Meta Analysis Article

Analysis of Spatial Geographic Data on The Event of Dengue Hemorrhagic Fever

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ABSTRACT

Dengue fever (DHF) in Indonesia is increasing and spreading. This is due to weak early warning systems and risk factors for disease spread that are influenced by geospatial changes. This study employs a systematic review approach with meta-analysis to ascertain the impact of regional spatial data on dengue incidence. The results showed that rainfall tended to have a large effect on dengue incidence with an ES value of (0.44), temperature had a very small effect on dengue incidence with an ES value of (0.02), humidity had a moderate effect on dengue incidence with an ES value of (0.18), and wind speed tended to have a very large effect on dengue incidence with an ES value of (1.19). Temperature change had a significant influence on the incidence of DHF. Rainfall, temperature change, humidity and wind speed had an I-squared value (OR variation caused by heterogeneity) of 100% while wind speed was 0%. Rainfall, temperature change and humidity tended to have variable results so that they had a strong influence on the results of the meta-analysis, while wind speed tended to be homogeneous, allowing for high research bias.

Keywords: Weather, rainfall, humidity, temperature, dengue fever

INTRODUCTION

The dengue virus is the cause of Dengue Hemorrhagic Fever (DHF). The fastest-growing mosquito in the world, Aedes spp., is the vector of the virus that causes dengue, which infects almost 390 million people annually. According to available data, dengue hemorrhagic fever has been on the rise in Indonesia for the past 50 years. It seems that incidence rates are cyclical, peaking roughly every six to eight years. Tropical and subtropical regions, primarily urban and suburban areas, are home to the dengue virus. Given its tropical climate, which is ideal for animal growth, Indonesia is a favorable location for the development of many diseases, particularly those spread by vectors, which are organisms that transfer pathogenic agents from host to host, such as mosquitoes which transmit many diseases.[1]

Every year, Java has the highest average number of dengue hemorrhagic fever cases. Bali and Kalimantan (Kalimantan) have experienced the highest occurrence in recent years. whereas the lowest frequency is found in Papua Island, which is the easternmost part of the Indonesian archipelago.[2]

The extraordinary incidence of DHF in Indonesia is caused by various factors. First, infectious diseases, including DHF, are still endemic in some areas because there are mosquito vectors in almost all parts of Indonesia and there are 4 types of virus cells that circulate throughout the year. The second factor is the weakness of the early warning system so that the handling and treatment of cases as an intervention has not been done properly. The third factor is the ease of transportation, which allows the movement of transportation equipment, passengers, materials/goods, and tools from one area to another which is an endemic area, and climate issues, especially due to climate change, which has resulted in many mosquito habitats changing, thus increasing the risk of DHF incidence. Environmental change and climate change are closely related to environmental health. The global environment, for example, an increase in the earth's temperature can affect environmental components that are a medium for disease transmission.

High temperatures and humidity are conducive to mosquito reproduction, increasing the population of mosquito vectors during the rainy season and potentially causing an outbreak.[3] According to Fitriana's 2018 research, the correlation between the temperature variable and dengue cases using the Chi Square test with a p-value of less than 0.05 (p-value 0.019) This indicates that an increase in dengue cases will occur along with an increase in temperature, while the Chi Square test between the humidity variable and dengue cases obtained a p-value of 0.797, indicating no relationship between the two variables This indicates that an increase in humidity will not be followed by an increase in the incidence of dengue disease.[4]

The results of other studies also show that high rainfall will be a breeding ground for DHF vectors, or which means that the higher the rainfall, the higher the incidence of DHF.[5,6] While the significant value or p-value is 0.001 so it can be concluded that there is a significant relationship between rainfall during the period 2006 - 2011 with the incidence of dengue hemorrhagic fever.[7] Then based on research in Surabaya City in the period 2010 - 2012, it shows that air humidity affects the Flies Free Number (ABJ), but ABJ has no effect on dengue cases.[8] While the results of research in Medan City using geo-spatial data for 5 years there is a relationship between monthly wind speed and high correlation (r=0.843), with a positive pattern, as well as wind speed per year in Medan City which is highly correlated (r=0.961).[9]

According to the research results of Sang et al and Xu et al, DHF cases are known to be strongly influenced by imported cases, mosquito density, meteorological factors (such as temperature and air), rainfall, relative humidity, water vapor pressure, air pressure, sea surface temperature, socio-economic factors, and environmental factors (such as water), vegetation, river elevation, paved road access, and housing conditions.[10,11] Solving the problem of DHF can be done with spatial-based disease management analysis techniques. The utilization of spatial analysis of DHF cases can provide benefits to determine the pattern of DHF disease spread so that it can solve DHF problems based on the region.

