ORIGINAL RESEARCH ARTICLE

# Risk Factors Dengue Fever in an Endemic Area in Sikka, Indonesia; A Case-Control Study

**AS Nong Erwin[1*], Nur Nasry Noor[2], Wahiddudin[3], A Arsunan Arsin[4], Hasanuddin Ishak[5], Andi Julia Junus[6]**

[1-5]Hasanuddin University, Makassar, Indonesia
[6]South Sulawesi Provincial Health Office, Makassar, Indonesia

**DOI:** 10.55489/njcm.150820244213

## ABSTRACT

**Background:** Dengue fever is a serious health problem that burdens public health and the economy. The aims to analyzing the risk factors for dengue fever in endemic areas in Sikka Regency.

**Methodology:** This research uses a case control study design with a ratio of 1:1. Cases are families whose members were diagnosed with dengue fever based on positive dengue NS1/IGM laboratory results (132). Controls are families whose members do not suffer from dengue fever coming from the same group as cases (132). Multivariate analysis with logistic regression in the STATA application.

**Results:** The total number of cases was 132 cases, (51%) male, with the majority in the 5–15-year age group (39.3%). House Index (62.5%), Breteau Index (386%), Container Index (49.93%), ABJ (37.5%). Multivariate analysis of variables that were risk factors were knowledge (AOR 2.48; 95% CI, 1.128- 4.928), habit of hanging up used clothes with value (AOR 2.93; 95% CI, 1.292 - 6.688), habit of storing water. in open containers (AOR 2.53; 95% CI, 1, 257- 5.090), residential density (AOR 2.20; 95% CI, 1.153 – 4.229), and the dominant risk factor is larval density (AOR 13.97; 95% CI, 6.793 – 28.735) with a probability (96.8%) of causing dengue fever.

**Conclusions:** Behavioral factors that influence the incidence of dengue fever are knowledge, attitude, the habit of hanging up used clothes, the habit of storing water in open containers, and the habit of not draining water containers regularly, while wearing long-sleeved clothes and the use of medication have no influence on the incidence of dengue fever.

**Key-words:** DHF, Risk factors, Case Control, Endemic

## ARTICLE INFO

**Financial Support:** None declared
**Conflict of Interest:** None declared
**Received**: 24-05-2024, **Accepted**: 13-07-2024, **Published**: 01-08-2024
***Correspondence:** A.S Nong Erwin (Email: anongerwin@gmail.com)

**How to cite this article:** Erwin ASN, Noor NN, Wahiddudin, Arsin AA, Ishak H, Junus AJ. Risk Factors Dengue Fever in an Endemic Area in Sikka, Indonesia; A Case-Control Study. Natl J Community Med 2024;15(8):676-684.
DOI: 10.55489/njcm.150820244213


*www.njcmindia.com | pISSN: 0976-3325 | eISSN: 2229-6816 | Published by Medsci Publications*

# Introduction

Dengue hemorrhagic fever (DHF) is an infectious disease that causes serious health problems globally and burdens public health and the economy.[1] DHF is caused by the dengue virus (DENV) from the Flaviviridae family. Dengue virus (DENV) has four main serotypes, namely DENV-1, DENV-2, DENV-3, and DENV-4, and is transmitted to humans through the bites of Aades Agepty and Aedes albopictus mosquitoes.[2,3]

Sikka Regency is one of the regencies in East Nusa Tenggara Indonesia that often experiences Extraordinary Events (KLB) with a three-year cycle, while East Alok District is one of the endemic DHF sub-districts in Sikka Regency with the highest number of cases every year, with 53 cases in 2021. (IR 162.5 per 100,000 population) with 1 case of death due to CFR (1.5%) In 2022, there will be 74 cases (IR 226.88 per 100,000 population) with 1 case of death due to dengue fever (CFR, 1.56%), and from 2023 to October 2023, the number of cases will be 148 (IR 383.2 per 100,000) with no deaths.[4,5]

Various prevention and control efforts and strategies have been carried out but have not been able to reduce the incidence of dengue fever significantly, so understanding the risk factors underlying the spread of dengue fever remains the main focus. Comprehensive and in-depth research on risk factors for dengue fever, especially in endemic areas, is very important.[3,6]

This research is different from previous research, namely conducting an in-depth and comprehensive analysis of various risk factors that influence the incidence of dengue fever simultaneously, including behavioral factors, environmental risk factors, and vector density factors, and using a Geographic Information System (GIS) to map the distribution of dengue cases. with a focus on endemic areas, so that it is hoped that it can provide more comprehensive recommendations, provide significant new insights into the understanding of dengue fever epidemiology, and assist in developing more effective prevention strategies, especially in dengue endemic areas.[6,7]

**Objectives:**

Based on the problem description above and the results of a review of several previous studies related to risk factors for dengue fever, researchers wish to identify, analyse, and evaluate risk factors for dengue fever by analyzing the distribution of dengue cases and vector density, as well as interactions between risk factors and their impact on the spread of dengue fever. in a complex manner from behavioral factors, namely knowledge, attitudes, and actions to prevent dengue fever; environmental factors, namely residential density and the presence of houses in residential areas; and vector density in order to provide recommendations in efforts to control dengue fever in endemic areas.

