The Impact of Environmental and Behavioral Factors on the Incidence of Dengue Hemorrhagic Fever in Indonesia: Meta-analysis

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ABSTRACT

Cases of dengue fever in Indonesia will increase to 143,000 by the end of 2022. The aim of the research is to examine the impact of environmental and behavioral factors on the incidence of dengue hemorrhagic fever in Indonesia. This research uses the Meta-Analysis Method with PICOS technology. Some sources of information used include Google Scholar, Research Gate, and Plos ONE, with the help of keywords such as "Environmental factors" and "Behavior." 193 articles were obtained, 151 articles came from Google Scholar, 37 articles from Research Gate, and 5 articles from Plos ONE. The articles obtained were filtered using inclusion criteria such as articles that had a 2x2 table, and discussed dengue fever and behavior with the number of selected articles being 21. At the screening stage, researchers used a cross-sectional research design. JASP application version 0.16.3.0 was used to process meta-analysis data. The key findings show that the habit of hanging clothes has a 2.386 higher risk as a cause of dengue hemorrhagic fever, with the pooled OR value as follows e0.87 = 2.386 (CI 95% 0.17-1.57). The presence of larvae has a risk of 2.075 for dengue fever with the following pooled value e0.73 = 2.075 (CI 95% 0.12-1.33). Meanwhile, the 3 M movement has a risk of 0.406 for the incidence of dengue fever with the following pooled value e-0.90 = 0.406 (CI 95% -1.66-0.15). The conclusion is there is an influence of the habit of hanging clothes, the presence of larvae and the 3M movement on the incidence of dengue hemorrhagic fever.

Keywords: Presence of Larvae, Habit of Hanging Clothes, 3M Movement, Dengue Hemorrhagic Fever

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INTRODUCTION

Dengue Virus (DENV) is a virus that causes dengue fever, a viral infection spread by the Aedes aegypti and Ae. albopictus mosquito.¹² DENV infection sufferers experience various clinical manifestations, ranging from asymptomatic to severe dengue fever, such as dengue hemorrhagic fever and dengue shock syndrome, or dengue fever.³⁴ Dengue fever infections are estimated to occur 390 million times a year, of which 96 million cause symptoms due to the increasing incidence of DENV infections.⁵ In addition, it is estimated that there were 565,900 disabilities and 9,110 deaths in 2013 due to dengue virus infection.⁶-⁸ The first licensed recombinant attenuated dengue fever vaccine (Dengvaxia) was recently clinically available. However, high risks and adverse effects were found among vaccinated individuals.⁹-¹² Severe and fatal dengue cases are consistently reported in several endemic areas, such as Southeast Asia, the Western Pacific and the Americas.¹³-¹⁷

It was also reported that deaths due to dengue shock syndrome were 50 times higher
than that of dengue fever\textsuperscript{4,18,19}. If this virus is properly diagnosed and treated promptly, the death rate from dengue fever will fall from more than 20\% to less than 1\%\textsuperscript{4}. Therefore, early prediction and case recognition are very important for controlling dengue fever. The number of dengue fever cases in Indonesia reached 143,000 by the end of 2022, with West Java, East Java and Central Java having the highest number of dengue fever cases. Nationally, the number of dengue cases is much lower than the estimated number of dengue cases in Indonesia\textsuperscript{20}.

In humans, one dengue serotype confers lifelong immunity against reinfection but provides only temporary and partial immunity against other serotypes\textsuperscript{21}. Enhancement of antibody-dependent immunity also plays an important role in the incidence of dengue fever\textsuperscript{22}. The first dengue outbreaks were reported in 1779 in Jakarta, Indonesia and Cairo, Egypt\textsuperscript{23,24}. However, the only confirmed outbreak in North America, by DENV, was the Philadelphia plague in 1780\textsuperscript{25}. The largest outbreak of dengue fever was seen in 2016 in the Americas, with more than 2.38 million cases. In this outbreak, the highest contribution was in Brazil, with 1.5 million cases\textsuperscript{26}. When dengue became a global concern, currently almost 75\% of the global population is affected by dengue, the majority of which are in the Asia-Pacific region\textsuperscript{27}. Apart from that, there has been an increase in the proportion of dengue fever cases, especially in Thailand, Indonesia and Myanmar\textsuperscript{28}.

