Dengue Hemorrhagic Fever (DHF) Cases in Semarang City are Related to Air Temperature, Humidity, and Rainfall

by Suhartono Suhartono

Submission date: 21-Feb-2020 02:09PM (UTC+0700)
Submission ID: 1261357745
File name: 2._jurnal_C3.pdf (646.54K)
Word count: 3045
Character count: 15482

RESEARCH ARTICLE

Advanced Science Letters
Vol. 23, 3283–3287, 2017

Dengue Hemorrhagic Fever (DHF) Cases in Semarang City are Related to Air Temperature, Humidity, and Rainfall

Prasti Widyorini[1,*], Kintan Arifa Shafrin[1], Nur Endah Wahyuningsih[1,*], Retno Murwani[2,3,*], and Suhartono[1]

[1]*Public Health Faculty, Diponegoro University, Jl. Prof. Soedarto, SH, Tembalang, Semarang 50275, Indonesia*
[2]*Faculty of Animal Science and Agriculture, Diponegoro University, Jl. Prof. Soedarto, SH, Tembalang, Semarang 50275, Indonesia*
[3]*Centre of Research and Services, Diponegoro University, Jl. Prof. Soedarto, SH, Tembalang, Semarang 50275, Indonesia*

Background: Dengue Hemorrhagic Fever (DHF) is an infectious disease caused by dengue virus and transmitted through the bite of mosquito *Aedes aegypti*. Spreading of DHF and the occurrence of DHF cases are strongly influenced by climate, but the relationship is not simple. The purpose of this research was to determine the relationship of DHF cases in Semarang city to air temperature, humidity, and rainfall in Semarang City (from January 2011 to April 2016). *Method*: The rainfall data were obtained from 9 monitoring stations, while the air temperature and humidity data were obtained from 1 monitoring station (Meteorology, Climatology and Geophysics Board of Semarang City) from January 2011 to April 2016. The data of DHF cases (9,294 patients) were collected from Health Office of Semarang City. A relationship between two variables i.e., air temperature, air humidity, or rainfall with DHF cases was analyzed by Rank Spearman correlation test. *Results*: The highest number of DHF cases yearly was found during January to April. The range of recorded air temperature i.e., 25.9 – 30.1 °C, correlation analyses showed that lower air temperature increased the number DHF cases or higher air temperature reduced the number of DHF cases ($p = 0.0001$; $r = -0.425$). However, higher humidity ($p = 0.0001$; $r = 0.659$) and rainfall ($p = 0.0001$; $r = 0.465$) increased the number of DHF cases. *Conclusion*: Higher air temperature reduced the number DHF cases, but higher humidity and rainfall increased the number of DHF cases.

Keywords: Dengue Hemorrhagic Fever, Climate, Air Temperature, Rainfall, Humidity.

1. INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is an infectious disease caused by dengue virus and transmitted through the bite of a mosquito. *Ae. aegypti* is the primary vector, but other species such as *Ae. albopictus* can also transmit the virus. Several factors can influence the transmission of dengue i.e., susceptible human hosts, competent mosquito which is associated with their breeding places during the rainy season, and suitable climate.[1,2]

Climate or weather pattern that occurs over many years can affect the number of mosquito breeding sites.[3] Ideal air temperatures for optimal growth of mosquitoes are 25–30 °C.[4] Rainfall can increase mosquito breeding areas, but high moisture can drift mosquitoes larvae and make them die. Climate change such as transitional seasons marked by rain and high temperatures may also cause several viruses to increase in number. On the contrary, the dry condition can lower the ability of mosquitoes to live.[5]

In spite of the knowledge that climate affects dengue transmission, DHF cases in Indonesia remain high and are the largest in Southeast Asia.[6] In 2010 Indonesia was ranked as the largest dengue cases with 1317 deaths.[7] In 2015 the number of dengue cases in Semarang had increased by 6.7% or 1737 patients compared to 2014.[8] It appeared that the relationship between climate variables and dengue transmission are not straightforward and long-term climate variability does not regulate long-term pattern in transmission.[2] Therefore we carried out the following study to analyze the relationship between climate (air temperature, humidity, and rainfall) and dengue cases in Semarang City between January 2011 until April 2016. We hope that the result of this study can be used to design a preventive program by the respective authority in Semarang city.

2. METHOD

This research was observational descriptive and analytic study using secondary data from Meteorology, Climatology, and Geophysics Board of Semarang City and Health Department of Semarang City from January 2011 to April 2016. Bivariate analysis was conducted to analyze the relationship between two variables i.e., air temperature, air humidity, or rainfall with dengue cases.

