District.*
***Methodology**: Daily malaria data were collected, using a passive surveillance system, from patients visiting local health facilities in both Tha Song Yang and Hlaingbwe regions. ArcMap software version 10.4.1 was used to describe the disease mapping of malaria incidence rate in both regions.*
***Results**: Compared to their counterparts, male gender had higher malaria incidence rates in both Tha Song Yang and Hlaingbwe regions. Non-Thai people had higher incidence rate than Thai in Tha Song Yang district. The higher incidence rates had seasonal pattern and the pattern was similar in both regions. The areas with a higher incidence rate could be seen in both inner side and along Thai-Myanmar border (upper and lower parts) in Tha Song Yang area. But in Hlaingbwe Township, the higher incidence rate occurred only in the inner and upper parts except for Me La Yaw and Tar Le areas which are situated along the Thai-Myanmar border. Along the border, the higher incidence rates were connected to the adjacent area in upper and lower parts between these two regions.*
***Conclusion**: The descriptive statistics and presented map in this study gave the health policy makers an important overview of malaria situation in this regions in order to intervene high risk areas more effectively, and distribute the resources in a useful manner.*

***Keywords**: malaria, border regions, Thailand, Myanmar*

INTRODUCTION

Malaria case incidence rates are estimated to have diminished by 21% globally between 2010 and 2015, and malaria mortality rates by 29%. In spite of this striking advancement, malaria keeps on devastatingly affecting people's health and livelihoods [1]. Despite malaria incidence falls, the disease often focus on the border area population groups, such as political, religious and ethnic minorities groups; the society residing in the border regions and hard-to-reach areas. Running of facilities to these groups may be tricky and more costly due to traditional beliefs, language obstacles, infrastructural challenges and political concerns [2]. Malaria is heterogeneously distributed in the border area and cases are often clustered along the international borders. Being a border area for different nations, with unequal policy, economic and public health infrastructure, Thailand-Myanmar border take after that condition [3]. The national malaria control program in Myanmar cannot provide adequate coverage in some border areas and local political setting and military conflicts more intensify malaria situation in these fringe areas [4]. To recognize the areas or population groups of malaria cases and deaths, effective surveillance is imperative for this viewpoint and also for the effective management of assets to the most required communities [2]. Therefore, this study focused on the high malaria incidence rates in the Myanmar-Thailand border areas, the Hlaingbwe Township and Tha Song Yang District. In addition, the recent space and time distribution of malaria incidence rate between these two regions were explored.

METHODS

The study area was conducted in Hlaingbwe Township of Kayin state in Myanmar and Tha Song Yang district of Tak province in Thailand. Hlaingbwe Township is the third largest of Kayin State in Myanmar and its population was 265,883 in 2014. It is located between 17.1333' N and 97.8333'E and bounded on the north and northeast by Hpa-pun Township, on the west and northwest by the Hpa-an Township, on the south and south east by the Kawkareit and Myawaddy Township and on the east and southeast by the Tha Song Yang district which is located in Tak province of Thailand. The township is subdivided into 75 village tracts.

Tha Song Yang district is situated in the Tak province of Thailand and covered 1,920.38 km^2 area. It is located between 17° 13' 36" N and 98° 13' 30" E and its population was 61,161 in 2015. The neighboring districts are (Northwest from clockwise): Sop Moei of Mae Hong Son Province, Omkoi of Chiang Mai Province and Mae Ramat of Tak Province. Moei River is situated in the other side of Kayin State of Myanmar. The district has 6 sub-districts, and there are totally 66 villages in the village level.

The study population included all people living in these areas. All malaria cases were identified as those who were diagnosed with malaria, either falciparum, vivax or mixed, with microscopy and RDT.

Malaria data

Malaria case information was obtained from the routine surveillance database maintained by National Malaria Control Program under the Ministry of Health and Sport (MOHS) in Myanmar, and Thailand's national E-Malaria Information System (EMIS) for Thailand, a database which recorded routine health data. The malaria data used in this study was for the period January 2016 - December 2016.

Population data

Population and other demographic indicators for Thailand were obtained from the Statistical Yearbook Thailand 2016 and for Myanmar, it was obtained from 2014 Myanmar population and housing census published by department of population, Ministry of immigration and population.