Spatial analysis can be used as an early warning system by paying attention to environmental factors that are very instrumental in the observation of vector-based diseases. Faiz's research (2013) in Semarang City found that spatial analysis can produce information about the distribution pattern of dengue disease that tends to cluster in Semarang City and can be used for control efforts based on the distribution area in Semarang City.[12] Likewise, research in Thailand on the use of GIS/GIS applications by collecting data on 11 factors namely population density, number of households, altitude, temperature, humidity, rainfall, residential areas, drainage areas, agricultural areas and artificial and human water resources from related organizations to analyze their relationship with dengue patients in the province.[13]

The purpose of this study is to analyze the influence of spatial data on the incidence of dengue fever cases. Research on geo-spatial influences (air temperature, air humidity, rainfall, and wind speed) on the incidence of dengue fever has been done but one study is not strong enough to generalize to the population, so there is a need for several studies on geo-spatial influences (air temperature, air humidity, rainfall, and wind speed) on the incidence of dengue fever so that there is a need for in-depth analysis related to these problems.

METHOD

This kind of study use a meta-analysis and systematic review methodology. In order to address pre-established research questions, this approach is used to find, evaluate, and interpret all findings related to a study issue. This approach is implemented methodically by adhering to steps and procedures that enable the literature review procedure to prevent prejudice and the researchers' subjective perception.[14]

The idea of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) can be used in research protocols for meta-analyses. All full-text international journal articles published in the PubMed and Google Schoolar databases that satisfy the requirements for selecting articles using the PRISMA method on the impact of geographic spatial data—such as humidity, rainfall, air temperature, and wind speed—on the incidence of DHF contained in the keywords comprise the population in the Systematic Review and Meta-Analysis that was employed.

A portion of the population that can be selected for use as study subjects makes up the sample. The number of articles from screening and extraction in the earlier phases of at least ten research articles from respectable international journals and Indonesian journals indexed by SINTA 1-4 serves as the sample for this systematic review and meta-analysis.

Sampling techniques are the methods used in sampling, in order to obtain an appropriate sample of the entire research subject. The sampling technique used is purposive sampling with the inclusion criteria set by the researcher.

Inclusion criteria include:

1. The variables studied were the incidence of DHF and geographic spatial data which included air temperature, humidity, rainfall, and wind speed (which was found in keywords).
2. The purpose of the included research articles was to determine the effect of geographic spatial data (air temperature, humidity, rainfall, wind speed) on the incidence of dengue fever.
3. The design in the research articles that are screened is a cross-sectional study design.
4. Statistical data is prevalence rate (PR) data with 95% CI which can represent the actual situation in the population populasi.
5. The languages used are English and Indonesian in complete research articles (fulltext) published online for the last 5 years from 2016 – 2020 in Databased Pubmed and Google Schoolar.

Exclusion Criteria include:

1. The research variable is not one of the incidences of DHF or geographic spatial data.
2. Case-control study design, cohort, randomized controlled trial, systematic review, scoping review, literature review.
3. Statistical data is data outside surveillance without including CI.
4. Research articles have been published for more than 5 years.
5. Languages other than English and Indonesian

The variables that will be used in the research to be carried out consist of:

1. Independent Variable
   The independent variables that will be examined in this study are geographic spatial data consisting of rainfall, air temperature, air humidity, and wind speed.
2. Dependent Variable
   The dependent variable or the dependent variable that will be examined in this study is the incidence of dengue cases kasus.

One question that serves as the foundation for a review is the identification of research questions. Therefore, we require a suitable question analysis method. Therefore, the SPIDER technique was used to create research questions because it concentrates on research design and samples rather than the population, with less emphasis on intervention. The SPIDER formulation is as follows[15]:

1. S for sample: this word represents the sample group in the study.
   S in this study are on geo-spatial variables (air temperature, air humidity, rainfall, and wind speed)
2. PI for phenomenon of interest: this word represents the phenomenon of how and why, behavior and experience and intervention.
   PI in this study were on geo-spatial variables (air temperature, air humidity, rainfall, and wind speed) on dengue fever incidence.
3. D for design: this word represents how this research was designed and carried out.
   D in this research is Cross Sectional.
4. E for evaluation: this word represents the evaluation results can include more subjective results, such as views, attitudes, etc.
   E in this study is the result of research from a journal that shows that there is or is not a relationship between research variables such as on geo-spatial (air temperature, air humidity, rainfall, and wind speed) on dengue fever incidence
5. R for research type: this word represents the type of research used. Types of research include quantitative, qualitative, or mixed methods.
   R in this study is quantitative.

