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ANALYSIS OF FACTORS ASSOCIATED WITH THE INCIDENCE OF DENGUE FEVER

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ABSTRACT
Dengue Hemorrhagic Fever (DHF) remained a public health problem in Bontang City. From January to December 2023, a total of 457 DHF cases were reported among 188,101 residents, with an incidence rate of 242.95 per 100,000 population and two deaths (Case Fatality Rate = 0.44%). This study aimed to identify factors associated with the occurrence of Dengue Hemorrhagic Fever in the working area of Bontang Barat Public Health Center. An analytic observational study with a retrospective case control design was conducted. The study population consisted of all DHF cases reported from January to December 2023, totaling 128 cases. Using simple random sampling, 192 respondents were selected, comprising 96 cases and 96 controls. Cases were patients with dengue hemorrhagic fever (DHF) confirmed by healthcare professionals, while the control group consisted of neighbors of the cases who agreed to participate and were matched by sex and residential area (±100 m). Data were collected from DHF surveillance records, interviews, observations, and measurements of housing density. Data were analyzed using the Chi-square test. The results showed a significant association between 3M Plus practices, the presence of mosquito larvae ($p < 0.001$), and the frequency of cleaning water storage containers ($p = 0.001$) with the occurrence of DHF. In contrast, housing density ($p = 0.721$) and the habit of hanging worn clothes ($p = 0.771$) were not associated with DHF incidence. Conclusion the occurrence of DHF was mainly influenced by behavioral and environmental factors therefore, strengthening community based 3M Plus prevention practices was identified as a key strategy for DHF control.

Keywords: aedes aegypti; dengue fever (DHF); 3M plus

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INTRODUCTION

Dengue Hemorrhagic Fever (DHF) was an acute infectious disease caused by the dengue virus and transmitted by Aedes aegypti mosquitoes. The disease was characterized by high fever lasting 2–7 days, which could be accompanied by bleeding manifestations, thrombocytopenia, and plasma leakage, as well as other symptoms such as headache, muscle and joint pain, skin rash, and retro-orbital pain (Pratiwi, 2022). Not all infected individuals developed severe symptoms; some experienced mild fever or remained asymptomatic. DHF incidence generally increased during the rainy season and occurred more frequently in tropical regions, including Indonesia (Husna et al., 2020).

Dengue continued to be a serious global public health problem. Studies by the World Health Organization (WHO) estimated that approximately 2.5 billion people, or 40% of the world's population living in tropical and subtropical regions, were at high risk of dengue virus infection (Mahardika, 2023). In Indonesia, dengue remained endemic in 33 provinces and 436 districts/cities. In 2022, the number of dengue cases reached 143,184, representing a 94.8% increase compared to 73,518 cases in 2021, with an incidence rate of 52 per 100,000 population (Febrian, 2024).

In East Kalimantan Province, dengue cases over the past five years fluctuated, with relatively high incidence and mortality rates. In 2023, a total of 45 dengue-related deaths were recorded, while by September 2025 the number declined to 11 cases. However, several districts remained areas of concern due to high case numbers, including Balikpapan (987 cases), Kutai Kartanegara (689

cases), Samarinda (544 cases), Kutai Timur (400 cases), Bontang (287 cases), Paser (272 cases), Penajam Paser Utara (174 cases), West Kutai (166 cases), Berau (51 cases), and Mahakam Ulu (8 cases) (Prabawati, 2025). These conditions were presumed to be associated with behavioral and environmental factors, such as suboptimal 3M Plus practices, the presence of mosquito breeding sites, and community preventive behaviors.

Based on the epidemiological triangle, dengue occurrence was influenced by the interaction between humans as hosts, the environment, and Aedes aegypti mosquitoes as vectors. Previous studies demonstrated that behavioral and environmental factors, including household habits, housing density, and environmental management, played an important role in increasing the risk of dengue transmission, although findings varied across studies. Several studies concluded that unhealthy household practices and poor physical environmental conditions served as breeding sites for Aedes aegypti mosquitoes (Saputra et al., 2023). A study conducted in Langkat District, North Sumatra, in 2021 found a significant association between hanging clothes indoors and dengue incidence ($p = 0.002$; OR = 8.50) (Fadrina et al., 2021). In contrast, another study in Semarang City in 2016 reported no significant association between 3M Plus practices and dengue incidence (Periatama et al., 2022). Based on these conditions, this study was conducted to analyze factors associated with Dengue Hemorrhagic Fever occurrence in the working area of Bontang Barat Public Health Center, Bontang City.

