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Spatio-Temporal Analysis of Dengue Cases in Kuningan District Since 2008-2017

Analisis Spasial Temporal Kasus Dengue di Kabupaten Kuningan Tahun 2008-2017

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ABSTRACT
Dengue has spread to over 400 of Indonesia's 497 districts, including West Java Province in which 26 of its districts have been declared as hyper-endemic. A study was conducted to describe the spread of dengue cases and its cluster during 2008-2017 in Kuningan District. The district is located in an important route, in migration and in the economic field, connecting the northern part of West Java to the southern part. A spatio-temporal analysis based on monthly dengue cases from the local District Health Office was performed using SaTScan™. This study revealed there were Statistically significant high-risk dengue clusters with various RR in half of the subdistricts in Kuningan in the ten-year periods of 2008-2017 and a retrospective space-time analysis detected 17 significant clusters ($P<0.001$). Subdistrict Kuningan is detected as a high-risk area every year except for 2008, whereas Jalaksana emerged as a high-risk cluster in six of ten-year periods. We conclude that there was a dynamic spread of dengue cases initiated from the north part of Kuningan District to western areas. This study results do not properly predict RR due to a lack of information on some significant factors, such as vector density and related environmental and socioeconomic parameters. However, this study has provided a perspective on dengue cases that can be used by local health managers and disease surveillance personnel to monitor prospective outbreaks and make decisions about how to implement an effective response.

Keywords: dengue, space time analysis, Kuningan

ABSTRAK
Dengue telah menyebar di lebih dari 400 kabupaten/kota di Indonesia termasuk di Jawa Barat, 26 kabupaten/kotanya merupakan daerah hiper endemis. Studi ini dilaksanakan untuk menggambarkan penyebaran dan cluster kasus dengue selama tahun 2008 – 2017 di Kabupaten Kuningan. Wilayah ini terletak di jalur penting, dalam migrasi penduduk maupun dalam bidang ekonomi, yang menghubungkan bagian utara Jawa Barat dengan wilayah selatan. Analisis spasial-temporal dilakukan pada data kasus dengue bulanan, yang diperoleh dari Dinas Kesehatan Kabupaten setempat, dengan menggunakan SaTScan™. Analisis retrospektif ini menunjukkan bahwa terdapat 17 cluster signifikan ($p < 0.0001$) selama 10 tahun periode studi. Kecamatan Kuningan terdeteksi sebagai daerah risiko tinggi di setiap tahun kecuali pada tahun 200, sedangkan Jalaksana muncul sebagai kluster risiko tinggi pada enam tahun dari periode studi. Kesimpulan studi ini adalah bahwa terdapat penyebaran kasus dengue yang dinamis dimulai dari bagian utara dan menyebar ke arah barat Kabupaten Kuningan. Hasil studi ini tidak dapat memprediksi RR secara tepat karena kurangnya beberapa informasi penting seperti kepadatan vektor serta parameter lingkungan dan sosioekonomi yang terkait dengan DBD. Meskipun demikian, hasil studi ini dapat digunakan oleh dinas kesehatan, khususnya petugas surveilans, untuk memonitor kemungkinan terjadinya wabah dan mengambil keputusan atau respon yang efektif.

***Kata kunci**: dengue, analisis spasial temporal, Kuningan*

INTRODUCTION

Before 1970, only nine countries were known as dengue-endemic but this disease has now become endemic in more than 100 countries spread in Africa, East Mediterranean, America, South East Asia, and West Pacific. This disease has spread from tropical to most subtropical regions of the world, causing human suffering and significant socioeconomic losses. It is estimated that 50 to 100 million dengue cases occur each year in about half of the world's population, particularly in locations where numerous virus serotypes cocirculate, known as hyperendemic regions in Southeast Asia and the Pacific. Dengue is also thought to be responsible for 20,000 deaths per year.[1]

Knowledge of dengue virus (DENV) epidemiological trends in hyper-endemics, both spatially and temporally, is essential to improve current management and prevention. This is especially crucial because neither treatment or vaccines are now available, even if a potentially helpful vaccine is developed within the next five years.[2]

In Indonesia, the first dengue outbreak was reported happened in 1968 in Surabaya. Outbreaks have occurred in 412 of Indonesia's 497 districts as a result of the four circulating DENV serotypes. Outbreaks of dengue virus (DENV) in Indonesia have been mainly caused by the DENV serotype-1; -2; or -3. The DENV-4 was the least-reported serotype in Indonesia during the last five decades.[3] In 2013, the Ministry of Health of Indonesia (MoHI) reported 112,511 cases (dengue Incidence Rate (IR) of 41.25 per 100,000 population) and 871 deaths corresponding to a Case Fatality Rate (CFR) of 0.7%.[4]

West Java is home to about 20% of Indonesia's total population, making it one of the most densely populated provinces in the country. West Java features 26 districts that have been categorized as hyper-endemic (2017 IR: 32.29 per 100,000 people; CFR: 0.03%). Insecticide resistance, as well as related studies on the epidemiological condition of dengue spatial-temporal distribution in Indonesia, control, and prevention, are deemed insufficient.[5]

Based on data from the local District Health Office, the number of dengue cases in Kuningan District from 2008 to 2016 continued to increase. The highest dengue IR was recorded in 2016 (149.2) with a CFR of 0.98%. Those numbers were an increase up to 70.63 % compared to 2015. Meanwhile, in 2017 there was a decrease in cases with IR of 68.15 and CFR of 0.27%.