# Methodology

**Research design:** The designed of this researched is analytical observational with a case control study. Researched in East Alok District, which is an endemic district for dengue fever in Sikka Regency, from January to February 2024. The population in this study is all people who live in endemic districts in Sikka Regency from January to December 2023.

**Sampling technique:** The sampling technique for the case group was total sampling, namely all dengue fever cases that had been diagnosed by laboratory examination and recorded at community health centers and hospitals in 2023. Meanwhile, the control group used a purposive sampling technique from the same group as the case group. The total sample in this study was 264 people with a ratio of 1:1 with a total of 132 case samples and 132 control samples with the criteria. Cases were families whose members were diagnosed with dengue fever by laboratory examination, rapid test for NS1 antigen or positive IgM antibodies. recorded in health centers and hospitals in the period January to December 2023 and Controls are families whose members do not suffer from dengue fever and reside in endemic areas of Sikka Regency in 2023.

**Questionnaire Design and Data collection:** This study aims to look at 3 (three) groups of risk factors for the incidence of dengue fever, namely behavioral risk factors, environmental risk factors and vector density risk factors. To measure behavioral risk factors and environmental risk factors, a structured questionnaire is used, guided by CDC and WHO [2,3] which have been revised by 3 competent experts on dengue fever. The questionnaire was converted in Kobotoolbox application, while the larval density measurements used standard larval survey format.

The design of the larva survey format refers to the technical guidelines for controlling dengue fever from the Ministry of Health of the Republic of Indonesia to determine larva density figures (House index, Container Index and larva free figures) and risk factors for larva density by observing the presence of larvae in Aedes containers in respondents' homes, namely containers for household purposes. daily, containers not for daily needs and natural containers, also observing the location of containers inside and outside the house as well as the condition of open and closed containers and then recapping in Excel format for validation and input into the Stata application for processing. do analysis.[2,3]

Before the measurements were carried out, validity and reliability tests were carried out on the respondents' knowledge and attitude variables. The questionnaire measurements were tested on 30 respondents and analyzed using IMB SPSS 20. Data collection was carried out with 2 emulators who were experienced independent public health workers before carrying out the collection. The data underwent training for 3 days on how to use the Kobotoolbox application and retrieve coordinates using GSP Essentials.

**Table 1**: **Measurement of study variables**

| Variable | How to Measure | Measuring instrument | Objective Criteria |
|---|---|---|---|
| DHF Incident | Reports of dengue fever cases from Sikka Regency, recorded in health facilities, health centers and hospitals. | View data on dengue case reports from hospitals. Nominal Scale | 1. DHF: If you have been diagnosed as a DHF patient by laboratory examination<br>2. Non-DHF: If not diagnosed as a DHF patient |
| Knowledge | Interviews to measure respondents' knowledge used the Guttman Scale with 13 questions, based on a score, correct answers were given a value of 1 and incorrect answers were given a value of 0 with a value range of 0 - 13. | Questionnaire,<br>Scale: Nominal | 1. Poor: If the total score is 0 – 8 (< 75%).<br>2. Good: if total score ≥ 8 – 13 (≥ 75%) |
| Attitude | Interviews for measuring attitudes use a Likert Scale (1 – 4) with 14 statements, if you answer strongly agree the value is 4, agree the value is 3, Disagree the value is 2 and strongly disagree | Questionnaire,<br>Scale: Nominal | 1. Negative: if the total score is 25 - 35 (< 63%)<br>2. Positive: if the total score is 36 – 56 (≥ 63%) |
| Use of mosquito nets | Observation of the installation of mosquito nets on the beds in respondents' homes | Questionnaire Observation,<br>Scale: Nominal | 1. Risk: if there is no mosquito net installed on the bed.<br>2. No risk: if you install a mosquito net on the bed and use it while sleeping. |
| Wear long sleeves | Interviews are conducted by asking questions to respondents | Observation Questionnaire,<br>Scale: Nominal | 1. Risk: if you don't wear long-sleeved clothes during your morning and evening activities at home.<br>2. No risk: if you wear long-sleeved clothes when doing activities at home. |
| Use of mosquito repellent | Interviews are conducted by asking questions to respondents. | Observation Questionnaire,<br>Scale: Nominal | 1. Risk: if you don't use anti-mosquito medicine or lotion during morning and evening activities.<br>2. No risk: if you use anti-mosquito medicine/lotion during morning and evening activities. |
| The habit of hanging up used clothes | Interviews are conducted by asking questions to respondents in the form of a questionnaire. | Observation Questionnaire,<br>Scale: Nominal | 1. Risk: if you have a habit of hanging clothes that have been worn inside or outside the house.<br>2. No risk: if you don't have the habit of hanging clothes that have been worn inside or outside the house. |
| The habit of storing water in open containers | Interviews and observations of water storage containers in respondents' homes | Observation Questionnaire,<br>Scale: Nominal | 1. Risk: if you have the habit of storing water in an open container for more than 7 days<br>2. No risk: if you don't have the habit of holding water in an open container for more than 7 days. |
| The habit of draining water storage places regularly | Interviews and observations of water storage containers in respondents' homes | Questionnaire,<br>Scale: Nominal | 1. Risk: if you don't have the habit of draining water reservoirs less than once every 7 days<br>2. No risk: if you have a habit of draining the water reservoir less than once every 7 days |
| Residential Density | Measuring the floor area of the respondent's house. | Meters,<br>Scale: Nominal | 1. Risk: if the room area is <8 m2 / occupant.<br>2. No risk: if the room area is ≥ 8 $m^2$/occupant. |
| Status of the existence of the house/residence in the residential location | Observation of the patient's home/residence | Observation Questionnaire,<br>Scale: Nominal | 1. Risk: if the respondent's house or residence is in the city center<br>2. No risk: if the respondent's house/area of residence is in an area outside/on the outskirts of the city. |
| Flick Density | Calculate the total containers containing dengue larvae divided by the total containers examined times a constant (100%). | Container Index (CI),<br>Scale: Nominal | 1. Risk: If the Density Figure (DF) Category is Medium/High ≥ 3%<br>2. No Risk: If the Density Figure (DF) Category is no larvae/low < 3%) |