*Authors to whom correspondence should be addressed.

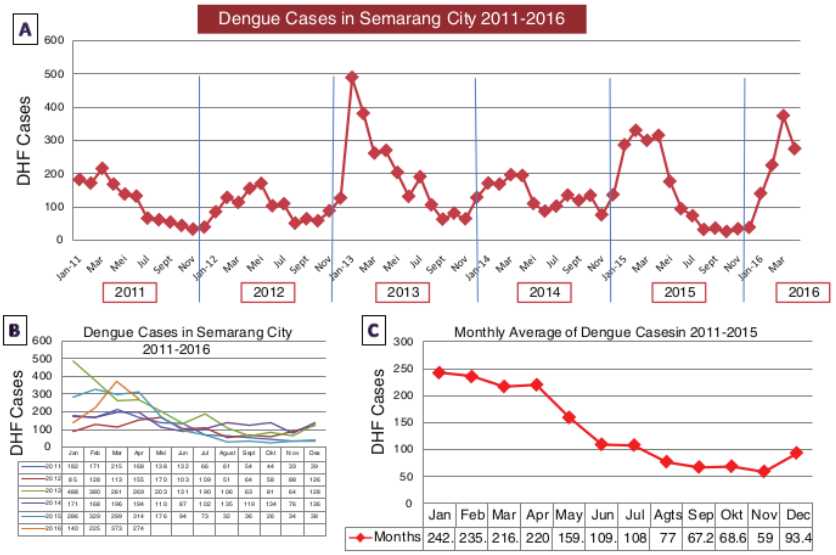


Fig. 1. The distribution of dengue cases by month for each year.

3. RESULTS

3.1. The Distribution of Dengue Cases by Month

Monthly cases of dengue during the years 2011–2016 (Fig. 1(A)) showed that increased number of dengue cases consistently occurred during January to April with the highest number of cases were found in January 2013 (Figs. 1(A and B)-488 cases). After April the number of dengue cases declined until December, and the lowest number was found in November (Fig. 1(C)). In 2011, the highest number of dengue cases occurred in March as many as 215 cases and the lowest one 33 cases in November. In 2012, the largest number of dengue cases (170 cases) occurred in May, and the lowest occurred in August (51 cases). In 2014,

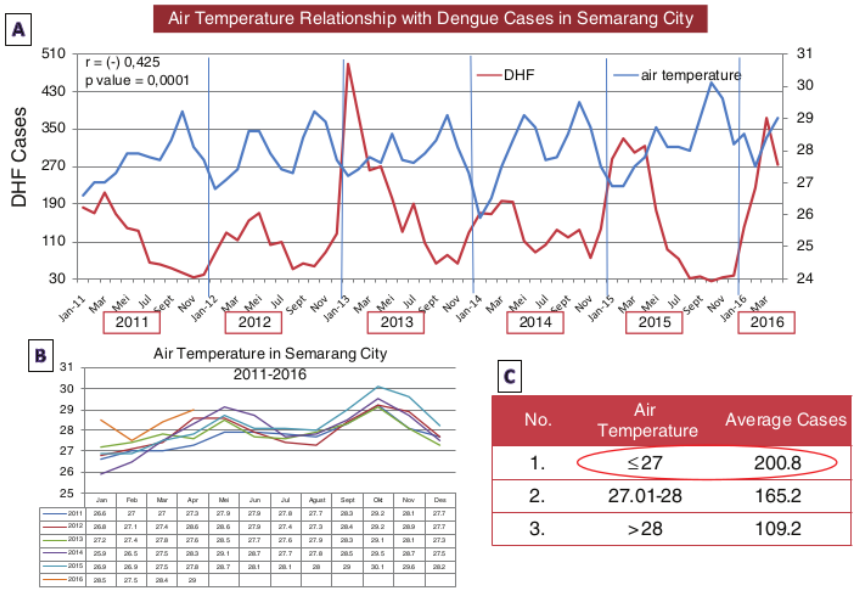
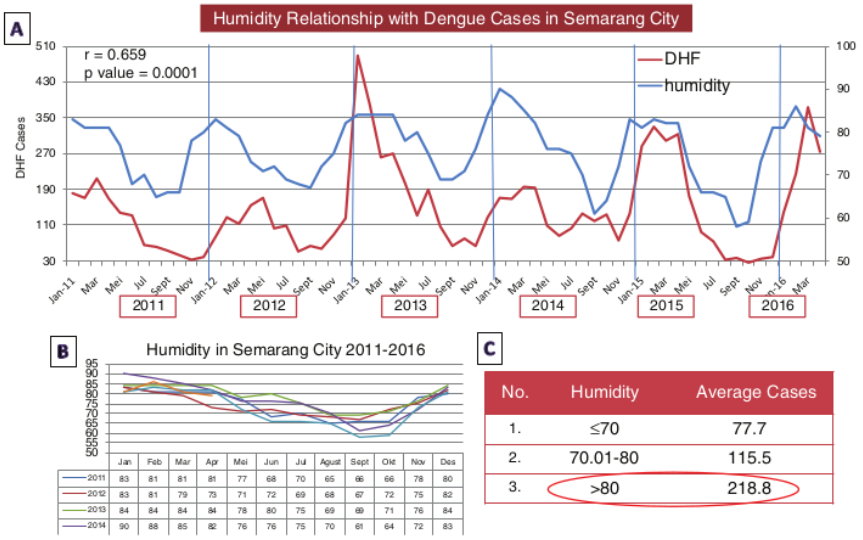