RESULT AND DISCUSSION

The research started from the journal search process, below are the results of 14 articles from several journals in PubMed and Google Shcoolar databases. This section is the last step after the screening process of relevant journals in the systematic review stage of the research. The quality analysis of the JBI critical evaluation tools was used to determine each article's study quality as a source for the systematic review. The following are the findings of the literature review that were examined and decided upon in the systematic review.

Table 1. Critical Appraisal Tool Question Checklist for Research Articles with Cross-sectional Design JBI

Question	Yes	No	Unclear	Not-Aplicable
1. Were the requirements for sample inclusion well-defined?				
2. Were the study subjects and the setting described in detail?				
3. Was a valid and trustworthy method used to measure the exposure?				

Question	Yes	No	Unclear	Not-Aplicable
4. Did the condition be measured using standard, objective criteria?				
5. Were confounding variables found?				
6. Were methods for handling confounding variables mentioned?				
7. Were the results measured in a way that was reliable and valid?				
8. Did the right statistical analysis get applied?				

No	Title with author	Question								Total
		1	2	3	4	5	6	7	8	
1	The time series seasonal patterns of dengue fever and associated weather variables in Bangkok (2003-2017) Tahun: 2020 Penulis: Sittisede Polwiag BMC Infectious Diseases[16]	Yes	Yes	Yes	Yes	Not	Not	Yes	Yes	6/8
2	Different responses of dengue to weather variability across climate zones in Queensland, Australia Tahun:2020 Penulis: Rokeya Akter Environmental Research Elsevier[17]	Yes	Yes	Yes	Yes	Not	Not	Yes	Yes	6/8
3	Climate variability and dengue fever in Makassar, Indonesia: Bayesian spatio-temporal modelling Tahun :2020 Penulis: Aswi Aswi Spatial and Spatio- temporal Epidemiology Elsevir[18]	Yes	Yes	Yes	Yes	Not	Not	Yes	Yes	6/8
4	Environmen Asia Implication of Climatic Factors on Dengue Fever in Urban Tahun :2020 Penulis: Ruhil A. Adnan The international journal by the Thai Society of Higher Education Institutes on Environment[19]	Yes	Yes	Yes	Yes	Not	Not	Yes	Yes	6/8
5	Spatial and temporal variation of dengue incidence in the island of Bali, Indonesia: An ecological study Tahun :2019 Penulis: Pandji Wibawa Dhewantara Travel Medicine and Infectious Disease Elsevie[20]	Yes	Yes	Yes	Yes	Not	Not	Yes	Yes	6/8
6	Climate Change And Dengue Hemorrhagic Fever In Banggai Regency	Yes	Yes	Yes	Yes	Not	Not	Yes	Yes	6/8

No	Title with author	Question 1	2	3	4	5	6	7	8	Total
	Tahun :2017 Penulis: Erni Yusnita Lalusu Advances in Health Sciences Research [21]									
7	Developing a dengue prediction model based on climate in Tawau, Malaysia Tahun :2019 Penulis: Vivek Jason Jayaraj Acta Tropica Elsevier[22]	Yes	Yes	Yes	Yes	Not	Not	Yes	Yes	6/8
8	Early warning signal for dengue outbreaks and identification of high risk areas for dengue fever in Colombia using climate and non-climate datasets Tahun :2017 Penulis: Jung-Seok Lee BMC Infectious Diseases[23]	Yes	Yes	Yes	Yes	Not	Not	Yes	Yes	6/8
9	The Relationship Between Rainfall, Air Temperature And Wind Speed Effects Dengue Hemorrhagic Fever Case In Bengkulu City At 2009-2014 Tahun :2018 Penulis: Chandra Gunawan Sihombing Jurnal Kedokteran Diponegoro[24]	Yes	Yes	Unclear	Yes	Not	Not	Yes	Yes	5/8
10	Forest cover and climate as potential drivers for dengue fever in Sumatra and Kalimantan 2006–2016: a spatiotemporal analysis Tahun :2019 Penulis: Zida Husnina Tropical Medicine and International Health Willey[25]	Yes	Yes	No	Yes	Not	Not	Yes	Yes	5/8
11	The climatic factors affecting dengue fever outbreaks in southern Taiwan: an application of symbolic data analysis Tahun :2018 Penulis: Yi-Horng Lai BioMedical Engineering[26]	Yes	Yes	Yes	Yes	Not	Not	Yes	Yes	6/8
12	Geographic information system based spatio- temporal dengue fever cluster analysis and mapping Tahun :2019 Penulis: Shuchi Mala The Egyptian Journal of Remote	Yes	Yes	Unclear	Yes	Not	Not	Yes	Yes	5/8