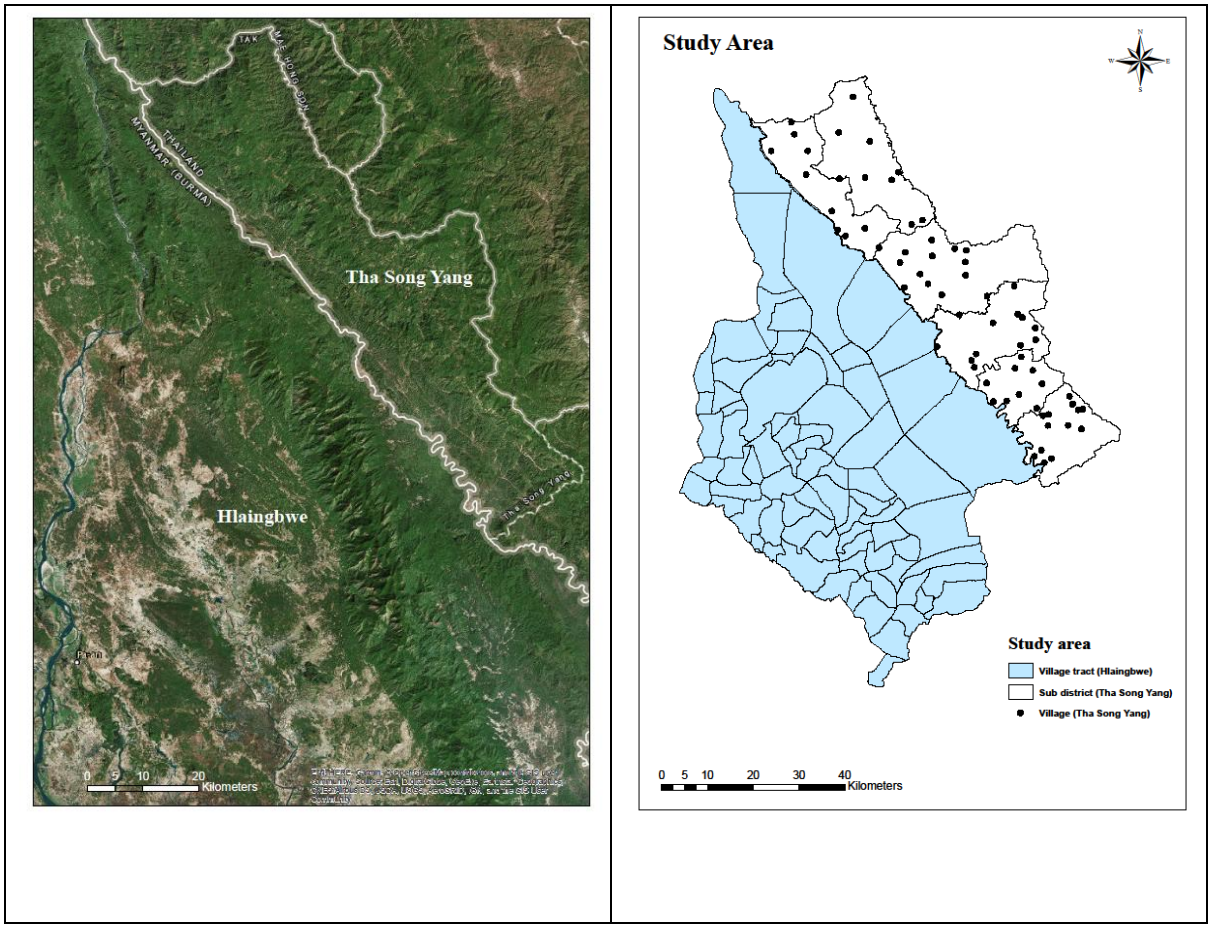


Figure 1 Study area in Hlaingbwe Township of Myanmar and Tha Song Yang District in Thailand

The data were entered into Microsoft excel spreadsheet for the data cleaning and validation. ArcMap software version 10.4.1 was used for the disease mapping. The results were described as two separate regions of Hlaingbwe Township in Myanmar and Tha Song Yang District in Thailand with overall malaria incidence rate and monthly malaria incidence rate by gender and nationality.

RESULTS

There were 561 total cases of malaria in Tha Song Yang district with 227 cases in Thai citizens and 334 cases in Non-Thai people for the year 2016. Higher incidence rates were seen in January, May, June and July for total, Thai and Non Thai groups. Regarding Hlaingbwe Township, all of the 266 cases were Myanmar citizens and higher incidence rates were seen in January and July for the year 2016 (Table 1).

