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DAFTAR ISI

APPLICATION OF SPATIAL ANALYSIS OF DENGUE HEMORRHAGIC FEVER RISK FACTORS IN TAMAN DISTRICT MADIUN

Riyani Dwi Rivyantanti[1], Nur Fitriana Arifin[2]✉, Mursid Rahardjo[1], Yusniar Hanani Darundiati[1]
[1]Public Health Faculty, Diponegoro University, Semarang
[2]Post Graduate Program of Epidemiology, Diponegoro University, Semarang
e-mail: nurfitrianaarifin@gmail.com

ABSTRACT

DHF often causes outbreaks and closely related to the environment. Dengue incidence in the Madiun City increase continuously and the highest incidences occurred in Taman Sub District with IR reached 108.4 per 100,000 population. This research has purpose to analyze the spatial relationship between environmental and behaviors factors with the incidence of Dengue Hemorrhagic Fever (DHF) using Geographic Information System (GIS) in the Taman Sub District of Madiun City. This was an observational analytic research applying case control design. In this research, the sample groups were case sample and control sample. The total members of case and control were 40 members in every group.The case samples were DHF patients from January to May 2015 who living in Taman sub district and the case control were the neighbors who were not infected by DHF. Data were analyzed in univariate and bivariate using Chi Square and spatial analysis using ArcMap. Univariate analysis showed 76.2% risk oftemperature, 18.8% risk of humidity, 75% of high population density, 100% risk altitude, 72,5% ABJ & HI-risk, 31,2% risk CI, 31,2% poorknowledge, 31,2% poor attitude,42,5% poorpractice. This research found that there was a association between the ABJ (p=0,001), HI (p=0,001), CI (p=0,054), and practice (p=0,003) and the dengue case. There was no a relationship between temperature (p=0,599), humidity (p=1,000), population density (p=1,000), knowledge (p=0,335), attitude (p=1,000) with dengue case, while for altitude obtained homogeneous. Mapping the incidence of DHF showed the proportion of a greater dengue incidence was found in the region which was has an average risk temperature, high overcrowding, ABJ & HI-risk, as well as poor of attitudes and practices. Therefore, spatial analysis showed that ABJ & HI-risk and poor PSN practices affected the increase of dengue incidence in Taman sub districts.
Keywords: DHF, environmental factors, behavioral factors, spatial analysis

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is one of transmitted diseasecaused by dengue virus and transmitted by the biting of Aedesaegyptimosquito (1). At global scale, 2.5 billions of people are living in areas with high risk of the dengue virus transmission (2). In Indonesia, DHF was firstly found in Surabaya in 1968. The outbreak caused 58 people infected, 24 of them died (Case Fatality Rate = 41.3%). Since then, the DHF incident have spread nationwide (3).

The DHF spread pattern is affected by several behavioral and environmental factors, which allow the growth of Aedesaegyptiand dengue virus transmission. Environment factors such as temperature and humidity affect the survival rate of the mosquitos (4)(5).

Aedesaegyptiis a mosquito species that grows in both tropical and sub-tropical areas. Therefore, the species does not grow well in the area beyond 1,000 meters above the sea level.4. In addition, the spread is also affected by the species ability to fly up to approximately 100 meters. The virus works well in the area with high density rate (6).

Vector density in an area may determine the risk of the area to suffer from DHF. Indicators that can be used for measuring the risk are larvae-free rate (ABJ), house index (HI), container index (CI), and Breteau index (BI) (5).

In addition to environmental factors, the DHF is also affected by behavioral factors, such as knowledge, attitude, and practice. Knowledge is a very important aspect to develop overt behavior of an individual. Behavior is an introvert reaction of an individual to a particular object. Results of the knowledge and behavior is manifested into a real action in the form of practice (7). Practice of preventing the DHF and vector elimination are two important efforts to decrease morbidity and mortality rates due to the disease.

The intervention of the DHF case needs a good surveillance, among others, through the application of the Geographical Informa-tion System (GIS). GIS is capable of displaying DHF-prone areas, so that it can help minimize the DHF transmission by controlling vectors and potential outbreak (8).