METHOD

This study used a case control design with a retrospective approach. The study population consisted of all Dengue Hemorrhagic Fever (DHF) patients confirmed by health professionals who resided in the working area of Bontang Barat Public Health Center, Bontang City, from January to December 2023, totaling 128 individuals. The sample size was determined using simple random sampling and calculated with Sample Size software version 2.1, resulting in 96 respondents with a 1:1 ratio (96 case; 96 control).

The case group included patients with DHF confirmed by health professionals, while the control group consisted of neighbors of the cases who agreed to participate as research subjects, matched by sex and residential area (±100 meters from the case's residence). The study was conducted in May 2024 in the working area of Bontang Barat Public Health Center, specifically in Belimbing, Kanaan, and Gunung Telihan sub districts. The independent variables were 3M Plus practices, frequency of cleaning water storage containers, presence of Aedes aegypti larvae, housing density, and the habit of hanging worn clothes. The dependent variable was the occurrence of Dengue Hemorrhagic Fever. Data were collected through observation, interviews, and measurements by visiting the homes of both case and control groups. Data analysis was performed using bivariate analysis with the chi-square test to determine the association between independent and dependent variables. Furthermore, multiple logistic regression analysis was applied to identify the most dominant factors influencing the occurrence of Dengue Hemorrhagic Fever. This study received ethical approval from the Health

Research Ethics Committee of the Faculty of Medicine, Mulawarman University (Ethical Clearance No. 144/KEPK-FK/VII/2024). The researchers ensured compliance with all biomedical research ethical principles, including obtaining informed consent, maintaining respondent confidentiality, and respecting participants rights to withdraw from the study at any time without consequences, in accordance with established ethical standards.

RESULT

Univariate Analysis of Respondent Characteristics

The table below presented the results of the univariate analysis of respondents' characteristics. The characteristics examined in this study included age, sex, occupation and distribution of dengue

hemorrhagic fever occurrence based on 3m plus practices, frequency of water storage container cleaning, presence of aedes larvae, housing density, and the habit of hanging clothes Fever (DHF) Cases.

Table 1.
Univariate Analysis of Respondent Characteristics and Distribution of Dengue Hemorrhagic Fever (DHF) Cases

Characteristics of Respondents	Case (N=96)	Control (N=96)	Totally (N=192)
Age			
2 - 20 Years	0 (0%)	23 (24,0%)	23 (0%)
21 - 41 Years	65 (67,7%)	47 (49,0%)	112 (67,7%)
42 - 62 Years	30 (31,3%)	26 (27,1%)	56 (31,3%)
63 - 83 Years	1 (1,0%)	0 (0%)	1 (1,0%)
Sex			
Male	32 (33,3%)	32 (33,3%)	64 (33,3%)
Female	64 (66,7%)	64 (66,7%)	128 (66,7%)
Occupation			
Primary School	8 (8,3%)	15 (15,6%)	23 (12,0%)
Junior High School	17 (17,7%)	16 (16,7%)	33 (17,2%)
Senior High School	48 (50,0%)	50 (31,1%)	98 (51,0%)
Higher Education (University)	23 (24,0%)	15 (15,6%)	38 (19,8%)
3 M Plus Practices			
Yes (Practicing 3 M Plus)	34 (35,4%)	5 (5,2%)	39 (20,3%)
No (Not Practicing 3 M Plus)	62 (64,6%)	91 (94,8%)	153 (79,7%)
Frequency of Water Container Cleaning			
< Once Per Week			
≥ Once Per Week	96 (100%)	88 (91,7%)	184 (95,8%)
Presence Of Aedes Larvae	0 (0%)	8 (8,3%)	8 (4,2%)
Yes			
No	9 (9,4%)	40 (41,7%)	49 (25,5%)
Househod Density	87 (90,6%)	56 (58,3%)	143 (74,5%)
Crowded (≥ 2 adults/ 8 m^2)			
Not Crowded (< 2 adults/ 8 m^2)	5 (5,2%)	3 (3,1%)	8 (4,2%)
Habit of Hanging Clothes	91 (94,6%)	93 (96,9%)	184 (95,8%)
Yes			
No	52 (54,2%)	55 (57,3%)	107 (55,7%)
	44 (45,8%)	41 (42,7%)	85 (44,3%)