By gender, in general, male incidence rates was higher than female incidence rate in all of Thai, Non Thai and Myanmar population. In Tha Song Yang region, higher incidence rates were seen in the months of January, May, June and July for total, January, May, June and July for Thai male people, January, June, July and August for Thai female people, January, May, June and July for Non Thai male people and January, May, June and July for Non Thai female people to compare with other months of the year 2016. In Hlaingbwe area, higher incidence rate were seen in January and July for total, February and July for male and January, May, June and July for female among twelve months of the year 2016 (Table 2). According to the table 1 and 2, the higher incidence rates were seen in the beginning months of the year and during the rainy season (May to October).

Month	Total Inc	Tha Song Yang Thai Male Inc	Tha Song Yang Thai Female Inc	Tha Song Yang Non Thai Male Inc	Tha Song Yang Non Thai Female Inc	Hlaingbwe Myanmar Total Inc	Hlaingbwe Myanmar Male Inc	Hlaingbwe Myanmar Female Inc
January	8.09	3.24	4.38	33.49	12.72	1.09	1.07	1.1
February	4.64	2.36	2.19	13.61	12.72	0.86	1.23	0.51
March	3.45	2.65	0.63	11.51	8.10	0.56	0.77	0.37
April	4.16	2.65	1.88	14.65	6.94	0.64	0.92	0.37
May	7.02	3.83	2.82	21.98	18.51	0.94	0.92	0.95
June	12.73	7.96	4.38	40.82	31.23	0.9	0.99	0.81
July	10.82	6.48	5.64	35.58	19.66	1.46	1.99	0.95
August	4.28	2.06	3.44	11.51	8.10	0.49	0.61	0.37
September	2.85	0.88	0.94	15.70	3.47	0.68	0.92	0.44
October	2.26	0.88	1.57	8.37	3.47	0.68	0.84	0.51
November	2.38	1.47	0.94	6.28	6.94	0.83	1.07	0.59
December	4.04	2.95	2.50	11.51	5.78	0.86	1.15	0.59
Total	66.72	37.42	31.31	225.01	137.64	9.99	12.52	7.57

Table 1 Malaria incidence rate (per 10,000 population) by Nationality during the year 2016

Month	Tha Song Yang Total Cases	Tha Song Yang Total Inc	Tha Song Yang Thai Cases	Tha Song Yang Thai Inc	Tha Song Yang Non Thai Cases	Tha Song Yang Non Thai Inc	Hlaingbwe Myanmar Cases	Hlaingbwe Myanmar Inc
January	68	8.09	25	3.80	43	26.63	29	1.09
February	39	4.64	15	2.28	24	13.19	23	0.86
March	29	3.45	11	1.67	18	9.89	15	0.56
April	35	4.16	15	2.28	20	10.99	17	0.64
May	59	7.02	22	3.34	37	20.33	25	0.94
June	107	12.73	41	6.22	66	36.26	24	0.90
July	91	10.82	40	6.07	51	28.02	39	1.46
August	36	4.28	18	2.73	18	9.89	13	0.49
September	24	2.85	6	0.91	18	9.89	18	0.68
October	19	2.26	8	1.21	11	6.04	18	0.68
November	20	2.38	8	1.21	12	6.59	22	0.83
December	34	4.04	18	2.73	16	8.79	23	0.86
	561	66.72	227	34.46	334	183.51	266	9.99

Table 2 Malaria incidence rate (per 10,000 population) by gender during the year 2016

Figure 2 shows the incidence rate of malaria cases per 10,000 population per year by Tha Song Yang and Hlaingbwe regions for the year 2016. The incidence rates in Hlaingbwe Township were higher in Yin Baing, Ka Mawt Le(Kyanug), Mae Tha Mu, Ka Mawt Le (Ma Ae) (Ah Lel), Mae La Yaw and Tar Le. Regarding Tha Song Yang District, the higher incidence rates were seen in Ban Mo Ku Tu, Ban Mae Tan, Ban Suan Oi, Ban Mae Chawang, Ban Lam Rong and Ban Mae La Thai.

As for the whole year, the distribution of higher malaria incidence rate could be seen in upper and lower parts along the Thai-Myanmar border in Tha Song Yang site. However, in Hlaingbwe region, the distribution of higher incidence rate was found only in the inner side except a few areas such as Me La Yaw and Tar Le which are situated along the Thai-Myanmar border (Figure 2).