**Data Processing and Analysis:** Data from the Kobotoolbox application and larval survey format were exported as an Excel file for validation, editing, coding and cleaning, then imported into STATA, while the coordinate point data was imported into Quantum GIS for mapping the distribution of cases. Data that has been imported into the STATA application is subjected to Univariate, Bivariate and Multivariate analysis. Univariate analysis is made in the form of a distribution and frequency table of respondent characteristics as well as dependent and independent variables. Bivariate analysis was carried out by compiling a 2x2 table to calculate the OR value, while the significance test used the Confident Interval CI 95% and Chi square ($X^2$). Multivariate analysis uses Logistic Regression by entering variables that in the bivariate analysis that has been carried out previously have a Confident Interval CI value of 95% which is statistically significant to determine confounding variables and dominant variables that are risk factors as well as the probability value of independent variables that influence the incidence of dependent dengue fever and several variables. independent with the following stages, entering all independent variables that are statistically significant in bivariate analysis by carrying out gradual elimination using backward stepwise (Confident Interval CI 95% is not significant) will be removed to get a final model that is fit to see the independent variable which is the dominant risk factor Next, the probability value is calculated using the formula: (P = 1/ (1+exp (-y)) to determine the probability of the variable being a risk factor for dengue fever.

**Ethical Approval:** This research has already been approved by the Hasanuddin University Health Research Ethics Committee with approval recommendation number 6540/UN4.14.1/TP.01.02/2023. Data confidentiality is an agreement between the researcher and the respondent and will not be disseminated in accordance with the research Informed Consent, that the respondent is asked to provide information as honestly as possible, the respondent's identity will be kept confidential and will not be published, so the name will be displayed according to the initials, on the research documentation the face will.

## RESULTS

The distribution of dengue fever cases in East Alok District, Sikka Regency, has seen a significant increasing trend, where cases in 2022 were 71 cases, increasing to 148 cases in 2023 and are still concentrated in the city center residential area, however, there has been a significant increase in cases in subdistrict border areas in the region. city with suburban areas. Based on the distribution of dengue fever cases, the highest number is in the 1 - 4-year-old group, 49 (37.12%) and the 5 - 15-year-old group (39.3%) and this age group is mostly school age, while based on larvae detection, it is very high, namely based on the House Index (62.50%), Container index (43.93%) Bretaue Index (386%) while the Larvae Free Rate is very low, namely (37.5%) below the national target (95%).

Table 2 shows that the distribution of respondents' characteristics is mostly female (73.11%), based on education, the highest is at the high school level (33.71%), based on the age group 17 - 45 years (38.26%), while based on occupation the largest number is housewife. stairs (67.00%).

Table 3 shows the behavioral factors which are risk factors for dengue fever, namely knowledge with value (OR 2.98; 95% CI, 1.738 - 5.155), attitude with value (OR 2.17; 95% CI, 1.254 - 3.773), use of mosquito nets with value, (COR 2.88; 95% CI, 649 - 9.791), habit of hanging up used clothes value, (OR 4.57; 95% CI, 2.441 - 0.445), habit of storing water in open containers with value, (OR 2.44; 95% CI, 1.367 - 4.421), and the habit of regularly draining water reservoirs with a value, (OR 2.86; 95% CI, 1.672 – 4.911). The environmental factor which is a risk factor for the incidence of dengue fever is residential density with (OR 2.92; 95% CI, 1.695 – 5.049), and the larval density variable is a risk factor for the incidence of dengue fever with a value of (OR 15.24; 95% CI, 7.605 – 31.645).

Based on Table 4, the variables of attitude, use of mosquito nets, and the habit of draining water reservoirs are confounding variables which have a relationship with the knowledge variable and the incidence of dengue fever. The knowledge variables, the habit of hanging up used clothes, the habit of closing water reservoirs, residential density and density Larvae is a risk factor for dengue fever.