No	Title with author	Question								Total
		1	2	3	4	5	6	7	8	
	Sensing and Space Sciences Elsevier[27]									
13	Kejadian Demam Berdarah Dengue di Kota Sukabumi Berdasarkan Kondisi Iklim Tahun :2017 Penulis: Lisa Hidayati Journal Acta Veterinaria Indonesian[28]	Yes	Yes	Yes	Yes	Not	Not	Yes	Yes	6/8
14	Climate Variability and Dengue Hemorrhagic Fever in Hanoi, Viet Nam, During 2008 to 2015 Tahun :2018 Penulis: Tran Thi Tuyet- Hanh Asia Pacific Journal of Public Health[29]	Yes	Yes	Un cle ar	Yes	Not	Not	Yes	Yes	5/8

Based on the assessment of the feasibility of previous research used in this study, it can be seen that the previous research used meets the criteria needed in a study according to the Critical Appraisal Skills Program (CASP), which means that this research is feasible to continue and there are no problems with the previous research used.

Research heterogeneity

In the rainfall variable from 14 articles obtained from the inclusion criteria, there are 10 articles that discuss the influence of rainfall on the incidence of DHF. The results of heterogeneity analysis on rainfall variables can be seen in the following table tabel:

Table 2. Heterogeneity Test of Rainfall Variable Research

Heterogenity					Effect	
Chi^2	df (Q)	P	I^2	Tau^2	Z	P
3378,69	9	0,00001	100%	21,49	0,44	0,66

Nindrea's theory (2016), states that the value of heterogeneity if I^2 is more than 55% and p-value is less than 0,05 then the analytical test used is a random effect model, while I^2 is less than 55% and p-value is more than 0,05 then the analytical test used is the fixed effect model. Based on table 1 shows the results of data analysis from 10 research articles regarding rainfall with the incidence of DHF. The variance in the effect size includes the actual size of the research study, the I^2 value obtained is 100% and the p-value of the heterogeneity test is <0,05 meaning heterogeneity between studies is high and varies. Because the p value <0,05 and heterogeneity is above 50%, the random effect model is used to assess the effect of rainfall on the incidence of DHF.

In the air temperature variable from 14 articles obtained from the inclusion criteria, there are 11 articles that discuss the effect of air temperature on the incidence of DHF. The results of heterogeneity analysis on the air temperature variable can be seen in the following table:

Table 3. Heterogeneity Test of Air Temperature Variable Research

Heterogenity					Effect	
Chi^2	df (Q)	P	I^2	Tau^2	Z	P
479878,18	10	0,00001	100%	5,26	0,02	

The findings of data analysis from 11 research publications about the relationship between air temperature and the incidence of DHF are displayed in table 2. The impact size variance encompasses the real size of the research study; the p-value of the heterogeneity test is less than 0.05, indicating high and variable heterogeneity between studies, and the resultant I2 value is 100%. The impact of air temperature on the incidence of DHF is evaluated using the random effect model since the p value is less than 0.05 and the heterogeneity is greater than 50%.

In the air humidity variable from 14 articles obtained from the inclusion criteria, there are 8 articles that discuss the effect of air humidity on the incidence of DHF. The results of heterogeneity analysis on the air humidity variable can be seen in the following table:

Table 4. Heterogeneity Test of Air Humidity Variable Research

Heterogenity					Effect	
Chi^2	df (Q)	P	I^2	Tau^2	Z	P
17858,79	7	0,00001	100%	3,70	0,18	0,86

Based on table 3 shows the results of data analysis from 8 research articles regarding air humidity with the incidence of DHF. The variance in the effect size includes the actual size of the research study, the I² value obtained is 100% and the p-value of the heterogeneity test is <0,05 meaning heterogeneity between studies is high and varies. Because the p value <0,05 and heterogeneity is above 50%, to assess the effect of air humidity on the incidence of DHF is a random effect model.