Regarding the malaria incidence rate by monthly, the distribution of incidence rate was quite similar with the whole year of 2016. The areas which had higher incidence rates were Yin Baing, Me La Yaw, Ka Mawt Le (Kyaung), Me Tha Mu and Ka Mawt Le (Ma Ae) (Ah Lel) in Hlaingbwe Township and In Tha Song Yang district, Ban Mo Ku Tu, Ban Mae Tun, Ban Suan Oi, Ban Mae Chawang, Ban Lam Rong and Ban Mae La Thai in Tha Song Yang District. (Figure 3).

As by months, higher malaria incidence rate could be seen in some groups of villages along the Thai-Myanmar border on Tha Song Yang side. The villages were connected to the adjacent areas of some village tract on Myanmar site especially with a higher incidence rate in some months along the Thai-Myanmar border.

In the upper part, the higher incidence rate were found in some villages of Tha Song Yang sub-district as well as Me La Yaw village tract in Myanmar. Some villages of Mae U Su, Mae Tan and Mae La sub-district in Tha Song Yang side had the higher incidence rate similar with the adjacent areas of Myanmar side, Tar Le and Win Saw which are located in the lower part along the Thai-Myanmar border.

The higher incidence rate of adjacent areas in the lower part of Thai-Myanmar border could be seen frequently in most of the months if compared with the upper parts which is connected to adjacent areas in some months. In the middle part of Thai-Myanmar border, the higher incidence rate in Thailand did not go together with adjacent area on Myanmar side (Figure 3).