Based on table 1, the majority of respondents were aged 21–41 years, accounting for 67.7% of the total sample. Most respondents were female (66.7%). In terms of educational background, more than half of the respondents had completed senior high school (51.0%), followed by higher education at the university level (19.8%). Regarding preventive behavior, only 20.3% of respondents practiced 3M Plus, while the majority (79.7%) did not practice 3M Plus. Most households cleaned water containers less than once per week (95.8%). The presence of Aedes larvae was found in 25.5% of households, whereas 74.5% showed no aedes larvae. With respect to housing conditions, the vast majority of respondents lived in non-crowded households (95.8%). More than half of the respondents reported the habit of hanging clothes inside the house (55.7%).

Bivariate Analysis

The table below presents a bivariate analysis between independent and dependent variables based on the research results.

Table 2
Bivariate Analysis

Variable	Dengue Fever		Totaly	*p value*
	Case (n=96)	Control (n=96)		
3 M Plus Practices				
Yes (Practicing 3 M Plus)	5 (5,2%)	34 (35,4%)	39 (20,3%)	< 0,001
No (Not Practicing 3 M Plus)	91 (94,8%)	62 (64,6%)	153 (79,7%)	
Frequency of Water Container Cleaning				
< Once Per Week	8 (8,3%)	0 (0,0%)	8 (4,2%)	0,011
≥ Once Per Week	88 (91,7%)	96 (100%)	184 (95,8%)	
Presence Of Aedes Larvae				
Yes	40 (41,7%)	9 (9,4%)	49 (25,5%)	< 0,001
No	56 (58,3%)	87 (90,6%)	143 (74,5%)	
Househod Density				
Crowded (≥ 2 adults/ 8 m^2)	3 (3,1%)	5 (5,2%)	8 (4,2%)	0,721
Not Crowded (< 2 adults/ 8 m^2)	93 (96,9%)	91 (94,8%)	184 (95,8%)	
Habit of Hanging Clothes				
Yes	55 (57,3%)	52 (54,2%)	107 (55,7%)	0,771
No	41 (42,7%)	44 (45,8%)	85 (44,3%)	

Based on table 2, the bivariate analysis demonstrated a statistically significant association between 3M Plus practices and dengue fever incidence ($p < 0.001$), with a higher proportion of dengue cases found among respondents who did not practice 3M Plus compared to controls.A statistically significant association was also observed between the frequency of water container cleaning and dengue fever incidence ($p = 0.011$). Respondents who cleaned water containers less than once per week were more frequently identified among dengue cases than controls. Furthermore, the presence of *Aedes* larvae showed a statistically significant association with dengue fever incidence ($p < 0.001$), indicating a markedly higher proportion of larvae-positive households among cases compared to controls.Conversely, household density did not show a statistically significant association with dengue fever incidence ($p = 0.721$). Likewise, the habit of hanging clothes indoors was not statistically significantly associated with dengue fever incidence ($p = 0.771$).

Multivariate Analysis

The results of the logistic regression analysis indicate that 3M Plus practices have a strong association with dengue fever incidence. Respondents who did not practice 3M Plus had 8.047 times higher odds of experiencing dengue fever compared to those who practiced 3M Plus. Additionally, the presence of mosquito larvae was associated with an increased likelihood of dengue fever. Respondents living in households with mosquito larvae had 5.656 times higher odds of developing dengue fever compared to those in households without larvae. The constant value ($Exp(\beta) = 0.118$) represents the baseline odds of dengue fever occurrence when all independent variables in the model are absent or at their reference categories.