In the wind speed variable from 14 articles obtained from the inclusion criteria, there are 2 articles that discuss the effect of wind speed on the incidence of DHF. The results of heterogeneity analysis on wind speed variables can be seen in the following table:

Table 5. Heterogeneity Test of Wind Speed Variable Research

Heterogenity					Effect	
Chi^2	df (Q)	P	I^2	Tau^2	Z	P
0,09	1	0,41	0%	0,00	01,19	0,23

Based on table 4 shows the results of data analysis from 2 research articles regarding wind speed with the incidence of DHF. The variance in effect size includes the actual size of the research study, the I² value obtained is 0% and the p-value of the heterogeneity test is >0,05, meaning that the heterogeneity between studies is low and does not vary. Because the p>0,05 and heterogeneity is below 50%, the fixed effect model is used to assess the effect of wind speed on the incidence of dengue fever.

Forest plot

The results of data analysis from 10 research articles, the results of which stated that there was an influence of rainfall on the incidence of DHF and were analyzed using the random effects analysis model

a. Rainfall

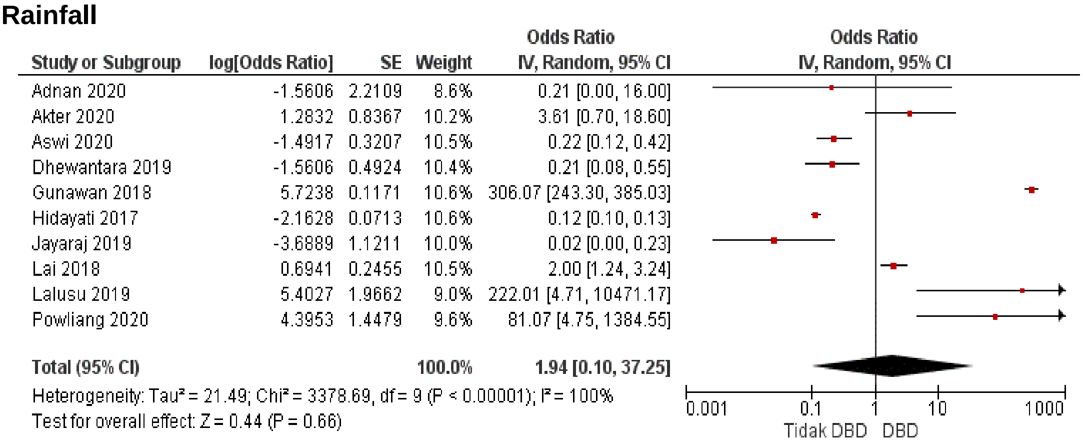

Figure 1. Forest Plot Variable Rainfall

This random effect model is expected to yield an effect size in all research (random) with different interpretations, as shown in Picture 1 above. With a 95% CI range of 0,10-37,25, the impact of rainfall on the incidence of DHF is 1,94. This figure indicates that, in comparison to low rainfall, significant rainfall raises the incidence of DHF by 1.94 times. The chi-squared heterogeneity, which indicates that the combined OR has a heterogeneous distribution (p = 0,66 p> 0,05), provides insight into the quality of the data used to construct the combined risk factors (combined OR). The difference in OR due to heterogeneity, or I-squared variance, is 100%. With an ES value of 0,44, rainfall tends to have a significant impact on the incidence of DHF.

The findings of the meta-analysis of the effect of rainfall on the incidence of DHF are in line with the research Climate Factors Are Affecting Dengue Hemorrhagic Fever (Dhf) Case by Fuadiyah in 2018 which states that rainfall has a significant effect on the incidence of DHF.[30] The results of this study are supported by research conducted by Arcari, et al. (2007) who conducted research in Indonesia to see the relationship between climate and the increase in dengue fever and dengue hemorrhagic fever (DHF) cases which found that there was a climate correlation (rainfall) with the incidence of DHF with a p-value = 0.01 and the category of relationship strength was moderate (r = 0.43). In a study by Aracari, et al. found that increased rainfall per month was associated with vector bite intensity and DHF incidence.[31]

The existence of a significant relationship between environmental factors, especially rainfall, and the incidence of DHF from the analysis of environmental epidemiology and the incidence of a disease, especially vector-borne diseases (Aedis Aegypti) can be caused because high rainfall can increase the potential for the formation of breeding places or breeding places for vectors or mosquitoes Aedis Aegypti or Aedis Albopictus which can support an increase in vector populations so that there is a density of dengue virus spreading vectors which will ultimately lead to the risk of contact between dengue vectors and humans.