Fig. 2. Air temperature relationship with dengue cases in Semarang city.



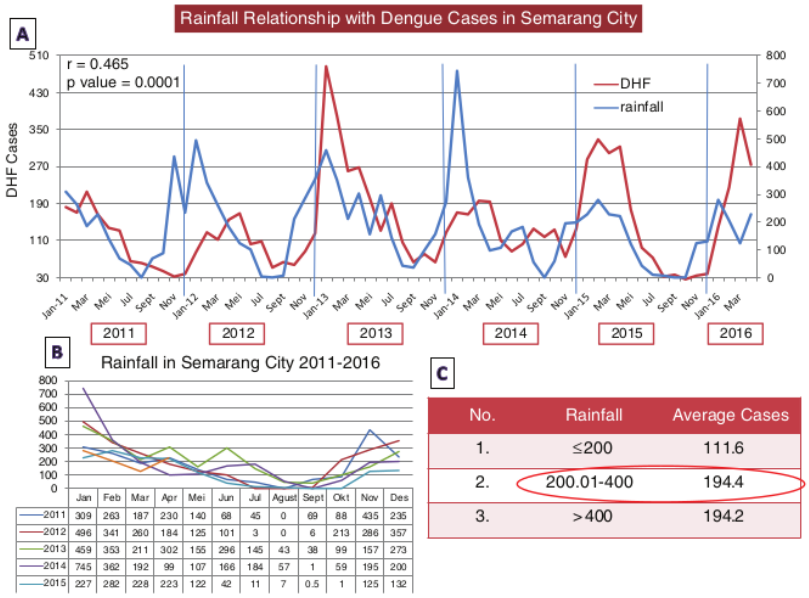
No.	Humidity	Average Cases
1.	≤70	77.7
2.	70.01-80	115.5
3.	>80	218.8

Fig. 3. Humidity relationship with dengue cases in Semarang.

the largest number of dengue cases occurred in March as many as 196 cases, and the lowest number occurred in November as many as 76 cases. In 2015, the highest number of dengue cases occurred in February as many as 329 cases, and the lowest number occurred in October as many as 26 cases which were also the lowest number of DHF cases during 2011–April 2016.

3.2. Air Temperature Relationship with Dengue Cases

Figure 2 showed that air temperature was inversely correlated to dengue cases with $r = -0.45$ and $p = 0.0001$. Within the recorded air temperature data i.e., 25.9 to 30.1 °C, this relationship meant that the number of dengue cases increased as air temperature lowered and vice versa. The highest number of



No.	Rainfall	Average Cases
1.	≤200	111.6
2.	200.01-400	194.4
3.	>400	194.2

Fig. 4. Rainfall relationship with dengue cases in Semarang.

Adv. Sci. Lett. 23, 3283–3287, 2017

dengue cases in Semarang city were found during January 2011–April 2016 (200.8 cases, Fig. 2(C)) when the air temperature was ≤27 °C (the lowest temperature data was 25.9 °C). The minimum number of dengue cases were found during September 2015 to January 2016 with air temperature from 28.2 to 30.1 °C (Figs. 2(A and B)).

3.3. Humidity Relationship with Dengue Cases

Figure 3 showed that air humidity was directly correlated to dengue cases with $r = 0.659$ and $p = 0.0001$. The highest number of dengue cases during January 2011–April 2016 (218.8 cases, Fig. 3(C)) were found when air humidity was >80%.

