SPATIAL ANALYSIS MOVEMENT OF DENGUE FEVER IN X HEALTH SERVICE, WEST JAVA INDONESIA: 2016 – 2019

Analysis Spasial Pola Pergerakan Demam Berdarah Dengue di Wilayah Kerja Puskesmas X, Jawa Barat Indonesia; 2016 – 2019

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ABSTRAK

Peningkatan kasus DBD sangat signifikan di Kabupaten Bandung Barat pada awal tahun 2019, hingga akhir Januari tahun 2019 mencapai 356 kasus. Belum ada informasi mengenai pola sebaran kasus dan lokasi yang berpotensi sebagi tempat penularan DBD. Informasi spasial dapat memperkirakan pola persebaran kasus dan dapat menjadi dasar pengambilan keputusan dalam pengendalian DBD. Tujuan penelitian ini adalah memetakan kasus DBD berdasarkan lokasi pasien di wilayah kerja Puskesmas X Kabupaten Bandung Barat, mengidentifikasi karakteristik pasien, menganalisis kepadatan penduduk, dan menentukan peta sebaran kasus DBD. Jenis penelitian merupakan deskriptif dengan pendekatan analisis laporan kasus dan spasial. Hasil analisis menunjukkan bahwa persebaran DBD di Puskesmas Cimareme tahun 2016 – 2019 menyebar ke arah timur laut dan barat daya. Daerah tersebut merupakan wilayah Desa Cilame dan Desa Tanimulya, yang merupakan wilayah dengan kecenderungan kasus dan kepadatan penduduk yang tinggi. Sedangkan Pola pergerakan kasus DBD pada tahun 2016, 2018 dan 2019 termasuk mengelompok, sedangkan tahun 2017 termasuk kategori mengacak. Upaya pengendalian kasus DBD dapat dilakukan melalui Gerakan 1 Rumah 1 Jumantik (G1R1J), membudidayakan kerjabakti setiap jumat (Jumat Bersih), dan pengendalian nyamuk dengan 3 M.

Kata kunci: Kasus DBD, Karakteristik DBD, Pola Pergerakan DBD

ABSTRACT

The increase in dengue cases was very significant in West Bandung Regency from early 2019, until the end of January 2019 reaching 356 cases. There is no information about the pattern of distribution of cases and locations that have the potential to be a place for dengue transmission. Spatial information can estimate the pattern of distribution of cases and can be the basis for decision-making in dengue control. The purpose of this study was to map DHF cases based on the patient's location in the working area of the X Health Center, West Bandung Regency, identify patient characteristics, analyze population density, and determine a map-based distribution of DHF cases. This type of research is descriptive with a case report analysis and spatial approach. The analysis shows that the distribution of DHF in the Cimareme Health Center in 2016 – 2019 spread to the northeast and southwest. The area is the area of Cilame and Tanimulya Villages, which are areas with a tendency for cases and high population density. Meanwhile, the pattern of movement of dengue cases in 2016, 2018, and 2019 is classified as clustered, while 2017 is a randomized category. The dengue case-control can be carried out through the Jumantik 1 Rumah 1 Jumantik (G1R1J). cultivate community service every Friday (Jumat Bersih), and mosquito control with 3 M.

Keywords: *DHF Cases, DHF Characteristics, DHF Movement Patterns*

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is transmitted through the bite of the Aedes aegypti or Aedes albopictus mosquito, which lives throughout the year and can attack all age groups of the population. This disease is related to environmental conditions, climate, high mobility, population density, housing expansion, and community behavior. The study in Purwosari Village, Gunung Kidul District, Indonesia, showed a correlation between dengue cases and physical geography, water sources, high vegetation density, elevation, humidity, and rainfall, which created ideal habitats for mosquito growth [1].