According to data obtained from the Municipal Office of Health Affairs of Madiun (2012-2014), the DHF case in Madiun had been continuing to grow, with the highest rate recorded in 2014 (IR = 97.9 per 100,000 population) (9). The highest DHF case in 2014 occurred in Taman District (IR = 108.4 per 100,000 population). Furthermore, data of Madiun also reports that Taman District becomes the DHF endemic area (10).

Insights gained in this study are the environmental and behavioral factors related to the DHF incident using the GIS in Taman District Madiun.

METHODS

This study applied an observational research method with an analytic case control study design. Samples consisted of 80 respondents, divided into two groups (40 samples for case group and 40 samples for control group). The case group consisted of DHF patients for the period of January-May 2015. They were collected by a simple random sampling. The control group consisted of individuals who live nearby the patients at the distance of approximately 100 meters for the period of January-May 2015. There was a matching between case and control by age (the maximum age difference was five years) and by similarity of neighborhood conditions. The data were analyzed by univariate and bivariate techniques using chi square, followed by a spatial analysis using ArcMap.

RESULTS

The field observation found that the dominant DHF patient characteristics were 10-19 years old (47%), females (52.5%), and domiciled in Manisrejo Village (32.5%). The dominant respondent characteristics were 30-39 years old (31%), females (80%), highschool graduates (70%), and housewives (46%).

Table 1.Univariate analysis of environmental and behavioral factors of respondents in Taman District Madiun in 2015

Variable	Risk/Poor		No Risk/Good	
	n	%	n	%
Temperature	61	76.2	19	23.8
Humidity	15	18.8	65	81.2
Population density	60	75	20	25
Altitude	80	100	0	0
Larvae Free Rate	58	72.5	22	27.5
House index (HI)	58	72.5	22	27.5
Container index (CI)	25	31.2	55	68.8
Knowledge	25	31.2	55	68.8
Behavior	25	31.2	55	68.8
Practice	34	42.5	46	57.5

Table 2.Bivariate analysis of environmental and behavioral factors of respondents in Taman District Madiun in 2015

Variable	Category	Case (%)	Control (%)	P value	OR (95%CI)
Temperature	Risk (20-30°C)	72.5	80	0.599	0.659
	No Risk (<20oC/>30oC)	27.5	20		(0.233-1.865)
Humidity	Risk (70-90%)	17.5	20	1.000	0.848
	No Risk (<70% &>90%)	82.5	80		(0.275-2.613)
Population density	High densisty (>50 population/ha)	75	75	1.000	1.000
	Low density (<50 population/ha)	25	25		(0.353-2.751)
Altitude	Risk (< 1000m asl)	-	-	-	-
	No Risk (>1000m asl)	100	100		
Larvae free rate (ABJ)	Risk (<95%)	90	55	0.001	7.364
	No Risk (>95%)	10	45		(2.204-24.602)
House index (HI)	Risk (>5%)	42.5	20	0.054	2.957
	No Risk (<5%)	57.5	80		(1.091-8.009)
Knowledge	Poor	32.5	25	0.335	1.800
	Good	67.5	75		(0.689-4.702)
Attitude	Poor	32.5	30	1.000	1.123
	Good	67.5	70		(0.436-2.894)
Practice	Poor	60	25	0.003	4.500
	Good	40	75		(1.731-11.696)

DISCUSSION
Temperature

The Aedesaegyptimosquitos will grow optimally at the temperatures of 23-24°C (outdoor) and 25-26°C (indoor). The optimal temperatures for the growth of the mosquitos range from 20°C to 30°C. The upper and the lower thresholds of the optimal temperature allow the growth of parasite in the mosquito body (11).

Mosquito is a cold blooded animal so that its metabolism and life cycle greatly depend on the environment, in particular the temperature (12). The optimal temperature supports the mosquito to grow faster, with higher survival rate, and longer time to bite and to transmit the dengue virus to human.

The Chi Square test resulted in p value of 0.599 (p>0.05) and OR of 0.659. In other words, the study found an insignificant correlation of house temperature to DHF. This insignificant correlation occurred due to relatively similar temperatures between the case and the control groups (26.7-33.4°C). Therefore, no significant different was found between the two groups in case of temperature.