3.4. Rainfall Relationship with Dengue Cases

Figure 4 showed that rainfall was directly correlated to dengue cases with $r = 0.465$ and $p = 0.0001$. The highest number of dengue cases during January 2011–April 2016 (194.4 cases, Fig. 4(C)) were found when rainfall was above 200.01–400 mm/month.

4. DISCUSSION

Distribution of dengue cases over time was affected by the climate. In Indonesia, a climate cycle (transition) from rainy season to dry season is changing and uncertain. This condition can be advantageous to *Ae. aegypti* which can adapt to the situation so that seasonal factors only affect the density of mosquitoes.[9] Most dengue cases occurred in February to June with the highest cases (33.33%) in March.[10,11] A study by F. Kennet (1993) in Sitorus 2003 stated that as much as 120% increase in dengue cases was followed by monthly rainfall of over 300 mm. He also found that ±2–3 months after a heavy rain, there would be an outbreak of dengue fever. It appears that at the end of rainy season dengue cases will increase as rainwater becomes abundantly available and serves as a potential breeding place of *Ae. aegypti*.[12]

The highest number of DHF cases (200.8 cases) in Semarang coincided with temperature ≤27 °C. On the contrary, the lowest DHF cases (109.2 cases) were found at a temperature between 28.2 °C to 30.1 °C. These results suggested that air temperature affected directly the biology of mosquito within a narrow range (≤27 °C the highest number of cases compared to ≥28.2 °C the lowest number of cases). It is known that the average air temperature for optimum growth of mosquito is in the range of 25–30 °C. The air temperature has an influence on the development rate of mosquito, mortality, behavior, viral replication inside the mosquito, mosquito biting rate, resting and mating behavior, as well as the spread and duration of the gonotrophic cycle.[4,13] The extrinsic incubation period of the virus within the mosquito is influenced in part by environmental conditions, especially ambient temperature.[14] Higher temperature reduces the time required for the virus to replicate and disseminate in the mosquito.[2] However, our data showed that at temperature ≤27 °C appeared to be of benefit to the spread of the virus and hence higher DHF cases. This result could be because the temperature can interact with rainfall which regulates evaporation and further affects the availability of breeding places associated water. Therefore lower air temperature (≤27 °C) could maintain and favor the presence of breeding place associated water and hence support vector growth. Vector growth with its harboring virus and the presence of susceptible human host nearby can increase the occurrence of dengue cases.[2]

The result which showed that the number of dengue cases increased in direct correlation to rainfall could be due to the presence of *Ae. aegypti* mosquito breeding places. *Ae. aegypti* populations depend on the breeding sites. High moisture which lasts for a long time can cause flooding and consequently eliminate the breeding sites of *Ae. aegypti* that usually, lives in water. As a result, the number of mosquito breeding is reduced so that the mosquito population declines. However, when rainfall is low and long, it will increase the presence of breeding places and hence mosquito populations. As with other vector based diseases, dengue shows a pattern which is related to the climate especially rainfall as it influences the spread of the vector (mosquitoes) and the possibility of transmitting the virus from one human to another.[15]

Our result which showed that the number of dengue cases increased directly about raising in air humidity may be due to the effect of air humidity on the transmission of vectors. Mosquitoes as vectors are sensitive to moisture[7] and mosquitoes ability to survive in dry conditions declines. The average thickness has been found as the most critical factor in the climate to disease relationship.[15] As with other vector-based diseases, dengue showed an association with climate primarily because of humidity affecting the spread of vectors (mosquito) and therefore increasing the possibility of transmitting the virus. Also, moisture measurement is the best climatic factor to predict the spreading of DHF.[15]

5. CONCLUSION

The highest number of DHF cases each year was found during the month of January to April. Climatic condition showed that higher air temperature reduced the incidence of DHF ($p = 0.0001$, $r = -0.425$), but higher rainfall ($p = 0.0001$, $r = 0.645$) and humidity ($p = 0.0001$, $r = 0.659$) increased the incidence of DHF. The result of this research can be used as an input for the program manager of Disease Prevention and Eradication of Health Office in Semarang City in determining the strategy for prevention and eradication of dengue disease in Semarang. It also showed the importance of Meteorology and Climatology data in determining such strategy.

Acknowledgments: We thanked the Directorate of Research and Community-Ministry of Research, Technology, and Higher Education through the Institute for Research and Community Service Diponegoro University for financial support through funding schemes under the Grant Assignment No. 022/SP2H/L/DRPM/II/2016. We also thanked the research field team for their hard work, passion, and dedication.