DHF cases occurred in almost all West Java cities and districts in early 2019 [2]. Until January 31, 2019, there were 2,461 DHF cases, of which 18 people died. Five areas with high DHF cases were Depok City with 319 cases, Bandung Regency with 236 cases, Bandung City with 224 cases, West Bandung Regency with 356 cases, and Cimahi City with 200 cases. West Bandung Regency in 2017 saw 201 cases, with 48 cases in January; in comparison, 2018 had 429 DHF cases, with 40 cases in January. A sharp spike in cases occurred in West Bandung Regency with 32 Health Center working areas, two of which are Jaya Mekar Health Center and Cimareme Health Center.

Surveillance officers of the West Bandung Regency Health Office declared that the Jayamekar and Cimareme Health Centres were the two highest-ranked Health Centre for DHF cases in 2016 – 2019, with 314 cases and 399 cases with three deaths, respectively [3]. However, no information is available for the distribution pattern of DHF potential transmission places in the working area of the Cimareme Health Center, West Bandung Regency. Obtaining this information requires further study to confirm the case distribution location and the potential transmission location. Spatial data from DHF mapping can estimate the distribution pattern and help decision-making in DHF control, as has been done In Gunung Kidul Regency, Magetan (Indonesia), Taiwan, Putrajaya, and Seremban (Malaysia) [1],[4],[5],[6],[7].

Geographic Information System (GIS) using spatial factors will help identify the spread pattern of DHF spatial analysis movement of Dengue Fever in Cimareme Health service. Spatial factors can base planning when processed with the proper method. The spatial analysis considers the physical and socio-economic conditions of the area. Health risks can also be estimated based on determinants using spatial analysis to prioritize interventions and formulate mitigation policies [5]. Spatial information can ease local policy interventions, specifically in high-risk areas or regions. The purpose of this study was to map DHF cases based on the patient's location in the working area of the Cimareme Health Center, West Bandung Regency, identify patient characteristics, analyze population density, and determine a map-based distribution of DHF cases.

METHODS

This is a descriptive study with a case report and a spatial approach, quantitative and qualitative research in the working area of the Cimareme Health Center, West Bandung Regency, West Java Province. The working area covers six villages: Cimareme, Gadobangkong, Pakuhaji, Tanimulya, Cilame, and Margajaya. The research was conducted from April to November 2020. The study population was 399 DHF patients who lived in the working area of the Cimareme Health Center, West Bandung Regency in 2016 – 2019; and had been identified as immunologically positive (IgM and IgG) by doctor.

The sample inclusion criteria were DHF patients residing in the working area of the Cimareme Health Center, West Bandung Regency, in the last four years (2016 – 2019). While the exclusion criteria were not found at the recorded address, patients refusing to participate in surveys; and patients that moved locations. The research variables were the number of DHF patients based on location (2016 – 2019), patient characteristics based on gender, age, and time/month of illness, population density, and DHF mapping consisting of 4 maps: 1) case mapping based on location; 2) DHF patients distribution pattern; 3) DHF directional distribution; 4) distribution of DHF high-risk areas.

A descriptive study regarding the spatial analysis movement of Dengue Fever in Cimareme Health Service has been approved by the Bandung Health Polytechnic Ethics Committee with Ethical Certificate No. 25/KEPK/EC/X/2020.

Data collecting method by plotting GPS at the patient's house using a Hand Phone according to the patient's recorded address and conducting secondary data documentation of Cimareme Health Center, West District Health Office, and Ngamprah District West Bandung Regency. Data were collected with a Hand Phone (HP) and questionnaire sheets. Data analysis was carried out by 1) Digitizing data on DHF cases into coordinates by plotting the address of the case; 2) Nearest Neighbor Analysis (NNA) was used to explain the distribution pattern of location points by calculating the distance, number of location points and area [8]. Nearest Neighbor Analysis (NNA) analysis resulted in an index between 0 – 2.15; a value of 0 indicates a clustered pattern, a value close to 2.15 has a regular pattern, and a middle value indicates a random pattern; 3) Analyzing the density distribution pattern in an area, one of which is the DHF density using Kernel Density Estimation; 4) Calculating the DHF distribution trend in the work area of the West Bandung District Health Center, with the Standard Deviational Ellipse directional distribution, the directional distribution can be seen in a map, base on GIS-base analysis.