**Table 2**: **Distribution of Respondent**

| Respondent Characteristics | Case (n=132) | Control (n=132) | Total (132) |
|---|---|---|---|
| **Gender** | | | |
| Female | 88 (63.64) | 109 (82.58) | 193 (73.11) |
| Male | 48 (36.36) | 23 (17.42) | 71 (26.89) |
| **Age** | | | |
| 17-45 Years | 108 (81.06) | 69 (52.57) | 177 (67.00) |
| >45 Years | 25 (18.19) | 63 (47.73) | 88 (33.00) |
| **Education** | | | |
| No School | 0 (0.0) | 3 (2.27) | 3 (1.14) |
| Below Primary | 4 (3.03) | 11 (8.33) | 15 (5.68) |
| Primary | 21 (15.91) | 27 (20.45) | 48 (18.18) |
| Junior High School | 22 (16.67) | 22 (16.67) | 44 (16.67) |
| High School | 41 (31.06) | 48 (36.36) | 89 (33.71) |
| Academia | 20 (15.15) | 8 (6.06) | 28 (10.61) |
| Bachelor | 24 (18.18) | 13 (9.85) | 37 (14.02) |
| **Work** | | | |
| Farmer | 3 (2.27) | 3 (2.27) | 3 (1.14) |
| Civil Servaants/ TNI/Polri | 17 (12.28) | 8 (6.06) | 15 (5.68) |
| Self-employed | 35 (26.52) | 11 (8.33) | 48 (18.18) |
| Private employed | 12 (9.09) | 9 (6.82) | 44 (16.67) |
| Housewife | 59 (40.07) | 89 (67.42) | 89 (33.71) |
| Others | 6 (4.55) | 12 (9.09) | 28 (10.61) |

Source: Primary Data, 2024
Figures in the parenthesis indicate percentage.

**Table 3: Bivariate Analysis of Risk Factors for DHF**

| Risk Factors | Cases (%) | Control (%) | OR (CI 95% LL-UL) | *p-value* |
|---|---|---|---|---|
| **Respondent Knowledge** | | | | |
| Less | 71 (53.79) | 37 (28.03) | 2.98 | 0.000 |
| Good | 61 (46.21) | 95 (71.97) | 1.738 – 5.155 | |
| **Respondent Attitude** | | | | |
| Negative | 58 (43.94) | 97 (73.48) | 2.17 | 0.003 |
| Positive | 74 (56.06) | 35 (26.52) | 1.254 – 3.773 | |
| **Use of Mosquito Nets** | | | | |
| Not Use | 101 (76.52) | 70 (53.03) | 2.88 | 0.000 |
| Use | 31 (23.48) | 62 (46.97) | 1.649 – 5.079 | |
| **Wear Long Sleeves** | | | | |
| Not Use | 98 (74.24) | 106 (80.30) | 0.70 | 0.240 |
| Use | 34 (25.76) | 26 (19.70) | 0.378 – 1.312 | |
| **Anti-Mosquito Use** | | | | |
| Not Use | 70 (53.03) | 63 (47.73) | 0.38 | 0.388 |
| Use | 62 (46.97) | 69 (52.27) | 0.741 – 2.063 | |
| **The habit of hanging clothes after use** | | | | |
| Yes | 88 (66.67) | 119 (90.15) | 4.57 | 0.000 |
| No | 44 (33.33) | 13 (9.85) | 2.441 – 9.791 | |
| **Ability to store water in an open container for more than 7 days** | | | | |
| No | 51 (38.64) | 27 (20.45) | 2.44 | 0.001 |
| Yes | 81 (61.36) | 105 (79.55) | 1.367 – 4.421 | |
| **The habit of draining water reservoirs regularly every 7 days** | | | | |
| No | 72 (54.55) | 39 (29.55) | 2.86 | 0.000 |
| Yes | 60 (45.45) | 93 (70.45) | 1.672 – 4.911 | |
| **Population Density** | | | | |
| Room area < 8 m2 / occupant | 69 (52.57) | 36 (27.27) | 2.92 | 0.000 |
| Room area ≥ 8 m2 / occupant | 63 (47.73) | 96 (72.73) | 1.695 – 5.049 | |
| **Location of Residential Places** | | | | |
| City Centre | 79 (59.85) | 79 (53.03) | 1.00 | 1.000 |
| Sub urbans | 53 (40.15) | 53 (46.97) | 0.593 – 1.685 | |
| **Flick Density** | | | | |
| Density Figure (DF) CI ≥ 3% | 118 (89.3) | 47 (35.61) | 15.24 | 0.000 |
| Density Figure (DF) CI < 3% | 14 (10.61) | 85 (64.39) | 7.605 – 31.649 | |

Source: Primary Data, 2024

**Table 4: Multivariate Analysis of the Relationship between the Dependent Variable and the Independent Variable of DHF Incidence**

| Variable | AOR ((95% CI) |
|---|---|
| Knowledge | 2.14 (1.02–4.50) |
| Attitude | 0.87 (0.43–1.78) |
| Use of Mosquito Nets | 1.57 (0.79–3.13) |
| Habit of hanging clothes | 2.44 (1.04–5.72) |
| Habit of Storing water in open containers | 2.29 (1.12–4.69) |
| Habit of draining water reservoirs | 1.89 (0.92–3.78) |
| Residential Density | 2.23 (1.15–4.32) |
| Flick Density | 13.44 (6.37–28.41) |
| Total | 0.04 (0.01–0.09) |

**Table 5: Multivariate Analysis of Risk Factors for DHF**

| Research Variable | AOR (95% CI) | *p-value* |
|---|---|---|
| Knowledge | 2.48 (1.25 – 4.93) | 0.009 |
| The habit of hanging clothes | 2.93 (1.29 – 6.69) | 0.010 |
| The habit of storing water in an open container for more than 7 days | 2.53 (1.26 – 5.09) | 0.009 |
| Population density | 2.20 (1.15 – 4.23) | 0.017 |
| Flick Density | 13.97 (6.79 – 28.73) | 0.000 |
| **Constanta** | 0.053 (0.02 – 28.74) | 0.000 |

Source: Primary Data, 2024

Further multivariate analysis was carried out to get a final model that is fit to find out the dominant variables and obtain probability values for dengue fever, which can be seen in the table 5.