Humidity

Humidity greatly depends on rainfall. In addition to support the nursery ground for the mosquito, rainfall also causes the increase in humidity (13). The humidity affects longevity of the mosquito. The respiratory system of the mosquito uses trachea with spiracles. At the low humidity, spirakel opens wider without controlling mechanism, causing water evaporation from the mosquito body (13). this evaporationmade the body liquid of the mosquito, lowering its survival rate (14).

The Chi Square test of the humidity correlation to DHF resulted in p value of 1.000. In other words, the study found insiginificant correlation between house humidity and DHF.

The insignificant correlation occurred because the humidity in the case's and control's houses did not result in a significant different. The respondents' settlement is affected by altitude. They lived in the equal altitude so that no temperature variation found to affect the humidity.

Population Density

Population density is number of population who settle in particular area per hectare of the area. The higher the density, the higher the potential of disease transmission. It is due to the fact that the higher population density allows the higher transmission rate of the DHF (15).

The population density has been higher through the years, marked by the growing number of people and settlements. The distance between houses also affect the transmission of dengue virues by mosquitos. The closer the distance, the easier the transmission will take place because the mosquitos only have a maximum flying range of 100 meters. Besides, transportation between areas also contributes to the transmission to the other area.

There was no correlation between population density and DHF, as proven by the Chi Square (p value = 1.000). The insignificant correlation was due to the similarity of the population density between the case and the control groups, so that there was not any different potential of the DHF transmission.

Altitude

Altitude is one of environmental factors affecting the growth of the Aedesaegyptimosquito. The study found that the elevation where all respondents lived was categorized into risky elevation (<1000 asl). Taman District is situated on the altitude of 69-78 asl. Therefore, the study could not perform a correlation test because of homogenous data.

The Southeast Asian countries are situated on the altitude of 1000-15000 meters above the sea level, the spread limits of the Aedesaegypti. Adult mosquitos can fly up to 100-200 asl from their nursery grounds.16 Each 1 meter elevation, the temperature will changes 0.5°C. The altitude difference will affect the temperature difference and, in turn, affect the mosquito spread (13).

Larvae Free Rate & House Index

ABJ and House Index (HI) are two indices used for measuring the efforts of eliminating the hemorrhagic fever vectors by estinghuising the mosquito nests.

In principle, the ABJ and HI have the similar function to search for the larvae nest according to the number of house units. Both provide the similar data composition. The ABJ used larvae-free houses, whereas the HI used larvae-occupied houses. Soegiyanto explains that HI is more likely illustrating the mosquito spread in particular area, whereas the ABJ indicates the range of the mosquito spread in the area (14).

The Chi Square test in this study resulted in ABJ/HI correlation to the DHF with p 0.001 (p<0.05). The ABJ had a risk of being affected by vary aspects, among others, irregular larvae surveillance in the affected area. The larvae surveillance greatly depended on the municipal office of health affairs and public health centers. Only a few areas performed a regular surveillance of the mosquito larvae by applying a self-help mechanism mobilized by the local community. Therefore, a program is necessary to empower the community by education and training for larvae surveillance cadres on the responsibility for the prevention of the DHF at the neighborhood (RT/RW) level.

Container Index

Container Index (CI) is a percentage of the water container infected by larvae or pupa. The CI result is different from the HI result because the HI result depends on whether larvae to be found in particular house. On the other hand, the CI result is more specific because it follows the percentage of the containers occupied by the larvae.

In some cases found during the field observation, an area might have a high risk of HI because the larvae rate reached >5%. However, according to the container percentage, the rate became <5% because there were only small amounts of containers occupied by the larvae.

The Chi Square test revealed that the correlation between CI and DHF incident resulted in p = 0.054 (a = 0.05). This p value indicated that the CI correlated to the DHF

incident in Taman District. Such correlation was also proven by the OR = 2.957 (OR>1), meaning that the CI became the risk factor for the DHF in Taman District.

Larvae index calculation using CI can identify vary types of water containers with great potential to be the nursery ground of the Aedesaegyptimosquito (13). Therefore, the CI helps eliminate the mosquito nests in particular area.

The CI study in Taman District indicated a local community poor awareness of the water container as the breeding place for the mosquitoes. The larvae were mostly found in shower pool in the bathroom, still water tract, water container of dispenser or refrigerator, pet drinking tank, water plant pots, and other places with great potential to be the breeding place.