RESULT

DHF Cases in the Cimareme Health Center Working Area

The number of DHF patients by location in the six villages in the Cimareme Health Center work area, West Bandung Regency in 2016 – 2019 is shown in Table 1.

Table 1. Frequency and Percentage of DHF Patients by Location in the Cimareme Health Center's Working Area, West Bandung Regency 2016 – 2019

No	Village Name	Frequency (F)	Percentage (%)
1	Cimareme	23	8.8
2	Gadobangkong	25	9.6
3	Tanimulya	68	26.1
4	Pakuhaji	32	12.3
5	Cilame	91	34.9
6	Margajaya	22	8.4
	Amount	261	100.0

Table 1 shows the majority of DHF patients were located in Cilame Village (34.9%), Tanimulya (26.1%), Pakuhaji (12.3%), Gadobangkong (9.6%), Cimareme (8.8%), and Margajaya (8.4%).

Characteristics of DHF Patients

Characteristic data on DHF patients indicate that males tend to be infected with DHF more than their female counterparts, with 54.4% and 45.6%, respectively shown in Table 2.

Table 2. Frequency and Percentage of DHF Patients by Gender in the Work Area of the Cimareme Health Center, West Bandung Regency, 2016 – 2019

No	Gender	Frequency (F)	Percent (%)
1	Male	142	54.4
2	Female	119	45.6
	Amount	261	100.0

Table 3. Frequency and Percentage of DHF Patients by Age in the Working Area of Cimareme Health Center, West Bandung Regency, 2016 – 2019

No	Age (years)	Frequency (n)	Percentage (%)
1	Toddler (0 – 5 years old)	33	12.6
2	Children (6 – 11 years old)	56	21.5
3	Early Adolescence (12 – 16 years old)	57	21.8
4	Late Adolescence (17 – 25 years old)	43	16.5
5	Early Adult (26 – 35 years old)	27	10.3
6	Late Adult (36 – 45 years old)	20	7.7
7	Early Elderly (46 – 55 years old)	18	6.9
8	Late Elderly (56 – 65 years old)	5	1.9
9	Seniors (> 65 years old)	2	.8
	Amount	261	100.0

Table 3 shows the frequency and percentage of DHF Patients by age in the Working Area of Cimareme Health Center, West Bandung Regency, 2016 – 2019.

Population Density

The population density in the Cimareme Health Center working area, West Bandung Regency in 2019 is shown in Table 4.

Table 4. Frequency and Percentage of the Total Population in the Work Area of the Cimareme Health Center, West Bandung Regency in 2019

No	Village Name	Frequency (F)	Percentage (%)
1	Cimareme	22.215	17.5
2	Cilame	20.461	16.1
3	Margajaya	22.934	18.1
4	Tanimulya	20.674	16.3
5	Gadobangkong	21.026	16.2
6	Pakuhaji	19.877	15.8
	Amount	**127.187**	**100**

DHF Case sand Distribution in 2016 – 2019

Figure 1 shows the case and spatial Information of DHF Distribution in 2016 - 2019 in the Work Area Of Cimareme Puskesmas, Ngamprah District West Bandung District, West Java Province.