In Ministry of Health regulation No. 35/2012, rainfall can affect the lifespan of mosquito factors. Continuous high rainfall can result in the environment becoming flooded which causes the breathing please to be washed away this can help reduce the mosquito population. However, moderate rainfall over a long period of time will increase the breathing please, thus risking an increase in the factor population.[32] The same study used meta-analysis to investigate the impact of rainfall and ambient temperature on dengue fever after conducting a systematic review of published research on the subject. There was a substantial correlation between dengue risk and both temperature and precipitation.[33]

b. Temperature

The results of data analysis from 11 research articles whose results state that there is an influence of air temperature on the incidence of DHF and analyzed using the random effect model analysis model in the table as follows:

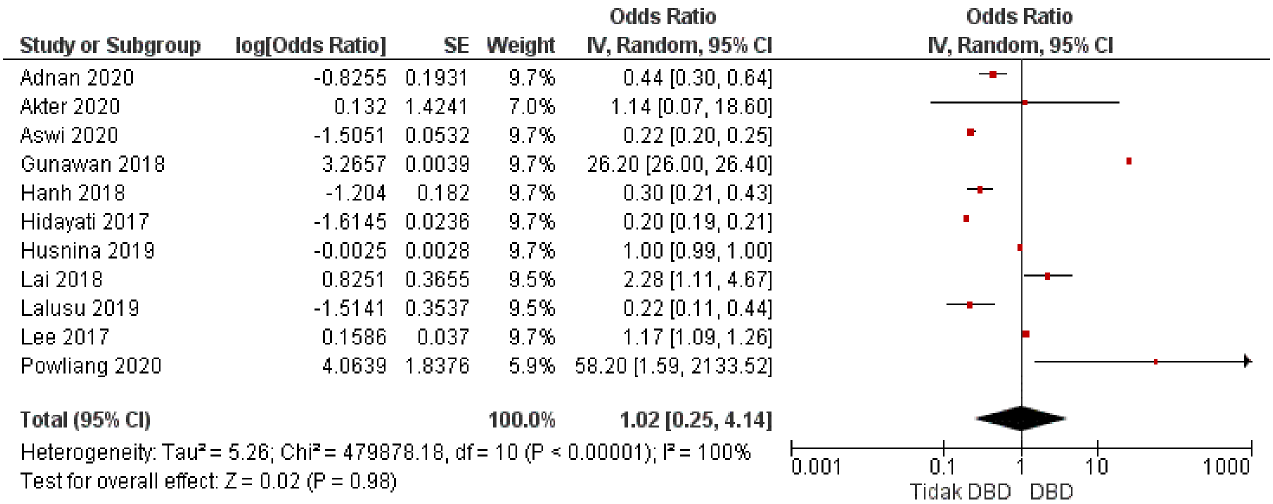

Figure 2. Forest Plot Variable Air Temperature

Some studies gave equal weight to 7 research articles out of 11 research articles that gave equal weight, which amounted to 9.7%. This is due to the heterogeneity of the test results so that one of the studies gives a small weight to the effect size meta analysis. The weight in this meta-analysis research is used to improve the accuracy of the effect size estimation of the analyzed research.[34] The effect given in this meta-analysis was 0.02 and the p-value was 0.98 (p-value>0.05, not significant). The meta-analysis results showed a small effect (ES 0.02) with a p-value of 0.98 which was not significant. There was no difference between high or low temperature on dengue incidence. Changes in air temperature in this random effect had a tendency to have a small effect on the incidence of DHF with an ES value (0.02).

Although some studies mentioned that an increase in temperature will also affect the breeding period of the cuckoo. Warmer temperatures warmer temperatures will increase mosquito metabolism, resulting in an increase in vector density when the number of breeding sites remains constant. As well as research conducted by Nitatpattana, et al. (2007) in Thailand who examined the correlation and influence of surface temperature and temperature with dengue incidence on an island with high temperatures, and showed that there was a correlation between air and surface temperature and dengue incidence with a p-value <0.05.[35] Changes in air temperature in this random effect have a tendency to have a small effect on dengue incidence with an ES value (0.02).