DISCUSSION

The Association Between 3M Plus Practices and the Incidence of Dengue Hemorrhagic Fever

In this study, the results of the chi square analysis showed a p-value of < 0.001 ($p < 0.05$), indicating a statistically significant association between 3M Plus practices and the incidence of dengue fever. The Odds Ratio was 9.981, meaning that respondents who did not practice 3M Plus were 9.981 times more likely to develop dengue fever compared to those who practiced 3M Plus. These findings were consistent with a study conducted by Sanisahhuri et al., (2024), which concluded that there was an association between 3M Plus preventive behavior and dengue fever incidence in the working area of Bintuhan Public Health Center, Kaur Regency, with a strong association category and an Odds Ratio (OR) of 48.438. This indicated that respondents who did not perform 3M Plus preventive behaviors were 48.438 times more likely to experience dengue fever compared to those who practiced 3M Plus. Similar findings were reported by Febriana (2022),

in the working area of Rawasari Public Health Center in 2022, where the p-value was 0.000 and the OR was 25. This suggested that poor 3M Plus practices increased the risk of dengue fever by 25 times, leading to the conclusion that there was an association between 3M Plus practices and dengue fever incidence. In the multivariate analysis, 3M Plus practices were identified as the most dominant variable associated with dengue hemorrhagic fever incidence. This finding was consistent with a study conducted by Prasetyo (2023), which reported an Odds Ratio (OR) of 3.373.

In contrast, a study by Periatama et al., (2022), reported different results. Their findings regarding the relationship between 3M Plus behavior and dengue fever incidence in Semarang City showed a p-value of 1.000, indicating no statistically significant association. The Odds Ratio for 3M Plus behavior (95% CI: 0.306–2.461) was 0.868, suggesting that 3M Plus behavior was neither a protective factor nor a risk factor for dengue fever. 3M Plus activities, which represent simple yet effective preventive measures, had important implications for dengue fever control. These included a reduction in dengue incidence, improvement in community quality of life, healthcare cost savings, and increased public awareness (Ridha et al., 2022).

The improvement in community quality of life was closely related to the creation of a healthier environment. The implementation of 3M Plus activities contributed to the establishment of cleaner and healthier surroundings. An environment free from mosquito larvae was likely to enhance community quality of life. Moreover, these preventive measures also contributed to the prevention of other mosquito-borne diseases, as Aedes aegypti is known to transmit not only dengue fever but also other diseases such as chikungunya.The implementation of 3M Plus activities had highly positive implications for individuals, communities, and governments. With consistent implementation and active community participation, these activities could serve as a key strategy in the control and prevention of dengue fever (Moreira, 2020). The elimination of dengue hemorrhagic fever mosquito breeding sites can be initiated in the residential environment, particularly within households. One of the essential family functions is the behavioral function, through which the health status of family members can be assessed based on their daily health related behaviors (Kulsum, 2023).

The Association Between the Frequency of Water Container Cleaning and the Incidence of Dengue Hemorrhagic Fever

The results of the study indicated that among respondents who cleaned water storage containers at least once per week, the highest proportion was found among those who experienced dengue fever (8.3%, case group). Meanwhile, among respondents who cleaned water storage containers less than once per week, the highest proportion was observed among those who did not experience dengue fever (100%, control group). The chi-square analysis showed a p-value of 0.011 ($p < 0.05$), indicating a statistically significant association between the frequency of water container cleaning and the incidence of dengue fever. However, the Odds Ratio was 0.478 (< 1), suggesting that water container cleaning frequency was not a risk factor but a protective factor against dengue fever. These findings were consistent with a study conducted by Saputra et al., (2023), in the working area of Sako Public Health Center, Palembang, which reported that respondents with poor water container cleaning practices were more likely to be dengue positive (23 respondents; 79.3%). The chi-square statistical test in that study yielded a p-value of 0.000 (< 0.05), indicating a statistically significant association between water container cleaning practices and dengue fever.