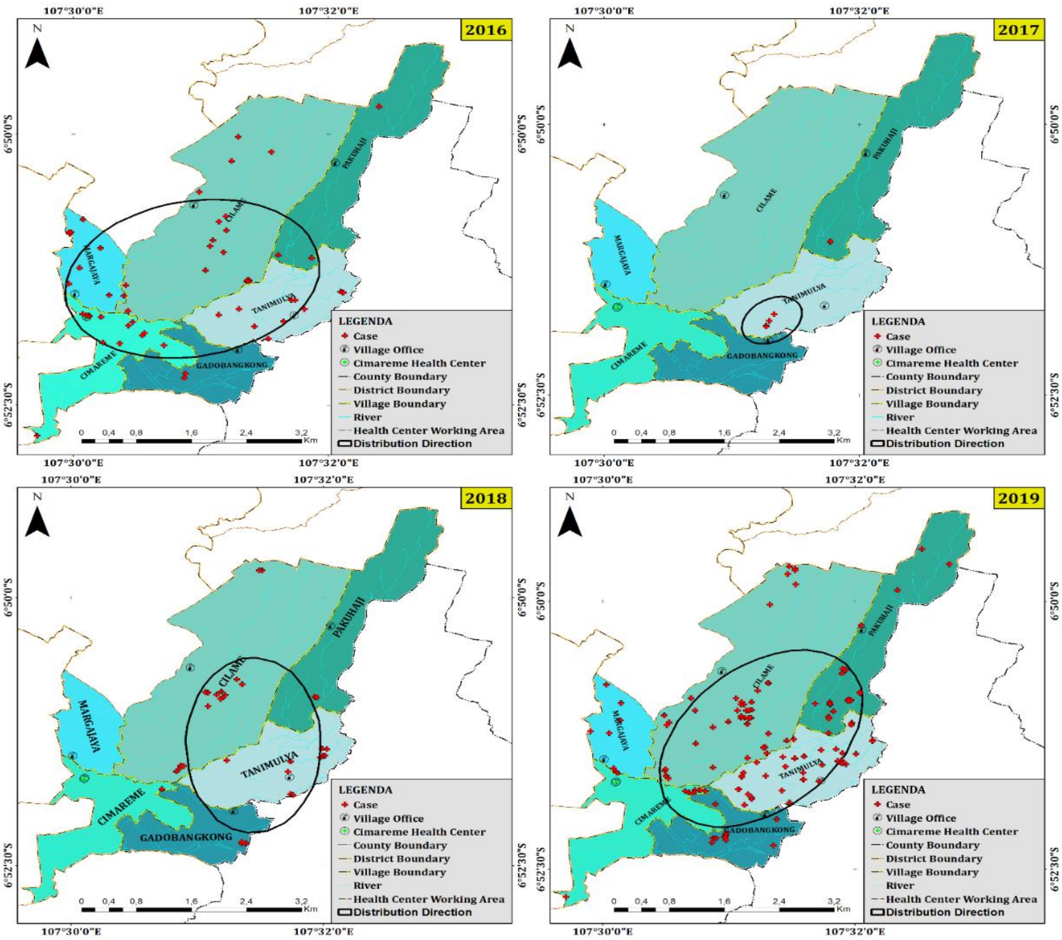

Figure 1. Standard Deviational Ellipse Test Results
DHF Cases And Distribution Spatial Direction in 2016 – 2019

Distribution Pattern of DHF Patients in 2016 – 2019

The distribution pattern with the ANN analysis from 2016 – 2019 is clustered; however in 2017 had a random pattern with few cases. The DHF distribution pattern in West Bandung Regency occurs in groups or clusters. Therefore, areas with clustering are at high risk of DHF as shown in Figure 2.