Knowledge

The study documented the knowledge of the respondents based on interviews, where some questions were asked related to the knowledge about DHF, DHF symptoms, and mosquito nest elimination (PSN) practice.

The Chi Square analysis of the correlation between knowledge and DHF incident resulted in p value of 0.335 (p<0.05), meaning that the study found an insignificant correlation between knowledge and DHF incident.

The knowledge possessed by an individual concerning health is very important before he or she acts in responding to health-related issues. However, such actions will never happen unless this individual receives a sign or a fundamental knowledge that motivates him or her to act (17).

The insignificant correlation between the knowledge and the DHF incident was due to good knowledge possessed by the respondents in Taman District about the DHF. Furthermore, knowledge also depends on other aspect than respondents' education level because those with poor education also had a satisfactory knowledge about the case.

On the other hand, adequate knowledge

does not guarantee an individual to have ability to prevent the DHF. It is sometimes difficult for the individual to predict where or when the DHF may infect. A good knowledge about the DHF prevention may not be supported by behaviors.

Attitude

Attitude is an aspect derived from personal experience, or other experience who live nearby the individual. Therefore, attitude is dynamic.17 The Chi Square test using SPSS resulted in p vale of 1.000 (OR=1.123). The p>0.05 indicated an insignificant correlation between attitude and DHF incident in Taman District.

The statistic analysis proved no correlation between attitude and DHF incident because there was not any difference in attitude toward the DHF incident between the

two groups (case and control) in Taman District.

The attitude of the respondents was in an acceptable or responding stage, leading to poor awareness. At this stage the respondents had not had any interest in performing the preventive acts. Besides, the study did not find positive responses to the environment.

Practice

Practice is a result derived from knowledge and attitude of an individual, which can be observed directly. The Chi Square test of the correlation between practice and DHF incident resulted in p value of 0.003 (p<0.05). In other words, there was a significant correlation between practice and DHF incident.

There were some inevitable bad habits, such as hanging clothes in bedroom. The
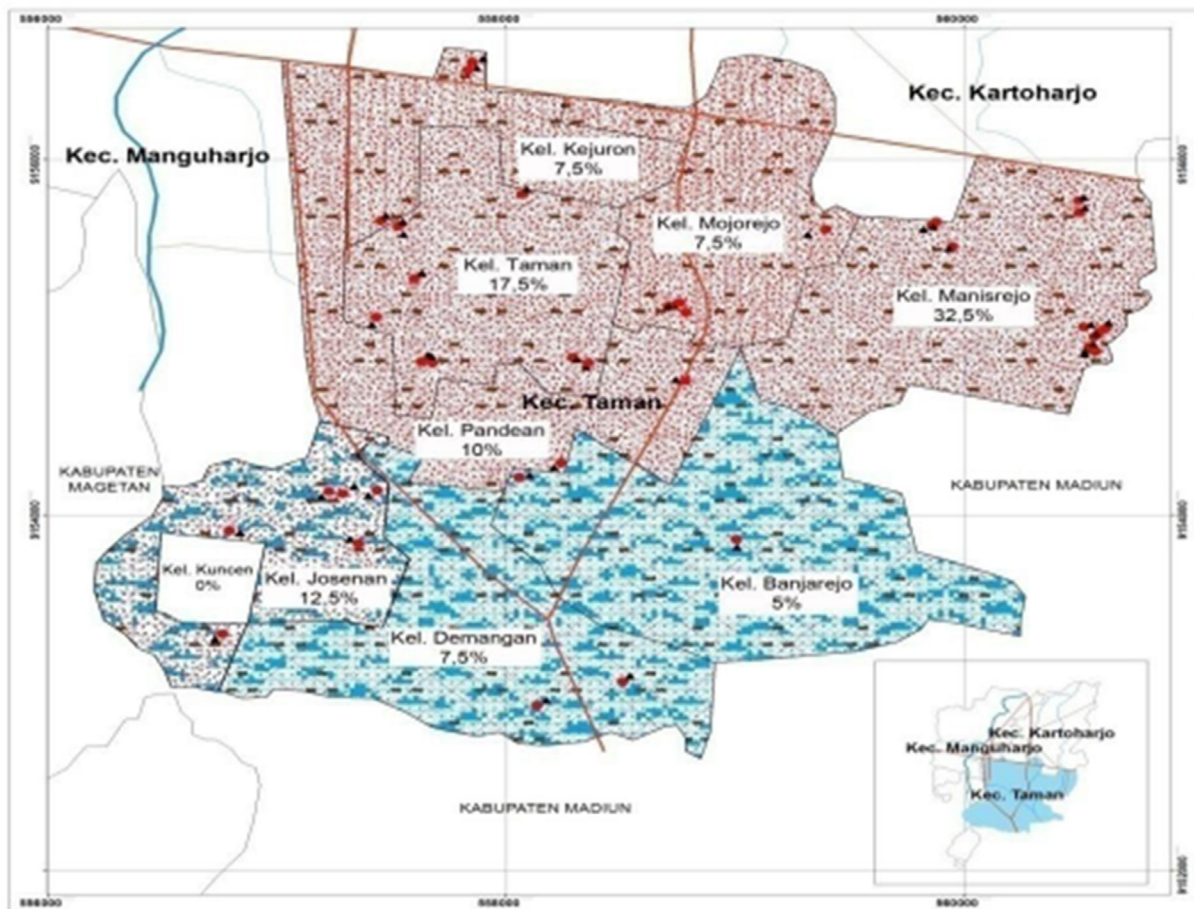