Because it is anthropophilic, the Aedes aegypti mosquito prefers human blood to animal blood\textsuperscript{29}. Because many factors include amino acids, lactic acid, body heat, body odor, sweat, and other things that can attract mosquitoes, Aedes aegypti mosquitoes will land on old clothes hangers. Therefore, hanging clothes will increase the number of mosquitoes\textsuperscript{30}. Suyasa's (2008) research findings show a correlation between the practice of hanging clothes and the prevalence of dengue fever vectors\textsuperscript{31}. Similar findings were also reported by T. Widiyanto in his research in 2007 which found a relationship between the practice of hanging clothes and the incidence of dengue fever (OR=7.851) in Purwokerto respondents\textsuperscript{32}. However, showering can stop the development of sweat odor. Bathing can reduce the smell of sweat, thereby reducing mosquito activity around humans. Human sweat is an important factor in the attraction of A. aegypti.

The aim of this research is to determine the risk variables that influence the incidence of dengue hemorrhagic fever in Indonesia, including the presence of larvae, the practice of hanging clothes, and the 3M movement. The uniqueness of this research is that researchers attempted to synthesize data from all research conducted between 2015 and 2023 to examine the relationship between variables that influence the incidence of dengue hemorrhagic fever.

**METHOD**

Meta analysis was carried out on data that had been extracted and synthesized from 21 research articles collected. The pooled prevalence ratio estimate value was obtained from analysis of this data. If the model used is a fixed effect model then the Mentel-Haenszel method is used, and if the model is a random effect then the DerSimonian-Laird approach is used. PICOS methodology, which involves combining two or more similar research findings to produce a combination of quantitative data with the same hypothesis, was used in the meta-analysis of this study\textsuperscript{33,34}.

Google Scholar, ResearchGate, and PlosONE were used as research data sources. "Environmental factors" and "behavior" are the main words of this research. The downloaded articles are articles that have abstracts and full text. The research articles found in this study were 193 journal articles. Then the articles were screened and sorted again using clear inclusion and exclusion criteria such as articles having 2x2 tables, articles discussing dengue fever, the environment and behavior in Indonesia, the number of articles in each variable was at least 10. The researcher used a cross sectional study design to screen at the next stage. Environmental and behavioral factors are selected variables that influence the incidence of dengue fever in Indonesia. Secondary data types from selected articles were used in this research. The incidence of dengue fever is the dependent variable, while environmental and behavioral factors are the independent variables of this research. The following is an image of the PRISMA flow diagram of this research.
Meta-analysis is often carried out in 5 steps, and the first involves the formulation of the study problem, followed by the collection of literature based on the expected objectives, as well as evaluation. The process then continues with analysis and interpretation of the literature obtained, followed by presentation in the form of articles.

The JASP application is used to process the collected data and then analyze it using classic meta-analysis. Data analysis goes through the following stages:

1. **Data Selection**
   The year of publication, variables, design, and results of each study are all included in state-of-the-art tables or the same tables as data collected from other papers. A 2x2 table is taken from this data to be entered into Excel and then converted into Comma Separated Values (CSV) in storage to be entered into the JASP application.

2. **Data Analysis**
   To process meta-analysis data using the JASP Version 0.16.3.0 application, a fixed effect model or random effect is a type of analysis method. To determine the type of IUI method, it depends on the p value in the heterogeneity test table. The analysis results are displayed in the form of a forest plot.

3. **Sensitivity Test**
   To find out whether the data is stable to change, this test examines the differences between the fixed effect model and the random effect model in terms of the pool prevalence ratio value and the difference in the Confident Internal (CI) range.
RESULTS AND DISCUSSIONS

Based on Table 1. The one with the highest risk factor is the habit of hanging clothes with the pooled OR value as follows $e^{0.87} = 2.387$ (CI 95% 0.17-0.57) so it can be concluded that the possibility of contracting dengue fever is 2.387 times higher in people who hang clothes. The possibility of contracting dengue fever is 2.075 times higher for people whose larvae are found around their house. Based on the findings of research conducted in the Semarang area, there is a large correlation between the prevalence of dengue fever and water reservoirs that accommodate mosquito larvae. To implement the 3M plus movement, it is necessary to promote health about the importance of environmental cleanliness and change community behavior through eradicating mosquito larvae. This will stop the breeding cycle of Aedes aegypti mosquito larvae in the surrounding environment.