In Figure 2 above, this random effect model tended to produce effect sizes with different interpretations across studies (random). The pooled OR value obtained from this meta-analysis was 1.02. This value indicates that the effect of air temperature on DHF incidence is 1.02 times greater than the effect of air temperature without DHF incidence. The confidence interval was 95% CI (0.25-4.14). The confidence interval was considered too narrow. This is due to the significant heterogeneity test results so that the results tend to vary. CI describes the approximate range of values in the actual population. Although the CI value obtained is narrow, the CI in the results of this meta-analysis is not accurate.

This 95% CI value will measure the bias of the study. In the funnel plot results, points that are above the vertical line and not symmetrical indicate publication bias. Dots that are above the curve indicate the effect size tends to be less accurate. Studies with accurate effect estimates if the points are below and parallel to the curve. Analysis that tends to be less accurate indicates the study cannot be generalized.

c. Humidity

The results of data analysis from 8 research articles whose results state that there is an effect of air humidity on the incidence of DHF and analyzed using the random effect model analysis model in the table as follows:

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Adnan 2020	-1.6296	1.1748	10.2%	0.20 [0.02, 1.96]
Aswi 2020	2.8572	0.0226	14.0%	17.41 [16.66, 18.20]
Hanh 2018	1.2809	0.4451	13.3%	3.60 [1.50, 8.61]
Hidayati 2017	-1.931	0.2033	13.9%	0.15 [0.10, 0.22]
Husnina 2019	-0.1301	0.0023	14.0%	0.88 [0.87, 0.88]
Jayaraj 2019	-1.9449	1.0036	11.0%	0.14 [0.02, 1.02]
Lalusu 2019	-1.1117	0.0471	14.0%	0.33 [0.30, 0.36]
Powliang 2020	4.0037	1.3295	9.5%	54.80 [4.05, 742.09]
Total (95% CI)			**100.0%**	**1.14 [0.28, 4.66]**

Heterogeneity: Tau² = 3.70; Chi² = 17858.79, df = 7 (P < 0.00001); I² = 100%
Test for overall effect: Z = 0.18 (P = 0.86)

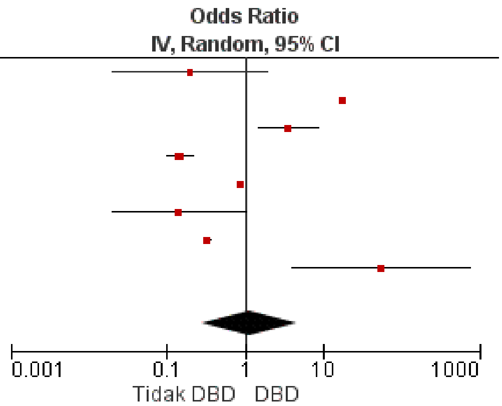

Figure 3. Forest Plot Variable Air Humidity

In figure 3 above, this random effect model is likely to produce an effect size with varying interpretations in all studies (random). The combined effect of 8 research articles that included air humidity on DHF incidence was 1.14 with a 95% CI range (0.28-4.66). This value indicates that changes in air humidity are 1.14 times more likely to cause DHF incidence. The effect size value obtained was 0.18, indicating that humidity had a moderate effect with an effect p-value of p=0.86 (p>0.05), indicating no significance of the air humidity factor on the incidence of DHF. The quality of data constructing the combined risk factor (combined OR) can be seen from the chi-squared heterogeneity which shows that the combined OR has an inhomogeneous distribution (p=0.86 p>0.05). The I-squared variance (variation in OR caused by heterogeneity) was 100%. Changes in air humidity in this random effect had a moderate effect on dengue incidence with an ES value of

0.18.

The high heterogeneity in this meta-analysis is due to the different characteristics of the population, time and place in these eight articles despite having the same climate of rainy and dry. The results showed that air humidity had a moderate effect on dengue incidence, but this study was not significant because it only identified certain populations, so the results could not be generalized to a wider population. Funnel plot of the effect of humidity on DHF incidence showed no publication bias but the results were less accurate.