Figure 1. Overlay map of DHF proportion to environmental factors in Taman District
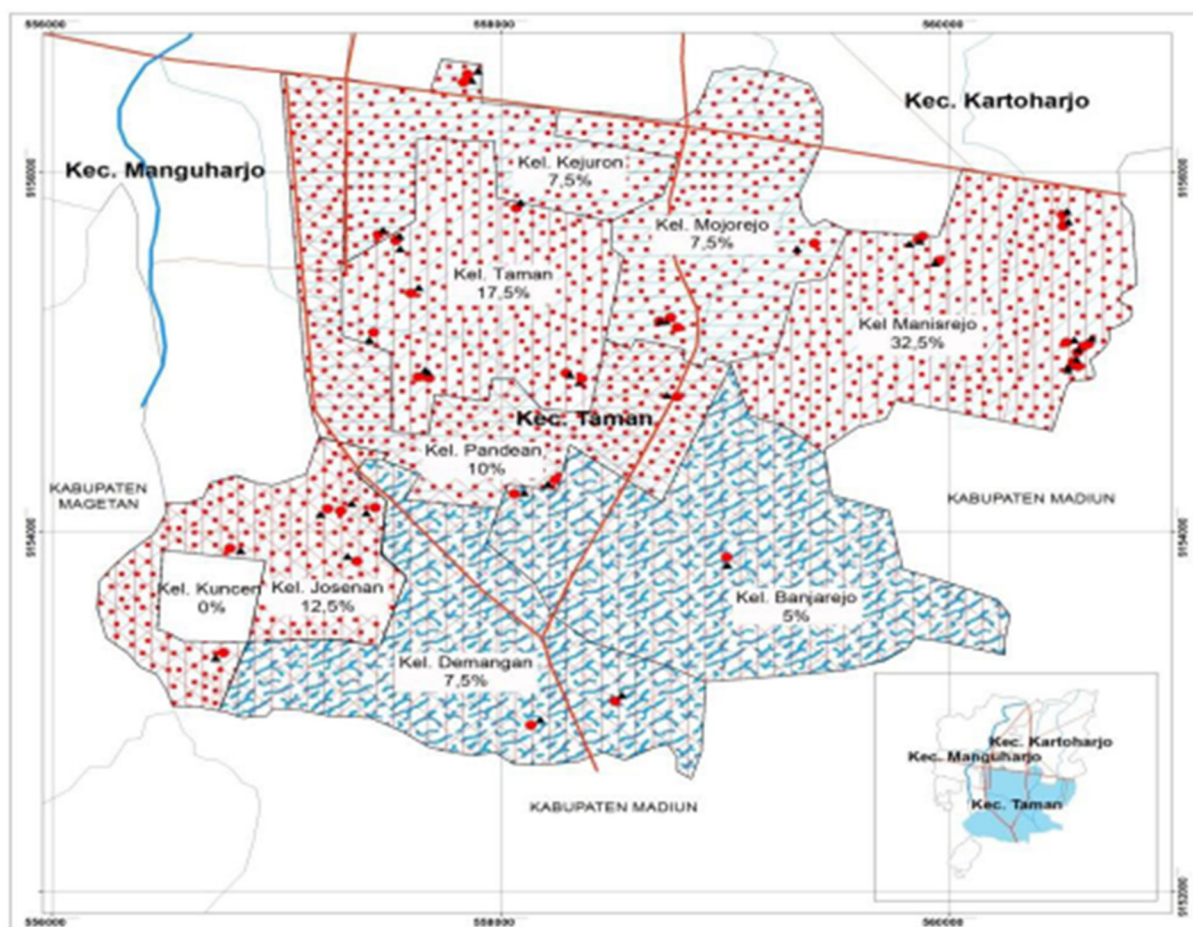
Figure 2. Overlay map of DHF proportion to behavioral factors in Taman District