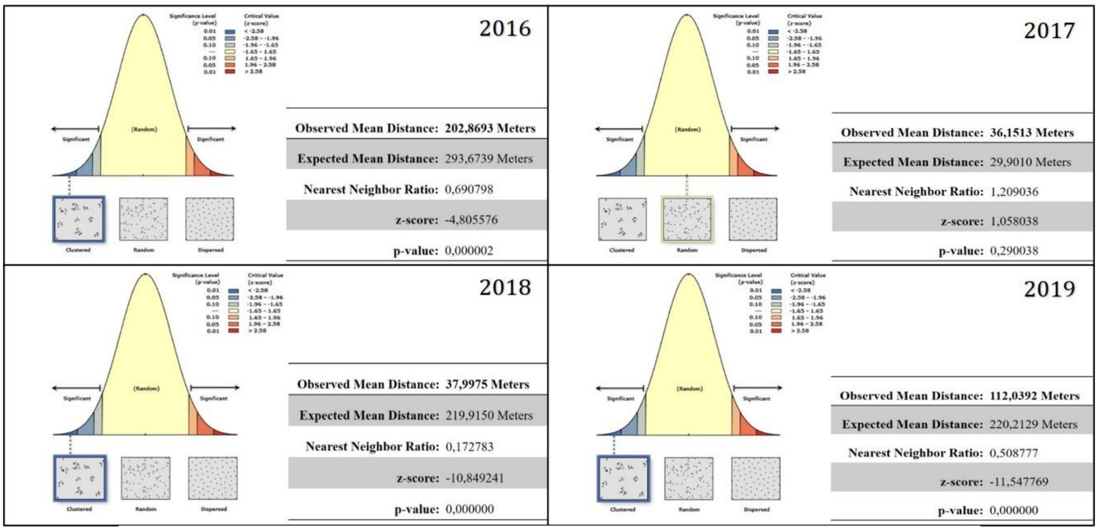

Figure 2. Distribution Pattern of DHF Patients in 2016 – 2019

Distribution of DHF-Prone Areas

Figure 3 shows the spatial distribution of DHF High-risk Areas in 2016-2019 using Kernel Density Estimation of Cimareme Health Center Work Area, Ngamprah District, West Bandung District, West Java Province.