People’s habit of hanging clothes is 6.29 times more likely to contract dengue fever compared to the habit of people who don’t hang clothes. When mosquitoes lay their eggs, they prefer wet and dark places. In rooms where more clothes are hung, there will be an increase in mosquito nests. In this case, it is very important to know about preventing dengue fever, especially the habit of hanging clothes, in order to suppress the growth of the Aedes aegypti mosquito population and stop the spread of dengue fever in the surrounding environment, especially by eradicating mosquito nests (PSN) in the home environment (inside and outside) using clothes that are no longer hanging.

### Table 1. Results of Meta Analysis of the Presence of Larvae, Habit of Hanging Clothes, and 3M Movement with Dengue Hemorrhagic Fever Cases.

<table>
<thead>
<tr>
<th>No</th>
<th>Research variable</th>
<th>N</th>
<th>Heterogeneity (p-value)</th>
<th>Fixed/Random Effect Model</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Presence of Larvae</td>
<td>10</td>
<td>&lt;0.001</td>
<td>2.075</td>
<td>0.12-1.33</td>
</tr>
<tr>
<td>2</td>
<td>the Habit of Hanging Clothes</td>
<td>10</td>
<td>&lt;0.001</td>
<td>2.387</td>
<td>0.17-0.57</td>
</tr>
<tr>
<td>3</td>
<td>the 3M Movement</td>
<td>10</td>
<td>&lt;0.001</td>
<td>0.406</td>
<td>(-1.66)-(-0.15)</td>
</tr>
</tbody>
</table>

The findings show that the Random Effect (RE) Model value represents the estimated Odd Ratio (OR) value showing a 95% CI of 0.73 with a value range of 0.12-1.33. The forest plot data shown in Figure 1 has a combined OR value of $e^{0.73} = 2.075$, which indicates that there is a 2.075 times higher risk of dengue hemorrhagic fever if larvae are present.

According to Nurrochmawati and Dharmawan stated that the presence of live mosquito larvae allows dengue fever to occur. The presence of A. aegypti larvae is significantly correlated with pH, temperature and humidity of the surrounding water and air. Although dissolved oxygen and pH appear to strongly influence the microfauna and associated flora at nest sites, mosquito larval development is directly influenced by parameters such as temperature and salinity. Previous research shows that the quality of the water in the breeding area, seen from the physical and chemical properties of the water, can have an impact on the presence of larvae. Aedes aegypti mosquito eggs will hatch if the water has the right pH, dissolved oxygen salinity and temperature. One of the main determinants of the existence of life in water is water quality, which is determined based on measurements of various characteristics, especially physical and chemical. The water temperature in the brooding area is 27.6°C. The average maximum number of larvae detected in the breeding water at this temperature was still within the range where Ae. aegypti grows most effectively. The water temperature where the Aedes aegypti mosquito breeds often ranges from 26.5°C to 29.3°C. Salinity and dissolved oxygen, for example, have been shown to impact the development of Aedes aegypti larvae. It is known that the growth of Aedes aegypti larvae is strongly influenced by salinity (amount of dissolved salts in the environment) and DO (amount of dissolved oxygen). The Random Effect (RE) Model value represents the estimated Odd Ratio (OR) value showing a 95% CI of 0.87 with a value range of 0.17-1.57. The forest plot results in Figure 1 are pooled OR $e^{0.87} = 2.387$. Therefore, it was determined that the danger of hanging clothes was 2.387 times higher than the number of
dengue hemorrhagic fever cases. This is in accordance with research. This shows that the incidence of dengue fever is correlated with hanging clothes, with a p value of 0.014 and an OR of 3. There are four types of surfaces that are breeding grounds for mosquitoes, such as metal, wood, clothes and cement. Female mosquitoes are more often found on clothing, while male mosquitoes are more often seen landing on metal surfaces. Hanging clothes also has an impact on the incidence of dengue fever.