Table 5 shows that the most dominant variable as a risk factor for dengue fever is larva density with (AOR 13.97; 95% CI, 6.793 – 28.735) a 13.97 times risk of causing dengue fever. Based on the results of the analysis above, it can be concluded that the probability of dengue fever occurring in endemic sub-districts in Sikka Regency is due to the influence of respondents' knowledge and the habit of hanging up used clothes. the habit of not closing water reservoirs, residential density and larval density was 96.8%.

## DISCUSSION

**Distribution of DHF Cases and Larval Density:** The research findings show that the distribution of dengue fever cases has increased significantly compared to the previous year, especially in villages or sub-districts located outside or on the outskirts of the city. However, overall, dengue fever cases are still concentrated in sub-districts in the city center with dense populations. This is in line with previous research.[9,10]

Several things that cause an increase in dengue fever cases are inadequate waste management, especially plastic waste, limited access to clean water which leads to poor water storage practices causing high larval density and high population mobility.[8,11,12] Intervention in suburban areas is very important to prevent the spread and increase in dengue cases and extraordinary incidents in the future. Some efforts that can be made are intensively eradicating mosquito nests, especially before entering the rainy season. Apart from that, public education about the dangers and risks of dengue transmission as well as dengue prevention practices also needs to be carried out.[13,14]

Based on age groups, it shows that the age group most vulnerable to dengue fever is children aged 1-14 years, with the largest number in the school age group (5-14 years). These findings are consistent with previous research conducted in various regions, which shows that the greatest risk factor for dengue cases occurs at the age of 5-14 years.[15] The findings above and several previous studies show that school-age children are at high risk of developing dengue fever. The potential for transmission in the school environment occurs where there are mosquito breeding places that are not monitored and no eradication action has been taken so that they become suitable places to support the breeding of Aedes mosquitoes.[16]

**Behavioral Risk Factors:** Analysis of behavioral risk factors found variables that had a significant influence on the incidence of Dengue Hemorrhagic Fever (DHF), namely the level of knowledge of respondents, attitudes of respondents, use of mosquito nets, the habit of storing water in open containers, and the habit of regularly draining water reservoirs while being able to hang clothes. consumables are a protective factor. This finding is consistent with previous research which found a correlation between knowledge and attitudes and the incidence of dengue fever[17] significant impact on the incidence of dengue fever[21,16].

This causes low public understanding, this is supported by the respondents' answers to research questionnaire where there is a gap in respondents' knowledge about dengue prevention efforts, namely more than 70% are not aware of the development of the Aedes mosquito from egg to adult in just 10-14 days and also understanding of the ability of Aedes mosquito eggs to survive in a dry container for 6 up to 8 months. This creates a challenge for the community to carry out routine eradication of mosquito nests in their homes and environments, this is in line with previous research.[23] Increasing public awareness about the life cycle of the Aedes mosquito and implementing effective prevention practices is very important Minimizing the risk of dengue fever transmission prevents an increase in cases.[8,24]

The results of the attitude assessment analysis towards dengue fever prevention efforts show that while around 70% of respondents have a positive attitude towards dengue fever prevention efforts, there are still more than 70% who show a negative attitude, namely they state that fogging carried out by health workers is sufficient to prevent dengue transmission in the area. their region, this fever is in line with previous research.[25] They believe that fogging is effective as the main preventive measure so that they do not carry out activities to physically eradicate mosquito nests at home or in their environment, there is an incorrect perception about the benefits of fogging in controlling the spread of dengue fever in the community, so it is necessary to increase public understanding about various prevention methods dengue fever, including fogging and eradicating mosquito nests, to increase public awareness and knowledge regarding dengue prevention efforts.[26,27]

The use of mosquito nets, especially insecticide-treated nets, is very important to prevent the transmission of not only malaria but other mosquito-borne diseases including dengue fever and filaria-sis.[21,22] Studies emphasize the importance of universal coverage and use of insecticide-treated bed nets, especially among vulnerable groups such as pregnant women and children. While some areas are not endemic for malaria, the use of bed nets remains effective in preventing vector-borne diseases such as dengue fever.[30]

Another behavioral factor that is a risk factor for dengue fever in endemic sub-districts in Sikka Regency is the varying habit of storing water in open containers and the habit of not draining water reservoirs regularly. The presence of open containers without lids, especially water reservoirs, provides an ideal breeding place for the Aedes aegypti mosquito, thereby contributing to an increase in mosquito density.[26,31] Apart from that, the lack of public awareness and knowledge regarding eradicating mosquito nests further worsens the situation and has the potential to cause a spike in dengue cases in the future.[32] This condition, coupled with residents' difficulty in accessing clean water, results in prolonged water storage, creating an environment conducive to mosquito breeding not only during the rainy season but throughout the year.[33]