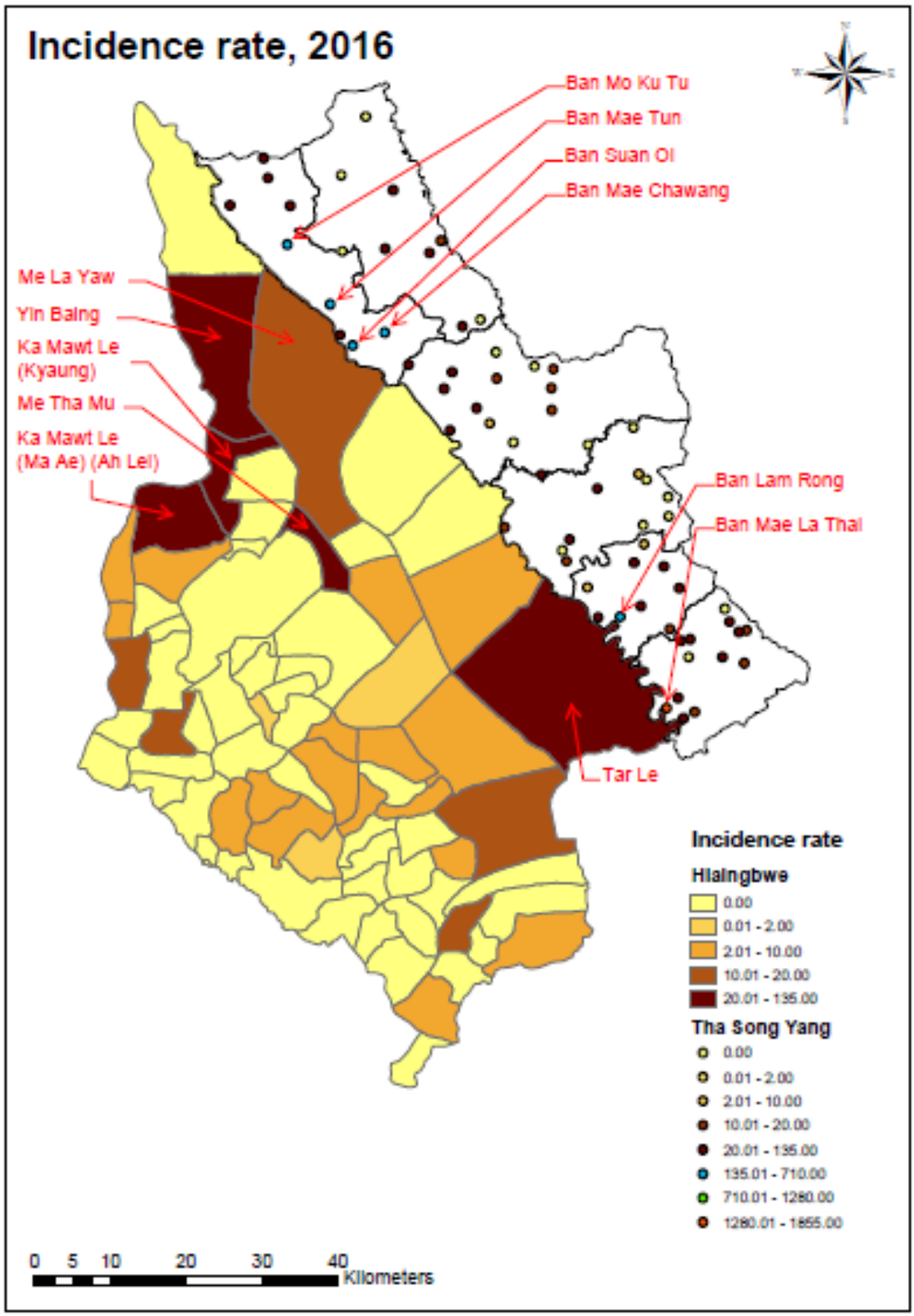
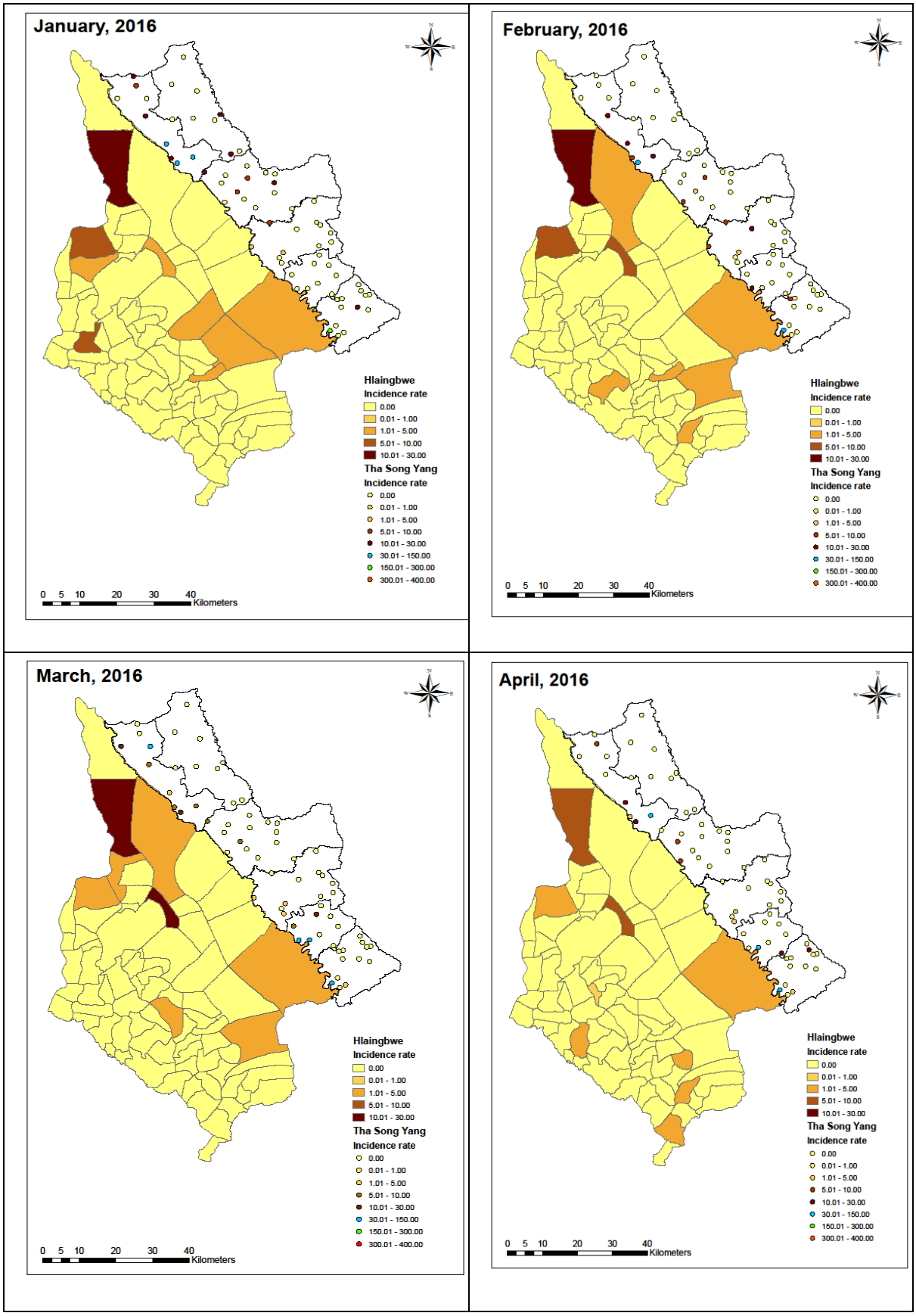