In order to improve our understanding of dengue distribution and trends over time, we conducted a retrospective spatial-temporal analysis of dengue cases in Kuningan District from 2008 to 2017. This work on spatial-temporal analysis using space-time scan statistics to analyze the dengue trend in West Java was previously carried out in Cimahi using data from 2007 to 2013.[6]

This approach has been implemented on various health-related matters, including infectious diseases such as dengue. Surveillance and early detection are important factors to face the local and global dengue threat. To find the spread of the disease in Kuningan District, it is necessary to identify the distribution pattern of dengue incidents. The purpose of our research was to look at the occurrence of high-risk dengue clusters in the area.

METHOD

Study Site

Study was conducted by using data of Kuningan District in West Java Province. For the purpose of analysis, we obtained a 10-year periods of hospital confirmed dengue cases data (2008-2017) from the Kuningan District Health Office. Subdistrict population data were obtained from the Kuningan District Bureau of Statistics.

Spatial-temporal Analysis

SaTScan^{TM} ver.9.8 was used in this study to do a retrospective space-time analysis with a Poisson model to identify villages at high risk for dengue between 1 January 2008 and 31 December 2017. To reduce bias, the maximum spatial cluster size is set by default at 50% of the population at risk.[7] To eliminate overlapping, our study utilized a modified maximum spatial cluster size of 15% of the total population at risk. The most likely cluster was identified to be the one with the highest Log-Likelihood Ratio (LLR), while the others with lower LLR were classified as secondary clusters. The geographic information system (GIS) program ArcGIS, version 9.0 (ESRI

Inc., Redlands, CA, USA) was used to depict the cluster pattern in a geographical context.

RESULT

West Java has the highest population density in Indonesia, with over 48 million people living at a density of 1,358 persons per square kilometer.[8] Kuningan District comprises 32 subdistricts, consisting of 376 villages. The population density varies in each Subdistrict, from 263 to 3,135 people per km^2. The city is located around latitude 6°45'S and longitude 107°13'E, covers an area of 1,195.71km^2 and has a total population of 1,068,201 people.[9]

Based on monthly dengue data from the ten-year study periods, the space-time analysis detected a total of 17 most likely clusters (Table 1). These dengue clusters were initially spatially concentrated in the northern of Kuningan District but moved towards the western region by the end of the study.

In the first year (2008), we identified one significant cluster (P<0.001) that is Garawangi with an RR of 4.26 covered the 17 villages in the subdistrict. In the second year of study, a most likely cluster, covering 9 subdistricts (RR=3.58; P<0.001) with more than 430,000 population at risk was detected. However, there was only one secondary cluster this year that was Cilimus with RR 1.66. There's no secondary cluster detected in 2011 until 2013. In 2011, the highest RR recorded at 7.44 with the population at risk were more than 300,000 people.