Efforts to increase access to clean water and good sanitation infrastructure, especially in suburban areas, are very important to reduce mosquito-borne diseases and other mosquito-borne arboviruses.[34] Increasing public awareness about draining/cleaning water reservoirs and closing water storage containers is very important to prevent the breeding of Aedes Aegypti mosquitoes, which are the main vectors of mosquito-borne diseases.[35] Expanding clean water distribution networks and integrating vector control measures into sanitation projects are steps it is important to create sustainable and effective interventions for disease prevention and control in suburban areas.[36]

**Environmental Risk Factors:** The results of the analysis of variable environmental factors which are risk factors for dengue fever, namely the residential density variable, are supported by the results of measuring the distance between case and control houses and other residents' houses on average under 10 meters, making it possible for rapid transmission to occur. Several studies show that there is an influence between residential density and the incidence of dengue fever.[38] Residential density is based on the Indonesian Ministry of Health No. 829/Menkes/SK/VII/-1999, namely a basic room area of 8 m2 for each individual If one of the family members has dengue hemorrhagic fever (DHF), a house with a high population density has a higher risk of transmitting this disease than a house with few people.[39]

Based on these findings, appropriate intervention steps are needed to reduce the risk of dengue fever due to environmental factors. Some solutions that can be done are increasing public awareness about the importance of using mosquito nets, using anti-mosquito lotion, and wearing long-sleeved clothes to prevent mosquito bites, especially in vulnerable populations.[40,41] Apart from that, health workers must also regularly carry out outreach and carry out community empowerment activities to prevent the risk of dengue transmission [8] and local governments also need to make efforts to improve sanitation infrastructure which can help reduce residential density and improve environmental conditions overall.[42]

**Risk Factors for Larval Density:** The results of the multivariate analysis showed that the variable larval density was a domain risk factor in the incidence of dengue fever. This finding is reinforced by the high number of House Index, Bretau Index, and Container Index, and the low Larval Free Rate (ABJ) in East Alok sub-district, as seen in the research results. Factors such as the behavior of throwing rubbish anywhere and inadequate waste management, especially plastic waste, create favorable conditions for the development of mosquitoes.[43] In addition, low public awareness and a lack of routine mosquito nest eradication (PSN) activities are carried out which combines physical, biological and chemical methods is very important to overcome this problem.[44,45] Implementing these strategies collaboratively across related programs and sectors is critical for effective vector control and reducing dengue incidence in the area. One effective solution is the spread of wolbachia mosquitoes.[46]

## Limitations

This research still has limitations, namely that it has not simultaneously looked at the role of health workers and related cross-sector support in efforts to control dengue fever in endemic sub-districts in Sikka Regency, so for the following research or researchers it is recommended to conduct research related to the role of officers and cross-sectors in supporting prevention efforts. and controlling dengue fever in endemic areas.

## Conclusion

Behavioral factors that influence the incidence of dengue fever are knowledge, attitude, the habit of hanging up used clothes, the habit of storing water in open containers, and the habit of not draining water containers regularly, while wearing long-sleeved clothes and the use of medication have no influence on the incidence of dengue fever. Environmental factors include residential density, while the location of the house in a residential area does not have a significant effect on the incidence of dengue fever, while larval density is the dominant risk factor influencing the incidence of dengue fever. This is supported by the high larval density rate.

## Acknowledgement

The author would like to thank the supervisor for his patience, time, energy and thought and attention in providing guidance during the process of preparing this scientific work and also to Health Security Partners (HSP), which has provided study task scholarships provided during the master's education program.

## References

1. Ye G, Xu Z, Yang M, Wang J, Liang J, Yin J, et al. Clinical features and transmission risk analysis of dengue virus infections in Shenzhen, During 2014–2019. *Comput Struct Biotechnol J*. 2023; 21(1); 3728–35. DOI: 10.1016/j.csbj.2023.07.001
2. CDC. About Dengue: What You Need to Know. 2023. Avaialable from: https://www.cdc.gov/dengue/about/ index.html
3. WHO. Dengue and severe dengue. 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue.
4. Mynistry of Health Republic of Indonesia. Ditjen P2P. 2024. Infografis DBD Week 12 Years 2023.
5. Sikka District Health Department. Sikka Regency Health Profile. 2024.
6. Nyenke CU, Nnokam BA, Esiere RK, Nwalozie R. Dengue Fever: Etiology, Diagnosis, Prevention and Treatment. *Asian J Res Infect Dis*. 2023; 14(1): 26–33.
7. Dalvi APR, Gibson G, Ramos AN, Bloch K V., de Sousa GDS, da Silva TLN, et al. Sociodemographic and environmental factors associated with dengue, Zika, and chikungunya among adolescents from two Brazilian capitals. *PLoS Negl Trop Dis*. 2023; 17(3): 1–17.
8. Kebede T, Tesema B, Mesfin A, Getachew D. A Community-Level Knowledge, Attitude, and Practice about Dengue Fever and the Identification of Mosquito Breeding Containers in Dire Dawa City of Ethiopia: A Cross-Sectional Study. *Can J Infect Dis Med Microbiol*. 2023;2023.