References and Notes

1. Departemen Kesehatan RI, January (2015), Demam Berdarah Biasanya Mulai Meningkat di January, Diperoleh Oktober **(2015)**, dari http://www.depkes.go.id/article/view/15011700003/demam-berdarah-biasanya-mulai-meningkat-di-januari.html#sthash.c3stHOD9.dpuf.
2. CDC, Centers for Disease Control and Prevention National Center for Emerging and Zoonotic Infectious Diseases (NCEZID) Division of Vector-Borne Diseases (DVBD), September **(2012)**, accessed on October 2016, from https://www.cdc.gov/dengue/entomologyEcology/climate.html.
3. A. Siwiendrayanti, Perubahan Iklim dan Pengaruhnya Terhadap Sektor Kesehatan, Juli **(2007)**, Vol. 3, Hlm. 17–26.

4. Cahyati and H. Widya, Dinamika Ades Agypti sebagai Vektor Penyakit, Kemas, Juli **(2006)**, Vol. II, Hlm. 40–50.
5. V. Sungono, Hubungan Iklim dengan ABJ dan Insiden Demam Berdarah Dengue di Kotamadya Jakarta Utara Tahun 1999–2003, Skripsi, Fakultas Kesehatan Masyarakat, Universitas Indonesia **(2004)**.
6. Ikatan Dokter Anak Indonesia (IDAI), Applied Management of Dengue Viral Infection in Children, Jawa Timur Perwakilan Jatim V dan Kediri **(2013)**.
7. KOMPAS, (2011, Februari), Kasus DBD di Indonesia Tertinggi di ASEAN, Diperoleh, Oktober **(2015)**, dari http://internasional.kompas.com/read/2011/02/19/07163187/Kasus.DBD.di.Indonesia.Tertinggi.di.ASEAN rabu.
8. Dinas Kesehatan Kota Semarang, Profil Kesehatan Kota Semarang 2015, Diperoleh Agustus **(2015)**, dari http://119.2.50.170:9090/profildkk/profilkesehatan2013.html.
9. Umaroh, A. Khoirotul, B. Kirwono, and D. Astuti, Kejadian Luar Biasa (KLB) DBD Berdasarkan Time, Place, Person Di Puskesmas Boyolali 1 (2011–2013), University Research Colloquium **(2015)**, ISSN 2407-9189.
10. Sasmito, H. Gunawan, and H. Widiatmoko, Informasi Meteorologi Untuk Peringatan Dini Bahaya Demam Berdarah Dengue (DBD) di Wilayah DKI Jakarta, Laporan Proyek.
11. M. R. Febrianto, Analisis Spasiotemporal Kasus Demam Berdarah Dengue Di Kecamatan Ngaliyan Bulan, Jurnal Media Medika Muda. Universitas Diponegoro, Semarang, Januari–Mei **(2012)**.
12. J. Sitorus, Hubungan Iklim dengan Kasus Penyakit Demam Berdarah Dengue di Kotamadya Jakarta Timur tahun 1998–2002, Tesis, Universitas Indonesia, Jakarta **(2003)**.
13. C. W. Morin, A. C. Comrie, and K. Ernst, *Enviromental Health Perspective* 121 **(2013)**, accessed on October 2016, from http://ehp.niehs.nih.gov/1306556/.
14. WHO, Dengue Guidelines for Diagnosis, Treatment, Prevention and Control, Joint Publication of the World Health Organization and the Special Programme for Research and Training in Tropical Diseases, France **(2009)**.
15. T. Suroso, et al. (eds.), Pencegahan dan Penanggulangan Penyakit Demam Dengue dan Demam Berdarah Dengue, Terjemahan, WHO dan Depkes RI, Jakarta **(2000)**.

Received: 19 October 2016. Revised/Accepted: 18 December 2016.

Dengue Hemorrhagic Fever (DHF) Cases in Semarang City are Related to Air Temperature, Humidity, and Rainfall

ORIGINALITY REPORT

12%	11%	9%	11%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.ingentaconnect.com Internet Source	10%
2	Ummi Khairunisa, Nur Endah Wahyuningsih, Suhartono, Hapsari. "Impact of Climate on the incidence of Dengue Haemorrhagic fever in Semarang City", Journal of Physics: Conference Series, 2018 Publication	2%

Exclude quotes	Off	Exclude matches	< 2%
Exclude bibliography	Off		