Similar results were found in a study on geographic spatial data on dengue incidence in Thailand (Spatiotemporal patterns and climatic drivers of severe dengue in Thailand), which revealed that severe dengue cases peaked in Northern and Northeastern Thailand from June to August, that relative humidity had a significant impact on dengue incidence, and that high risk groups of severe dengue in Thailand showed significant inter-annual variation.[36]

d. Wind

The results of data analysis from 2 research articles, the results of which stated that there was an influence of wind speed on the incidence of dengue fever and analyzed using the fixed effect model analysis model in the following table:

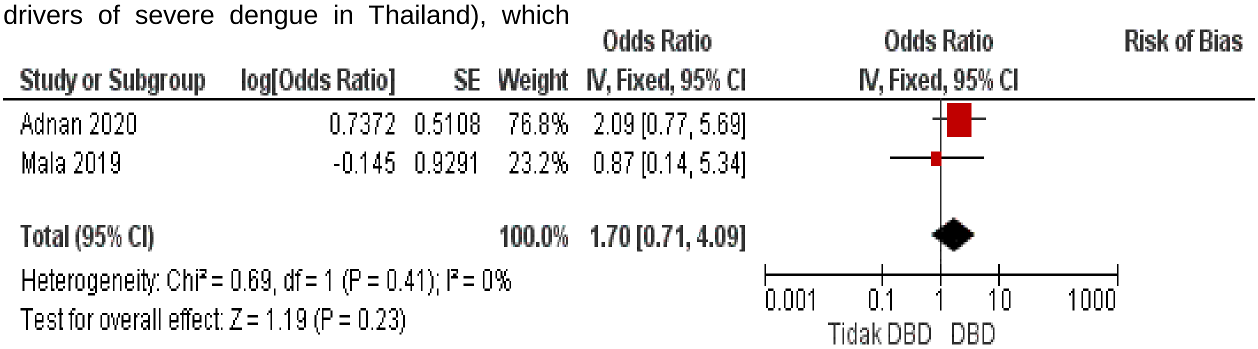

Figure 4. Forest Plot Variable Wind Speed

The effect size value (in fixed effect) of wind speed on the incidence of DHF is 1,70 in Figure 4 above, with a 95% CI range of 0,71–4,90. This figure indicates that there is a 1,70-fold increased risk of DHF due to wind speed. The chi-squared heterogeneity, which indicates that the combined OR has a heterogeneous distribution (p=0,23 p>0,05), provides insight into the quality of the data used to construct the combined risk factors (combined OR). The difference in OR due to heterogeneity, or I-squared variance, is zero. With ES levels, variations in wind speed typically have a significant impact on the incidence of DHF with value 1,19.

In the results of this meta-analysis, all factors involved in the Adnan (2020) and Mala (2020) studies are the same (homogeneous). In other words, all studies included in the analysis have identical functions, so a fixed model is used to determine the effect size.[19, 27] The purpose of using this model is to identify the population. Therefore, the results of the analysis show a large but insignificant effect because the study only identifies a specific population. The results of the study cannot be generalized to a wider population.

In accordance with the findings of a spatial-temporal study conducted in Guangzou China on the effect of wind speed on dengue incidence, which stated that maximum wind speed (>10.7 m/s) inhibits dengue transmission. Climatic factors have a significant impact on dengue fever in Guangzhou. The temperature lag effect on dengue lasts during the local epidemic season.[37] So to reduce dengue cases that may increase, more efforts are needed to strengthen public health system capacity building when climate change cannot be engineered.

CONCLUSION

We can conclude that: Rainfall tends to have a large effect on the incidence of DHF with an ES value (0,44); temperature changes tend to have a small effect on the incidence of DHF with an ES value (0,02); and changes in air humidity have a moderate effect on the incidence of DHF with an ES value based on the results of meta-analysis and data synthesis from prior research articles that meet the inclusion criteria. ES value (0,18), but, with an ES value (1,19), variations in wind speed tend to have a significant impact on the incidence of DHF. The change in wind speed has the largest impact on the incidence of DHF among the four variables examined by the meta-analysis. Wind speed has a 0% I-squared (variation in OR attributable to heterogeneity) compared to 100% for changes in rainfall, air temperature, and humidity. While the wind speed variable tends to be homogeneous, increasing the likelihood of research bias, the variables of rainfall, air temperature, and humidity tend to have a wide range of research findings, which will have a significant impact on the meta-analysis's findings.

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