9. Eldigail MH, Abubaker HA, Khalid FA, Abdallah TM, Adam IA, Adam GK, et al. Recent transmission of dengue virus and associated risk Facors among residents of Kassala state, eastern Sudan. *BMC Public Health*. 2020; 20(1): 1–9.
10. Nguyen-Tien T, Do DC, Le XL, Dinh TH, Lindeborg M, Nguyen-Viet H, et al. Correction: Risk factors of dengue fever in an urban area in Vietnam: a case-control study. *BMC Public Health*, 2021; 21 (1):1-13. DOI:10.1186/s12889-021-10687-y.
11. Indirawati SM, Salmah U, Chahaya I, Bukit DS, Situmorang RFR, Hutagalung DS. Relationship analysis of protection strategy and the number of containers with the existence of Aedes aegypti larvae at Tebing Tinggi city in 2022. *Int J Community Med Public Heal*. 2023; 10(7):43–9.
12. Salsabillah N, Rachman A, Fitri E. Overview of the zoonotic epidemiological investigation into the incidence of Dengue Hemorrhagic Fever (DHF) at the UPTD of the Lamaru Community Health Center. *Thesis*. Jember University. 2023: 14–22.
13. Carrillo MA, Cardenas R, Yañez J, Petzold M, Kroeger A. Risk of dengue, Zika, and chikungunya transmission in the metropolitan area of Cucuta, Colombia: cross-sectional analysis, baseline for a cluster-randomised controlled trial of a novel vector tool for water containers. *BMC Public Health*. 2023; 23(1): 1–15.
14. Souza RL, Nazare RJ, Argibay HD, Pellizzaro M, Anjos RO, Portilho MM, et al. Density of Aedes aegypti (Diptera: Culicidae) in a low-income Brazilian urban community where dengue, Zika, and chikungunya viruses co-circulate. *Parasites and Vectors.* 2023; 16(1): 1–15. https://doi.org/10.1186/s13071-023-05766-5
15. Masyeni S, Fatawy RM, Paramasatiari AAAL, Maheraditya A, Dewi RK, Winianti NW, et al. Dengue seroprevalence study in Bali. *PLoS One*. 2023; 18(1) :1–7. http://dx.doi.org/10.1371/journal.pone.0271939
16. Pérez-Guerra CL, Rosado-Santiago C, Ramos SA, Marrero KM, González-Zeno G, Miranda-Bermúdez J, et al. Community perceptions on challenges and solutions to implement an Aedes aegypti control project in Ponce, Puerto Rico (USA). *PLoS One.* 2023; 18(4 April):1–16.
17. Chng JWQ, Parvathi T, Pang J. Knowledge, attitudes and practices of dengue prevention between dengue sustained hotspots and non-sustained hotspots in Singapore: a cross-sectional study. *Sci Rep.* 2022; 12(1): 1–10. https://doi.org/10.1038/s41598-022-22776-y
18. Rahman MM, Tanni KN, Roy T, Islam MR, Al Raji Rumi MA, Sadman Sakib M, et al. Knowledge, Attitude and Practices Towards Dengue Fever Among Slum Dwellers: A Case Study in Dhaka City, Bangladesh. *Int J Public Health.* 2023;68:1605364. Doi: 10.3389/ijph.2023.1605364.
19. Mehmood A, Khan FK, Chaudhry A, Hussain Z, Laghari MA, Shah I, et al. Risk Factors Associated with a Dengue Fever Outbreak in Islamabad, Pakistan: Case-Control Study. *JMIR Public Heal Surveill*. 2021; 7(12): 1–7.
20. Podung GCD, Tatura SNN, Mantik MFJ. Risk Factors for Dengue Shock Syndrome in Dengue Hemorrhagic Fever. *J Biomedik.* 2021; 13(2): 161.
21. Sutriyawan A, ABA M, Habibi J. Epidemiological Determinants of Dengue Hemorrhagic Fever (DBD) in Urban Areas: Retrospective Study. *J Nurs Public Heal.* 2020; 8(2): 1–9.
22. Zain AA, Cahyati WH. Risk Factors for Dengue Hemorrhagic Fever in Children Aged 5-14 Years in Semarang City. *J Healthy Independent.* 2022; 17(1): 48–56.
23. Nikookar SH, Moosazadeh M, Fazeli-Dinan M, Zaim M, Sedaghat MM, Enayati A. Knowledge, attitude, and practice of healthcare workers regarding dengue fever in Mazandaran Province, northern Iran. *Front Public Heal.* 2023; 11(1): 1–10.
24. Salam I, Arsin AA, Wahyu A, Birawida AB, Syam A, Mallongi A, et al. Modeling dynamic system for prediction of dengue hemorrhagic fever in maros district. Open Access Maced. *J Med Sci*. 2021; 9(1): 901–5.
25. Arham AF, Amin L, Mustapa MAC, Mahadi Z, Yaacob M, Wasli MMP, et al. Fogging to combat dengue: factors influencing stakeholders' attitudes in Malaysia. *BMC Public Health*. 2023; 23(1):1–13. https://doi.org/10.1186/s12889-023-16054-3
26. Rajapaksha RMNU, Abeysena C, Balasuriya A. Health seeking behaviours, dengue prevention behaviours and community capacity for sustainable dengue prevention in a highly dengue endemic area, Sri Lanka. *BMC Public Health*. 2023; 23(1): 1–9. https://doi.org/10.1186/s12889-023-15404-5
27. Maduranga S, Valencia BM, Sigera C, Adikari T, Weeratunga P, Fernando D, et al. Genomic Surveillance of Recent Dengue Outbreaks in Colombo, Sri Lanka. *Viruses*. 2023; 15(7): 23-30.
28. Azizi S, Snetselaar J, Kaaya R, Matowo J, Onen H, Shayo M, et al. Implementing OECD GLP principles for the evaluation of novel vector control tools: a case study with two novel LLINs, SafeNet® and SafeNet NF®. *Malar J.* 2022; 21(1):1–17. https://doi.org/10.1186/s12936-022-04208-4
29. Kasili S, Wanjala C. Use, Disposal and Environmental Challenges of Insecticide Treated Nets. *East African J Heal Sci*. 2023; 6(1): 196–209.
30. Solanke BL, Soladoye DA, Birsirka IA, Abdurraheem A, Salau OR. Utilization of insecticide-treated nets and associated factors among childbearing women in Northern Nigeria. *Malar J*. 2023;22(1):1–11. DOI: 10.1186/s12936-023-04620-4
31. Peña-García VH, Mutuku FM, Ndenga BA, Mbakaya JO, Ndire SO, Agola GA, et al. The Importance of Including Non-Household Environments in Dengue Vector Control Activities. *Viruses*. 2023; 15(7): 43-49
32. da Silva AC, Scalize PS. Environmental Variables Related to Aedes aegypti Breeding Spots and the Occurrence of Arbovirus Diseases. *Sustain*. 2023; 15(10):32-37
33. Windyaraini DH, Giyantoli, Maulidi IS, Marsifah T. Density and Distribution and Resistance Status of Mosquitoes (Diptera: Culicidae) from DHF Endemic and Non-Endemic Areas in the DIY Region. *Maj Ilm Biol Biosf A Sci J*. 2019; 36(1): 19–25.
34. Novaes C, Silva Pinto F, Marques RC. Aedes Aegypti—Insights on the Impact of Water Services. *GeoHealth*. 2022; 6(11): 7-13
35. Overgaard HJ, Dada N, Lenhart A, Stenström AB, Alexander N. Integrated disease management : arboviral infections and waterborne diarrhoea. 2021;:583–92.
36. Anhar VY, Saputra PH, Khalishah N, Isnaniah R, Nurputri SFS. Concern for Public Health Education with Hygiene and Clean Water Using Posters and Leaflets. *J Berk Kesehat*. 2023; 9(1): 56-62.
37. Shah H, Pandey BD. Risk factors of adult Dengue Fever in urban community of Nepal. 2021; 7(1): 64–9. https://www.peertechzpublications.com
38. Rahman S, Mehejabin F, Arafat M, Rashid R. Public Health in Practice A case-control study to determine the risk factors of dengue fever in. *Public Heal Pract*. 2022;4(1): 100288. https://doi.org/10.1016/j.puhip.2022.100288
39. Ministry of Heaalth Republic Indonesia . Guidelines for the Prevention and Control of Dengue Hemorrhagic Fever in Indonesia. Guidelines for the Prevention and Control of Dengue Fever in Indonesia. 2017; 5(1): 1–128. https://drive.google.com/file/d/1IATZEcgGX3x3BcVUcO_l8Yu9B5REKOKE/view
40. World Health Organization (WHO). Comprehensive Guidelines for Prevention and Control of Dengue and Dengue Haemorrhagic Fever. Vol. 2, Epidemiology and Society Health Review (ESHR). 2021. 69 p.
41. Rodríguez-Mártínez LM, Correa-Morales F, González-Acosta C, Moreno-García M. Study of mosquito (Culicidae) larvae and characterisation of water bodies in urban and periurban areas. *Can Entomol*. 2023; 155(1).