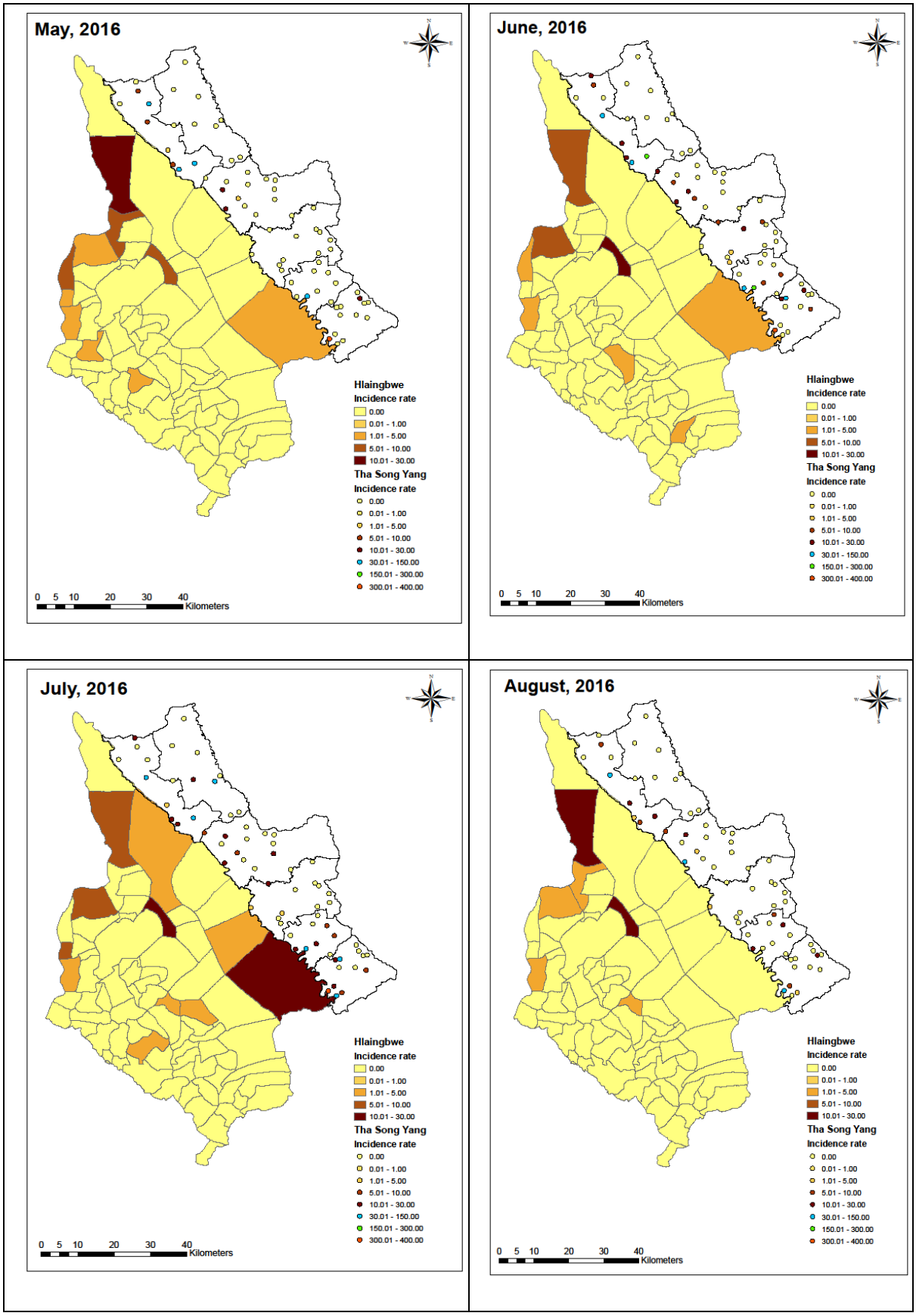