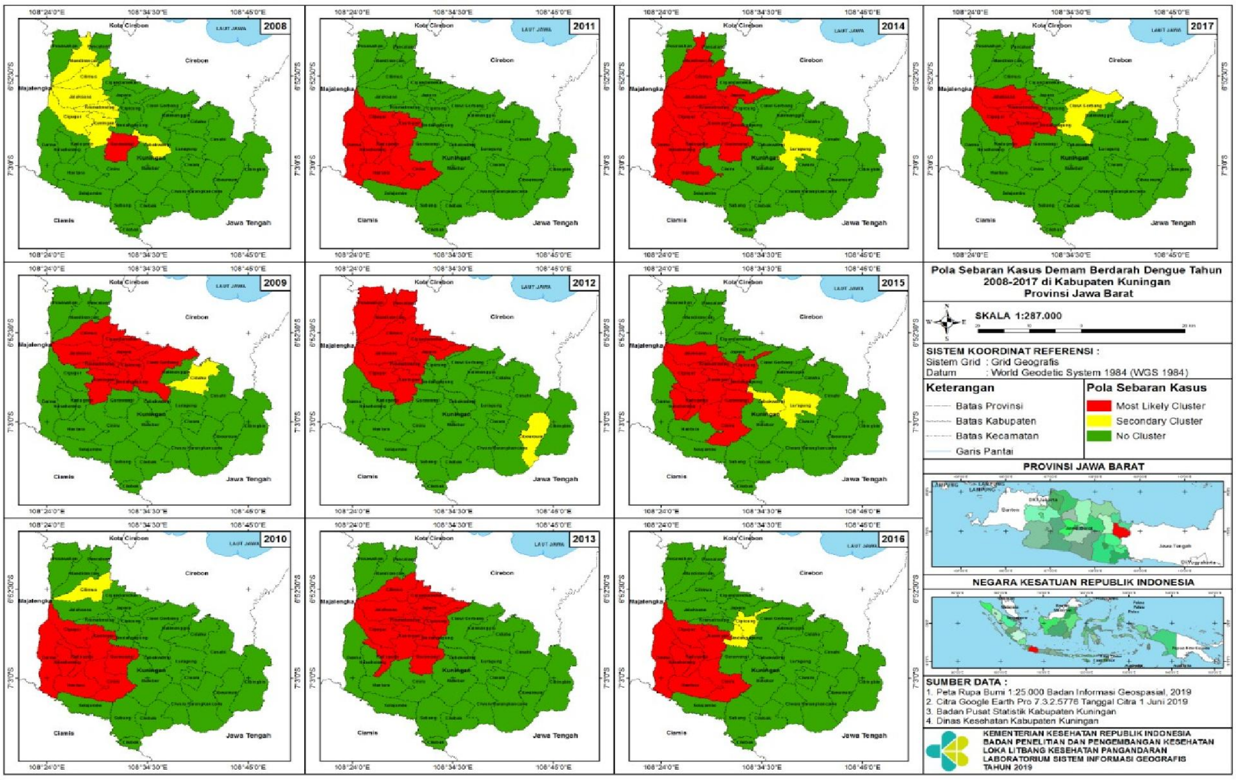

Figure 1. Spatio-temporal Dengue Cases in Kuningan District 2008 – 2017

Among those ten years, 2014 is the year with the most subdistrict found as most likely cluster (13 subdistricts). Its RR was 2.35 and the population at risk was more than 500,000 or almost half of Kuningan population. Even though there were more subdistricts that became the most likely cluster but the radius of risk area in 2014 was smaller than the radius of the risk area in 2012 that covered an area with a radius of 18.61km.

Statistically significant high-risk dengue clusters with various RR were discovered in half of the subdistricts in Kuningan in the ten-year periods of 2008-2017 and a retrospective space-time analysis detected 17 significant clusters (P<0.001). A dynamic distribution of most likely clusters was seen to spread from the northern of Kuningan westwards. We found Kuningan Subdistrict was most frequently detected as most likely clusters, except in first year. Jalaksana was the second most frequent subdistrict that showed up as most likely cluster with six years between 2009 until 2017. Kramat Mulya showed up in five sparsely years. Our findings show evidence of a significant spatio-temporal distribution of dengue high-risk areas in the study area.

Table 1 . Spatio-temporal Analysis of Dengue Cases in Kuningan District 2008-2017

Year	Cluster Type	Subdistrict	Population	Radius (km)	Actual Cases	Expected Cases	Relative Risk	LLR	p-value
2008	Most Likely	Garawangi	40684	0	22	5,78	4,26	14,077	< 0,001
	1 st secondary	Cigugur	43341	0	14	6,16	2,4	3,86	0,236
	2 nd secondary	Lebakwangi	43013	0	13	6,11	2,23	3,08	0,441
2009	Most Likely	Japara, Ciganda mekar, Cipicung, Kramat Mulya, Sindang Agung, Ciawi Gebang, Cilimus, Jalaksana, Kuningan	430954	9,47	248	166,57	2,16	31,466	< 0,001
	1 st secondary	Cidahu	43775	0	26	16,92	1,57	2,19	0,72
2010	Most Likely	Kadugede, Nusaherang, Darma, Kuningan, Cigugur, Hantara, Ciniru, Garawangi	301610	8,27	115	54,62	3,58	39,88	< 0,001
	1 st secondary	Cilimus	47889	0	14	8,67	1,66	1,45	0,939
2011	Most Likely	Kadugede, Nusaherang, Darma, Kuningan, Cigugur, Hantara, Ciniru	312212	8,05	36	12,44	7,44	24,096	< 0,001
2012	Most Likely	Pesawahan, Mandirancan, Pancalang, Cilimus, Jalaksana, Ciganda Mekar, Cigugur, Kramat Mulya, Japara, Kuningan	414237	18,61	42	24,94	2,79	8,768	0,0021
2013	Most Likely	Kramat Mulya, Kuningan, Jalaksana, Sindang Agung,	466279	8,94	171	109,58	2,63	29,277	< 0,001