42. Siddiq R, Aldri Frinaldi2 A, Rembrandt R, Lanin D, Umar G. Dengue Hemorrhagic Fever (DHF) Management Policy in Various Regions in Indonesia. *J Healthy Independent*. 2023; 18(1): 65–73.

43. Arsin AA, Amiruddin R, Marzuki DS, Elisafitri R, Basir B, Mallongi A, et al. Community Empowerment with Independent Larva Monitor in Reducing the Dengue Hemorrhagic Fever Incidence, in Sidrap Regency. *Pharmacogn J*. 2023; 15(4):622–5.

44. O'driscoll M, Imai N, Ferguson NM, Hadinegoro SR, Satari HI, Tam CC, et al. Spatiotemporal variability in dengue transmission intensity in jakarta, indonesia. *PLoS Negl Trop Dis*. 2020;14(3):1–15. DOI: 10.1371/journal.pntd.0008102

45. Mashudi DN, Ahmad N, Said SM. Level of dengue preventive practices and associated factors in a Malaysian residential area during the COVID-19 pandemic: A cross-sectional study. *PLoS One*. 2022; 17(4): 1–15. http://dx.doi.org/10.1371/journal.pone.0267899

46. Buchori D, Mawan A, Nurhayati I, Aryati A, Kusnanto H, Hadi UK. Risk Assessment on the Release of Wolbachia-Infected Aedes aegypti in Yogyakarta, Indonesia. *Insects*. 2022; 13(10):924. Doi: 10.3390/insects13100924.