respondents had done such habit for years.

In general, the respondents still did a poor practice by ignoring minor problems, such as cleaning the bathtub and other water containers potentially used as the breeding place by the mosquitoes.

Some respondents rejected to use abate because of difficulties they had when practicing the method. Efforts of preventing the DHF the respondents claimed to be difficult was that of related to human activities in the daylight where the Aedesaegyptimosquitos begin their feeding activities. The transmission occurred anywhere, the prevention using a good practice can avoid an individual from being infected by the DHF in the neighborhood. However, it was more difficult to control the transmission in public facilities, such as schools.

Spatial analysis of environmental factors

The overlay map of the environmental factors indicate a mapping of the proportion of the DHF incident by village to the environmental factors. The areas wit the average temperature at risk, humidity at risk, altitude at risk, ABJ & HI at risk, and CI at risk were marked with red color. On the other hand, the areas with low risk of temperature, humidity, altitude, ABJ & HI, and CI were marked with blue color.

Figure 1 indicates five of nine villages in Taman District at risk. In other words, these areas had more environmental factors at risk for DHF incident. The proportion rates of DHF in the five villages were as follows: Kejuron (7.5%), Mojorejo (7.5%), Pandean (10%), Taman (17.5%), and Manisrejo (32.5%).

Therefore, the average environmental factors with the risk for the DHF proportion ranged from 7,5% to 32.5% and those without risk ranged from 5% to 12.5%.

Spatial analysis of behavioral factors

The overlay map of the behavioral factors indicate a proportional mapping of the DHF by village to the behavioral factors. Areas with the inadequate knowledge, poor attitude, and poor practice were marked with red color. Areas with adequate knowledge, good attitude, and good practice were marked with blue color.

Figure 2 indicates six of nine areas with red color. It meant that these areas had more poor behavioral factors concerning the prevention of the DHF. The DHF proportion of the red areas were as follows: Kejuron (7.5%), Mojorejo (7.5%), Pandean (10%), Josenan (12.5%), Taman (17.5%), and Manisrejo (32.5%).The above explanation indicates that the average poor behavior had the higher proportion of the DHF incident ranging from 7.5% to 32.5%, whereas the good behavior ranged from 5% to 7.5%.

CLOSING

Results of the field observation of this study had the following conclusions: A significant correlation of DHF incident in Taman District to larvae-free rate (ABJ), house index (HI), container index (CI), and practice;

A higher risk for DHF transmission for the respondents with the higher risk of ABJ, HI, CI, and poorer practice of DHF prevention;

The high proportion of DHF incident was mostly found in the villages with the temperature at risk (5%-32.5%), high population density (7.5%-32.5%), ABJ and HI at risk (7.5%-32.5%), poor attitude (5%-32.5%), and poor practice (7.5%-32.5%);

Spatial analysis revealed that the ABJ and HI at risk and the poor practice of mosquito nest elimination (PSN) increased the DHF incident in Taman District.

The Municipal Office of Health Affairs of Madiun should publish a map of DHF case in order to find out the annual pattern of the DHF spread. This map is useful for predicting the annual DHF incident and helping draft the policy on the health care in the municipality.