The estimated Odd Ratio (OR) value is represented by the Random Effect (RE) Model value which has a CI 95% confidence interval of -0.90 and a range of -1.66 and -0.15. It can be concluded from the Forrest plot data in Figure 1 that the 3M movement has a protective factor of 0.406 against the incidence of Dengue Hemorrhagic Fever sufferers. The pooled OR value for the forest plot was e^{-0.90} = 0.406. Population density, screen ventilation, larvae, 3M behavior, hanging clothes, and use of mosquito repellent are additional factors that influence the occurrence of dengue fever.

### Table 2. Heterogeneity test for careful variables

<table>
<thead>
<tr>
<th>Meta-analysis heterogeneity test</th>
<th>Q</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>the presence of larvae in cases of Dengue Hemorrhagic Fever</td>
<td>Omnibus test of Model Coefficients</td>
<td>5.577</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Test of Residual Heterogeneity</td>
<td>133.099</td>
<td>9</td>
</tr>
<tr>
<td>the habit of hanging clothes in cases of Dengue Hemorrhagic Fever</td>
<td>Omnibus test of Model Coefficients</td>
<td>5.896</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Test of Residual Heterogeneity</td>
<td>124.323</td>
<td>9</td>
</tr>
<tr>
<td>the habit of hanging clothes in cases of Dengue Hemorrhagic Fever</td>
<td>Omnibus test of Model Coefficients</td>
<td>5.488</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Test of Residual Heterogeneity</td>
<td>194.019</td>
<td>9</td>
</tr>
</tbody>
</table>

Based on Table 2, it is known that the p-value of the heterogeneity test for each test variable is less than 0.05 or p = 0.001. Therefore, we used the Random Effect Model in this analysis because there are variations between studies.

### Table 3. Egger's Test

<table>
<thead>
<tr>
<th>Egger's Test</th>
<th>Z</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Factors for the Presence of Larvae in Cases of Dengue Hemorrhagic Fever</td>
<td>-0.059</td>
<td>0.953</td>
</tr>
<tr>
<td>Risk Factors for the Habit of Hanging Clothes in Cases of Dengue Hemorrhagic Fever</td>
<td>1.337</td>
<td>0.181</td>
</tr>
<tr>
<td>Risk Factors for the 3M Movement in Dengue Hemorrhagic Fever Cases</td>
<td>2.647</td>
<td>0.008</td>
</tr>
</tbody>
</table>

The findings show that the Egger's Test p value is > α (0.005), so the variable for the presence of larvae in Dengue Hemorrhagic Fever cases does not have publication bias. The findings also show that the Egger's Test p value is > α (0.005), so the habit of hanging clothes variable in Dengue Hemorrhagic Fever cases does not have publication bias. It is known that the p value of Egger's Test is > α (0.005), then the 3M Movement variable for Dengue Hemorrhagic Fever cases does not have publication bias.

### CONCLUSION

The findings show that the habit of hanging clothes has a 2.386 higher risk as a cause of dengue hemorrhagic fever, with the pooled OR value as follows e^{0.87} = 2.387 (CI 95% 0.17-1.57). The presence of larvae has a risk of 2.075 for dengue fever with the following pooled value e^{0.73} = 2.075 (CI 95% 0.12-1.33). Meanwhile, the 3 M movement has a risk of 0.406 for the incidence of dengue fever with the following pooled value e^{-0.90} = 0.406 (CI 95% 1.66-0.15). Based on these findings, it
was also concluded that there is an influence of the habit of hanging clothes, the presence of larvae and 3M movement on the incidence of dengue hemorrhagic fever. The habit of hanging clothes is the factor that has the highest risk value among the three research factors. With these findings, it can be recommended not to hang clothes and the alternative is to fold clothes and provide a place for dirty clothes that is disinfected so that it does not become a nest for mosquitoes. As for the presence of mosquito larvae, they can be eradicated by carrying out 3M and routinely cleaning up puddles that may arise.

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