Figure 2 Incidence rate of malaria cases (per 10,000 population) by Tha Song Yang and Hlaingbwe regions for the year 2016


January, 2016
Hlaingbwe
Incidence rate
0.00
0.01 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 30.00
Tha Song Yang
Incidence rate
0.00
0.01 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 30.00
30.01 - 150.00
150.01 - 300.00
300.01 - 400.00
0 5 10 20 30 40
Kilometers
February, 2016
Hlaingbwe
Incidence rate
0.00
0.01 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 30.00
Tha Song Yang
Incidence rate
0.00
0.01 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 30.00
30.01 - 150.00
150.01 - 300.00
300.01 - 400.00
0 5 10 20 30 40
Kilometers
March, 2016
Hlaingbwe
Incidence rate
0.00
0.01 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 30.00
Tha Song Yang
Incidence rate
0.00
0.01 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 30.00
30.01 - 150.00
150.01 - 300.00
300.01 - 400.00
0 5 10 20 30 40
Kilometers
April, 2016
Hlaingbwe
Incidence rate
0.00
0.01 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 30.00
Tha Song Yang
Incidence rate
0.00
0.01 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 30.00
30.01 - 150.00
150.01 - 300.00
300.01 - 400.00
0 5 10 20 30 40
Kilometers


May, 2016
June, 2016
July, 2016
August, 2016
Hlaingbwe
Incidence rate
0.00
0.01 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 30.00
Tha Song Yang
Incidence rate
0.00
0.01 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 30.00
30.01 - 150.00
150.01 - 300.00
300.01 - 400.00
0 5 10 20 30 40
Kilometers