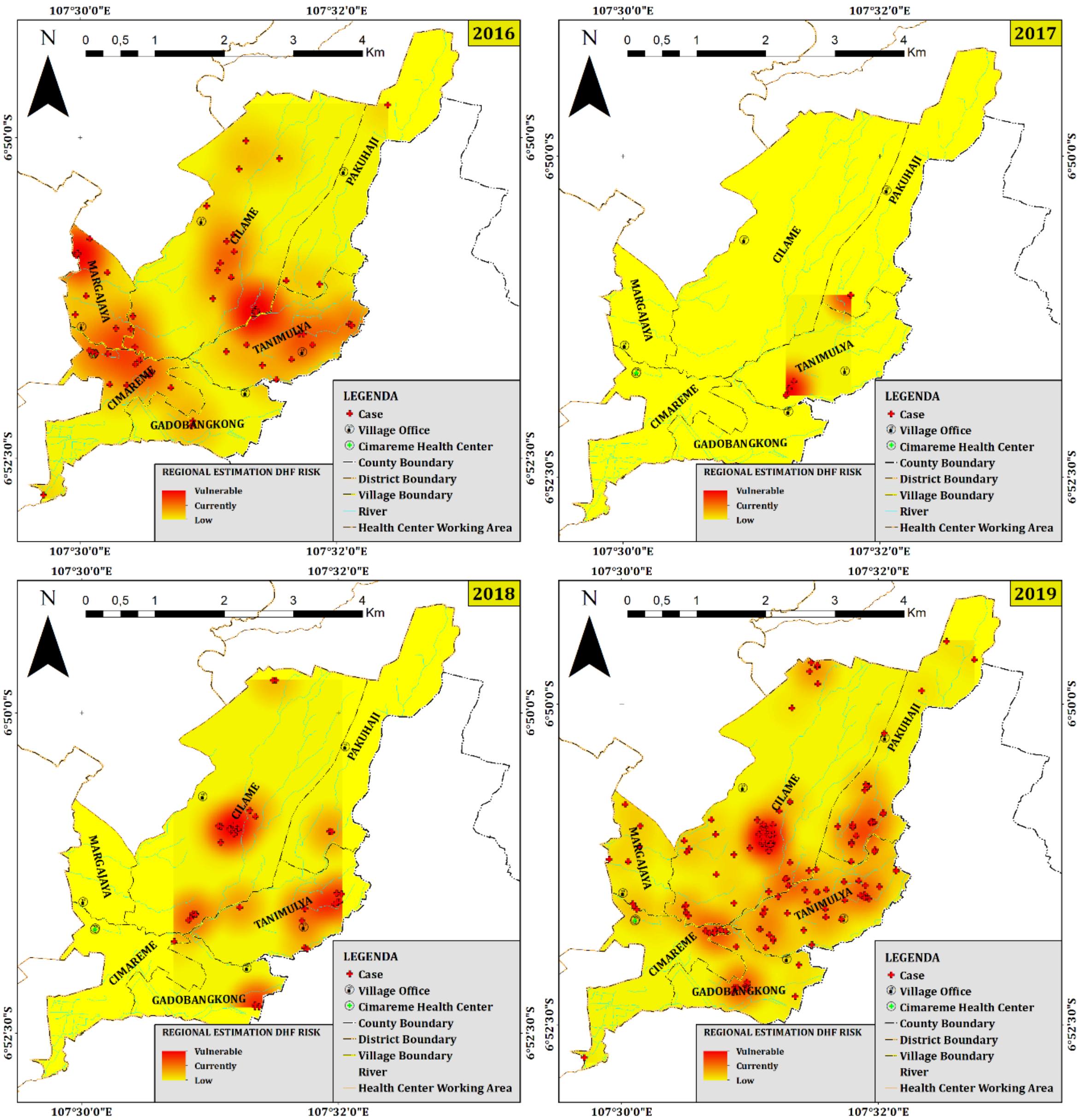

Figure 3. Kernel Density Estimation Spatial Distribution of DHF High-risk Areas in 2016 – 2019

DISCUSSION

DHF Cases in the Cimareme Health Center Working Area

The number of DHF patients by location in the six villages in the Cimareme Health Center work area, West Bandung Regency in 2016 – 2019 shows the majority of DHF patients were located in Cilame Village were 91 cases (34.9%). This is supported by the annual report Cimareme Health Service data shows that the Larva-Free Index (LFI) in 2016 and 2018 was 89%. A good LFI, according to the Indonesian Ministry of Health in 2019 > 95%. A past study showed a relationship between LFI and DHF in the research location of RW II Kedurus Village, Surabaya City [8].Another factor is the community's behavior regarding 3 M, namely closing and burying used goods, draining water reservoirs, the habit of hanging clothes, and the use of wire gauze on home ventilation. There was a relationship between behavior and DHF incidences in Ciracas District, East Jakarta [7]. Yenni's research noted a connection between home sanitation conditions (water reservoirs, landfill, and wastewater drain), and DHF incidence in North Rantau District, Labuhanbatu Regency[9].

Characteristics of DHF Patients

Characteristic data on DHF patients indicate that males tend to be infected with DHF more than their female counterparts, with 54.4% and 45.6%, respectively. This further supported Herlina's research in Rokan Hulu Regency, where it found that 107 cases (53.5%) of those suffering from DHF were male, and based on the researcher's analysis, most men in the Rokan Hulu Regency worked in offices, enabling the transmission of DHF [10] Research in Tasikmalaya City also showed that men tend to get DHF more than women with 52.82% and 47.18%, respectively. Out of the 1,437 case respondents 759 were male and 678 were female [11].

Women have a lower frequency of disease infection than men, because men conduct more outdoor activities, enabling more access for the vector, as opposed to women who remain at home during high dengue virus vector activity. In addition, women have a better immune response than men as the cytokines production in women is more significant than men. The cytokine hormone regulates the intensity and duration of the immune response in a person's body [12].The low incidence of DHF cases in women occurs because women stay at home more, reducing their exposure to the dengue virus when compared to men [12].

DHF patients based on age showed that 12 – 16 years (early adolescence) had the most DHF patients, which amounted to 57 people (21.8%). Age is a factor in a person's sensitivity to dengue virus infection, because their activity pattern and low body immunity. All age groups can be infected with the dengue virus, including babies only a few days old [13]. During 1968 – 1973, approximately 95% of DHF attacked children under 15 years old. In 1999 – 2009, DHF tended to attack people ≥ 15 years [14]. Figueiredo conducted a DHF case-control study in two coastal cities in Northeastern Brazil Salvador and Fortaleza showed 170 cases of DHF, approximately 79.4% occurred in individuals over 15 years old, and 20.6% occurred in individuals 15 years old and younger[15].