Year	Cluster Type	Subdistrict	Population	Radius (km)	Actual Cases	Expected Cases	Relative Risk	LLR	p-value
		Cigugur, Japara, Cipicung, Ciganda Mekar, Cilimus, Kadugede, Garawangi							
2014	Most Likely	Cigugur, Jalaksana, Kramat Mulya, Kadugede, Kuningan, Nusaherang, Darma, Cilimus, Sindang Agung, Garawangi, Mandirancan, Japara, Hantara	517955	12,32	86	59,57	2,35	11,079	< 0,001
	1 st secondary	Luragung	44738	0	9	5,15	1,81	1,23887	0,968
2015	Most Likely	Kuningan, Kramat Mulya, Sindang Agung, Garawangi, Kadugede, Cigugur, Nusaherang, Cipicung, Jalaksana, Ciniru	388940	8,75	539	371,47	1,97	57,398	< 0,001
	1 st secondary	Luragung, Lebakwangi	78085	5,75	90	74,58	1,23	1,62	0,915
2016	Most Likely	Kadugede, Nusaherang, Darma, Kuningan, Cigugur, Hantara, Ciniru	257432	8,05	685	416,98	2,07	101,679	< 0,001
	1 st secondary	Sindang Agung, Cipicung	61595	3,99	145	99,77	1,5	9,618	0,001
2017	Most Likely	Kramat Mulya, Kuningan, Jalaksana, Sindang Agung, Cigugur	265117	5,9	363	180,68	3,01	105,378	< 0,001
	1 st secondary	Ciawi Gebang	83302	0	68	56,77	1,22	1,138	0,979

Source: secondary data processing

DISCUSSION

Although there is still limited use of applied spatio-temporal techniques to understand dengue epidemiology in Indonesia, some studies had started to apply GIS approaches. For example, studies have used descriptive GIS and/or remote sensing techniques to document dengue in some endemic districts in Indonesia such as studies in Lampung[10], Tanjungpinang[11], South Kalimantan[12], and Yogyakarta[13]. A few studies were using saTScan to analyze spatio-temporal aspect of dengue cases in Indonesia such as in Jakarta[14], Yogyakarta[15], and Bandung[16]

From the cluster pattern in figure 1, we found that the high-risk areas spread from the north to the west during the timeframe of the study. The pattern is along the main route connecting the northern part of West Java (Cirebon) to the southern part (Majalengka-Ciamis). The route's major aim is travel and trade, which are globalization factors that contribute to the rapid spread of vector-borne infectious illnesses such as dengue. These variables were linked to vector-accommodating patterns in modern human settlements as well as favorable climate conditions.[17]

Asides from that, from the 17 most likely subdistricts that are shown as dengue high-risk areas (Table 1), Kuningan Subdistrict was consistently identified as a most likely cluster from 2009 until 2017. Kuningan Subdistrict, located in the heart of Kuningan, is the capital of the district with 3,167.93 persons per km^2.[18] One likely explanation for this phenomenon was that the potential transmission happened in the district's core, where most people interacted strongly in public spaces regardless of health status. Dengue fever transmission was aided by the presence of suitable breeding sites in public places, vector populations, and highly mobile persons (commuters).[19,20] Additional research is required to uncover potential risk factors in these high-risk clusters.

Potential risk factors that could be in association with the dynamic spread of high-risk areas within Kuningan were lie in the interaction between vector, host, and the environment. Climate (temperature, rainfall, and relative humidity), human-related, socioeconomic, demographic, and ecological factors all have an impact on these parameters (virus, vector, and human host).[21] For example, biophysical environments such as climate factors (precipitation, temperature) and immature habitat of vectors are affecting DENV ecology.[22] There were many different associations of dengue outbreaks with various climate and socio-economic variables reported. [23–27]

We urge more research because our results do not properly predict RR due to a lack of information on some significant factors, such as vector density and related environmental and socioeconomic parameters. However, our research has provided a perspective on dengue cases that can be used by local health managers and disease surveillance personnel to monitor prospective outbreaks and make decisions about how to implement an effective response.

CONCLUSION

Seventeen statistically significant dengue clusters were identified in the 2008-2017 period. Clusters were most frequently detected as in the nine of ten periods of study is Kuningan, whereas Jalaksana emerged as a high-risk cluster in six of ten-year periods. Importantly, there was a tendency of dengue cases spread from the north to the west part of Kuningan.

RECOMMENDATION

Future research to investigate the primary interconnected elements could be considered to investigate epidemics that may have originated from high migration across the districts. Dengue risk factor’s investigation is needed especially in subdistrict Kuningan and Jalaksana to provide evidence in dengue transmission control policy in Kuningan District.

AUTHOR CONTRIBUTION

In this article, both MEAF and AR are main contributors, with MEAF conduct conceptualization, investigation, analysis, and writing while AR conduct methodology, data curation, analysis, and review.

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