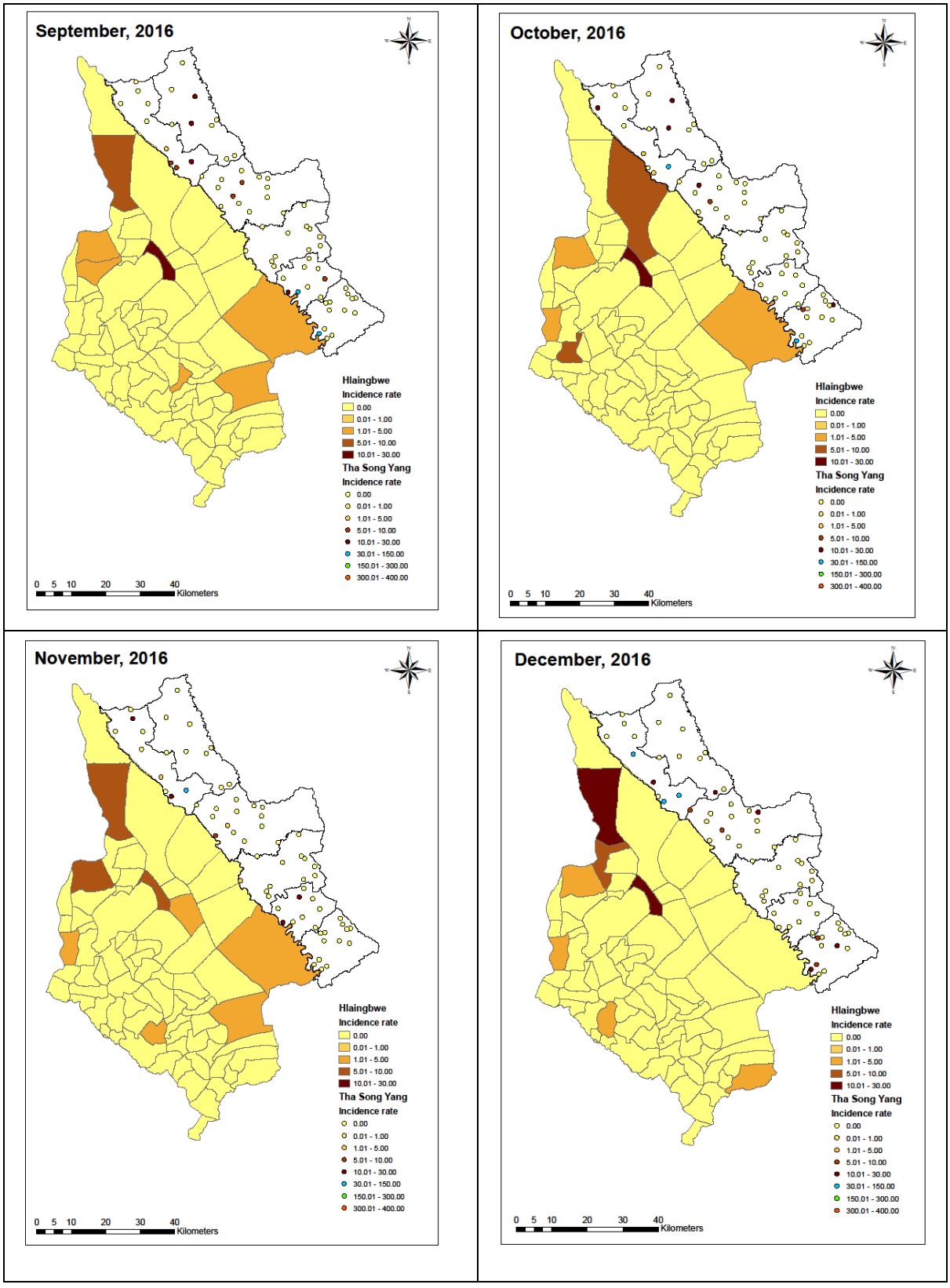


Figure 3 Incidence rate of malaria cases (per 10,000 population) by Tha Song Yang and Hlaingbwe regions from January to December, 2016

DISCUSSION

In this study, the chances of getting malaria depended on the gender differences in both Tha Song Yang and Hlaingbwe areas. Clearly, the main reason for higher incidence rate of malaria in male adults in Hlaingbwe area, and Thai and Non-Thai population in Tha Song Yang was related to their working environment with higher chances of human-vector contacts. The agriculture is the main livelihood for the rural population in this area and mosquito bite while they doing the agricultural work could be the contributing factor.

The peak of incidence rate in January could be due to the rise in temperature which enriches the process of the vector growth. The following highest peaks could have been associated with the rainy months, where there is abundant rainfall. This enhances the vector proliferation in the aquatic medium. Similar transmission patterns with two peaks in seasonal variation had been reported in Bhutan [5].

The study area was forested with heavy population movement and an important reservoir for malaria transmission was characterized by migrant populations. Cross-border migration could significantly contribute to a high malaria-endemic region in this area. Moreover, displaced minority populations were also the increasing risks of malaria infection and it could be suggested that political instability among the minorities in Myanmar has led to considerable cross-border population movements. Among the non-Thais, Myanmar migrant workers represent the largest foreign workers population. There are also displaced people without a nationality and illegal immigrants with significant numbers [6-9].

The areas fence with high mountainous and heavily forested terrain in upper and middle parts along the Thai-Myanmar border seen to have reduced malaria infection. On the other hand, large mobile cross-border population in the lower plain area along the Thai-Myanmar border makes a significant challenge for the management of imported malaria. It is because there is no significant natural barrier in this part. Due to a year-round movement as well as travelling across the river, migrants from a malaria-endemic regions can bring the parasite to a new, non-malarious regions [10]. The capable vectors in distinction to one region could take hold the disease in a new region. Likewise, migrants who spend time in the malaria-endemic areas may receive the parasite and carry it back to their original places where there is no malaria. However, the malaria parasite importation occurred only after the migrants have arrived back on their original place and the mosquitoes feed on them [11]. The researches on the spread of drug-resistant strains [12-15] explained that the migrants can move drug-resistant strains from the visited areas to the new places, regardless of whether the malaria is present or not in the new places. The individuals who enter into the malarious regions can also make the increasing number of susceptible individuals. The individuals may not have an acquired immunity if they are in a non-malarious region, and then, morbidity and moreover mortality of the malaria can be increased [16, 17].

Malaria is persistence along this international border. Several factors could be influenced the malaria epidemiology. Therefore, more collaborative effort for malaria prevention and control measures in border area between these two countries are needed.

CONCLUSION

The presented maps and determined demographic factors in this study could be beneficial to the health policy makers to set priority to the specific areas in the township/district based on the malaria situation. The preventive and control measures could be focused to intervene high risk areas more effectively, and distribute the resources in a useful manner. The findings from this study emphasize the preventive actions should be prioritized the high risk areas and in an appropriate time. The findings are also beneficial in conducting decisions in resource allocations to control the disease and in handling future studies.

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