Age is a massive factor in DHF incidence as children's immune systems are more vulnerable than adults; because DHF virus will attack the human immune system. Most children are active outside during the day and evening. Dengue transmission can occur in public places, including schools, which are potential places of transmission. *Aedes aegypti* mosquitoes are widely found in residential areas, and schools as these two locations accommodate its life medium.

Population Density

The total population in the Cimareme Health Center Work Area, West Bandung Regency was 2,257.8909 people, of 56.33 km^2 area, making the population density 2,257.8909 people/km^2. Based on Law No. 56 of 1960, population density is categorized into not dense if the population is less than equal to 50/km^2, less dense if the population per 51 – 100/km^2, sufficient if the population is 251 – 400/km^2, and dense if the population is more than 400/ km^2. Thus, the population density in the working area of the Cimareme Health Center is categorized as densely populated. Population density is one factor of DHF incidence, it showed a relationship between population density and DHF incidence in Sleman Regency [16].

DHF cases in West Bandung Regency, West Java Province in the map (Figure 1) are spread across the Health Centre working area. In 2016 the highest cases were in Cilame

Village with 20 cases, while the lowest cases were in Gadobangkong Village with 2 cases. In 2017 the highest cases were in Tanimulya Village with 4 cases, while Gadobangkong, Cimareme, Cilame, and Margajaya Village had no DHF cases. In 2018 the highest cases were in Cilame Village with 19 cases, while Margajaya Village had no DHF case. In 2019 the highest cases were in Cilame Village with 52 cases, while the lowest cases were in Margajaya Village with 8 cases

Distribution Pattern of DHF Patients in 2016 – 2019

Disease mapping can be used to formulate steps for DHF control through spatial analysis[17]. Spatial analysis shows locations of the DHF distribution and the actual distribution through the earth's surface. Like previous studies using spatial analysis, the 6,076 DHF cases during 2003 – 2009 in Seremban Malaysia District showed a clustered pattern of DHF cases [18]. The study in Kendari City showed a clustered DHF distribution in the working area of the Lepo-Lepo Health Center Kendari City from 2013 - 2016 with a smaller NNI value was -20.15 [19].

DHF was only concentrated in densely populated residential areas and endemic areas; thus, only certain areas are clustered [4]. In addition, the increasing population growth, especially in urban centers, pushes specific individuals to be vulnerable to DHF. Therefore, areas with large populations and high population density cause a high incidence of DHF. So far, DHF has been primarily reported in urban areas and areas with strategic new settlement developments. These conditions cause the population to become denser and cause residence density in the area. This causes the flight distance of dengue vectors to be shorter so that transmission is more accessible and creates ideal conditions for transmission [4].

The direction of DHF distribution in 2016 started from the northeast to the southwest; 2017 showed a southwest-to-northeast direction; 2018 showed south to north direction, and 2019 showed a southwest-to-northeast direction (Figure 3). The map demonstrates that the Standard Deviational Ellipse (SDE) model of DHF directional distribution in the Cimareme Health Center work area follows the x-axis or the northeast and southwest directions. This shows that DHF distribution in the Cimareme Health Center work area in 2016 – 2019 spread to the northeast and southwest

Direction of DHF Distribution in 2016 – 2019

The map further in Figure 3 indicates the direction follows the Cilame and Tanimulya Village, areas with a high DHF tendency and high population density. This phenomenon happens because the high DHF tendency and high population density, the Cilame and Tanimulya Village areas also have high population activities compared to other areas, especially housing complexes in the area.

High population activity results in higher mobilization in the area, causing many people to come and pass through the area; this can affect the health status of the local population [20]. This is in line with Barmak's statement, which states that population activities such as mobility affect DHF distribution as it helps and accelerates the spread of disease[21]. Gama and Betty's research found that population mobility is a risk factor for DHF as it is a carrier for DHF to enter the area[22].