The local community of Taman District should participate more actively in the mosquito nest elimination (PSN) by larvae surveillance activities at the neighborhood (RT/RW) level. The activity can be performed regularly bi-weekly.

Further studies are expected to examine other environmental and behavioral factors and compare the DHF incidents in DHF endemic, DHF sporadic, as well as DHF free area.

REFERENCES

1. Depkes RI. Petunjuk Teknis Penggerakan Pemberantasan Sarang Nyamuk (PSN) Demam Berdarah Dengue. Jakarta: Ditjen P2M & PLP, 1992.
2. World Health Organization (WHO). Dengue/Dengue Haemorrhagic Fever. (Online), (www.who.int/csr/disease/dengue/en/, diaksespada 1 Januari 2015)
3. Pusat Data danSurveilans Epidemiologi Kementrian Kesehatan RI. Demam Berdarah Dengue di Indonesia Tahun 1968-2009. Jakarta: Buletin Jendela Epidemiologi. Volume 2. Agustus, 2010.
4. Ginanjar G. A Survival Guide. Apa yang Dokter Anda Tidak Katakan tentang Demam Berdarah. Yogyakarta: B – First, 2008.
5. Mulyatno KC. Morfologi, Klasifikasi, Siklus Hidup, Habitat dan Penyakit yang Ditularkan oleh Nyamuk Aedes sp. Surabaya: ITD UniversitasAirlangga. (Online), (http://www.itd.unair.ac.id/files/pdf/protocol1/Aedes.pdf, accessedMaret 2015)

6. Canyon D. Advances in Aedesaegypti-Biodynamis and Vector Capacity. Tropical Infectious and Parasitic Diseases Unit, School of Public Health and Tropical Medicine, James Cook University, 2000.

7. Notoadmodjo S. PromosiKesehatandanIlmuPerilaku. Jakarta: RinekaCipta, 2007.

8. Ali M, Wagatsuma Y, Emch M, Breiman, Robert F. Use of A Geographic Information System for Defining Spatial Risk for Dengue Transmission in Bangladesh: Role for Aedes Albopictus in An Urban Outbreak. American Journal Tropical Medicine Hygiene. 69(6), 2003, pp. 634–640.

9. DinasKesehatan Kota Madiun. Data Infeksi Virus Dengue Kota Madiun Tahun 2010-2014. Madiun: Dinas Kesehatan Kota Madiun, 2014.

10. DinasKesehatan Kota Madiun. Data Status Endemisitas DBD per Kelurahan di Kota Madiun. Madiun: Dinas Kesehatan Kota Madiun, 2014

11. Boewono DT, Barodji, Suwasono H, et al. Studi Komprehensif Penanggulangan dan Analisis Spatial Transmisi Demam Berdarah Dengue di Wilayah Kota Salatiga. Balai Besar Penelitiandan Pengembangan Vektor dan Reservir Penyakit Salatiga, 2006.

12. Zoelkarnain P. HubunganIklimTerhadapKasusDemamBerdarah Dengue (DBD) di Kota Palembang Tahun 2003 - 2013. Fakultas Kesehatan Masyarakat Universitas Sriwijaya, 2013.

13. Suroso. T. Hadinegoro SR, Wuryadi S, Sumanjuntak G, Umar AI, Pitoyo PD, et.al. Penyakit Demam Berdarah Dengue dan Demam Berdarah Dengue. WHO danDepkes. RI, Jakarta 2000. P.3 – 58

14. Soegijanto S. DemamBerdarah Dengue. Surabaya: Airlangga University Press, 2006.

15. Suyasa. Hubungan Faktor Lingkungan Perilaku Masyarakat dengan Keberadaan Vektor Demam Berdarah Dengue di Wilayah Kerja Puskesmas I Denpasar Selatan. Poltekes Denpasar JurusanLingkungan, 2007. Ecotropic 3 (1):1-6.

16. Depkes RI. Panduan Praktis Surveilans Epidemiologi Penyakit. Jakarta: Depkes RI, 2003.

17. Notoatmodjo S. Pendidikan dan Perilaku Kesehatan. Jakarta : PT. RinekaCipta, 2003