Distribution of DHF-Prone Areas

The DHF high-risk area mapping in the Cimareme Health Center Work Area shows that the DHF high-risk areas are different every year. DHF high-risk areas are symbolized by a solid red color, the medium risk is symbolized by a pink color, and the low risk is symbolized by a yellow color on the map based on the area's case-point density. However, there is a consistent risk of DHF in Cilame and Tanimulya Village, as proven by the consistent DHF high-risk plottings every year, except in 2017, which had relatively small cases. According to Renni's research, Kernel density estimation could show DHF high-risk areas in Sukoharjo [23].

Physical Environmental Analysis DHF Cases in the Cimareme Health Center Working Area

Physical environmental secondary data analysis to identify whether the geographical features were suitable for the cycle of DHF-carrier mosquitos, including climate (temperature dan humidity), geomorphology (elevation), and rainfall data from Statistic Indonesia [24]. The area of Bandung Barat Regency, as a whole, is 1.305,77 km^2. Bandung Barat Regency is located at 6^0,373' – 7^0,131' South Latitude and 107^0,110' – $107^0$4,40' 06" East longitude. Ngamprah Sub District is located in West Bandung Regency with a 36,01 km^2 covered area, and 11 (eleven) villages including Cimareme, Cilame, Margajaya, Tanimulya, Gadobangkong, and Pakuhaji.

Ngamprah Sub District which is located from 800 – 1.000 meters above sea level (asl), where these elevations are suitable for the DHF-carrier mosquitoes for living and breeding conditions (0 – 1.700 m asl) [25],[26],[27]. Climate conditions showed that the temperature range was 19.5 °C – 29.9 °C, with an average temperature of 23.5 ^{0}C [24]. The average temperature condition in Ngamprah Sub District was ideal for living and breeding conditions of DHF-carrier mosquitoes (20°C – 30°C) [28],[29],[30]. An environment with lower or higher temperatures than this classification can inhibit the growth and multiplication of the carrier mosquitoes [1].

The annual range rainfall between 1.500 – 3.000 mm/year in Ngampah Sub District showed tropical regions with an average of 2.000 – 3.000 mm/year that larvae, pupae, and mosquitoes carry and transmit DHF[31],[32],[33]. The physical environmental analysis results that DHF-cases in Cimareme Health Center Work supported geographical features (elevation, temperature, and humidity) and annual rainfall for the cycle of *Aedes aegypti* mosquitoes, but it needs more future research.

CONCLUSION

The period with the highest DHF incidence was in February with 56 people (21.5%). The movement pattern of DHF cases in the Cimareme Health Center Work area, West Bandung Regency in 2016, 2018, and 2019 were clustered, while 2017 was random (not clustered). The DHF directional distribution in 2016 is from northeast to southwest, 2017 is from southwest to northeast, 2018 is from south to north, and 2019 is from southwest to northeast.

Distribution of DHF high-risk areas in the Cimareme Health Center Work Area, West Bandung Regency: In 2016, the high-risk areas were in parts of these villages: Tanimulya, Cilame, Margajaya, and Cimareme. In 2017 the high-risk areas were in parts of Tanimulya and Pakuhaji Villages. In 2018, the high-risk areas were parts of these villages: Tanimulya, Gadobangkong, and Cilame. Meanwhile, in 2019 the high-risk areas were parts of these villages: Tanimulya, Gadobangkong, and Cilame. The dark red color indicates that the area has a high risk of spreading dengue disease.

It is necessary to increase supervision and coordination between the West Bandung District Health Office, Public Health Centers, and local government officials to control DHF. Sanitation and surveillance officers in Cimareme Heath Service must activate the Jumantik 1 House 1 Movement (G1R1J) and cultivate community service every Friday (Clean Friday). The community must increase mosquito control efforts by 3 M and conduct community service every Friday (Jumat Bersih), especially in Tanimulya, Gadobangkong, and Cilame area.

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