Regular cleaning of water storage containers had a positive impact on preventing mosquito breeding, as it prevented mosquito eggs from hatching and larvae from developing into adult mosquitoes. Reducing mosquito breeding sites consequently decreased the population of Aedes aegypti in an area. A lower mosquito population reduced the risk of dengue virus transmission, as fewer mosquitoes decreased the likelihood of individuals being bitten by infected mosquitoes and developing dengue fever.

The Association Between the Presence of Mosquito Aedes Larvae and the Incidence of Dengue Hemorrhagic Fever

The presence of mosquito larvae, particularly Aedes aegypti, had a strong association with the incidence of dengue hemorrhagic fever (DHF). The results of this study showed a p-value of < 0.001 ($p < 0.05$), indicating a statistically significant association between larval presence and dengue fever incidence. The Odds Ratio was 6.905, meaning that respondents in whose surroundings mosquito larvae were found had a 6.905 times higher risk of developing dengue fever compared to respondents in whose surroundings no larvae were detected. This condition may have been influenced by the role of mosquito larvae in increasing the risk of dengue transmission. Some respondents were still found to have poor water container sanitation practices, resulting in more breeding sites for mosquitoes and consequently increasing dengue transmission rates.

Based on observational findings, mosquito larvae were identified in households with uncovered bathroom water tanks, water storage containers, and outdoor jars. In addition, discarded items capable of collecting water, such as used tires, bottles, and plastic waste, were still commonly found, leading to a higher abundance of Aedes aegypti larvae. These findings were consistent with a study conducted by Ashari et al., (2023), which found an association between mosquito larval presence and dengue fever incidence. In that study, most observed houses were free from mosquito aedes larvae (63.5%), and the majority of respondents did not suffer from dengue fever (82.5%). Similar results were reported by Nafisah and Sukendra (2021), who identified a significant association between larval presence in water containers and dengue fever incidence ($p < 0.001$) in the working area of Kedungmundu Public Health Center. Respondents with larvae found in containers around their homes had a 6.025 times higher risk of developing dengue fever compared to those without larval presence.

Larval presence also served as an important risk indicator, as the existence of larvae in a given area reflected a high risk of dengue transmission due to the likelihood of a high adult mosquito population. An increase in larval density could serve as an early warning signal for a potential dengue outbreak. Therefore, various control measures were required to interrupt the life cycle of Aedes aegypti mosquitoes and prevent dengue fever. The presence of Aedes aegypti larvae had significant implications for dengue fever incidence, highlighting the importance of sustained preventive efforts. Through collaboration between communities and government authorities, dengue incidence rates could be reduced, and a healthier environment could be achieved.

The Association Between Household Density and the Incidence of Dengue Hemorrhagic Fever

The results of this study found a p-value of 0.721 ($p > 0.05$), indicating that there was no statistically significant association between household density and the incidence of dengue hemorrhagic fever (DHF). The Odds Ratio was 0.578, suggesting that respondents living in crowded households had 0.578 times the odds of developing dengue fever compared to those living in non crowded households. These findings were consistent with a study conducted by Saputra et al., (2023), Girsang (2024) and Marlena (2020), which reported no association between household density and dengue fever incidence, with a p-value > 0,05. In contrast, a study by Sintia (2023), reported different results. Based on the Spearman correlation test, a moderate strength of association was found between dengue fever cases and population density.

Similarly, a study conducted by Kaeng et al., (2020), found that most respondents who had experienced dengue fever lived in non-crowded houses (27.1%), although a higher proportion of dengue cases was observed among residents of crowded houses (7.3%). Statistical analysis in that study yielded a p-value of 0.031 ($p < 0.05$), indicating a significant association between household density and dengue fever incidence.

Household density has often been considered a factor associated with dengue fever incidence; however, the relationship is complex and influenced by multiple factors. These findings suggested important implications for more targeted prevention strategies, improved housing planning, and increased community awareness. Nevertheless, household density may not always be associated with dengue fever incidence due to the effectiveness of public health interventions, such as community health programs promoting clean and healthy living behaviors (clean and healthy living behavior), larvicide distribution, and other mosquito control measures that effectively reduce Aedes aegypti populations, even in highly populated areas. Moreover, consistent implementation of preventive behaviors, such as 3M Plus practices (draining, covering, recycling containers, and other preventive measures), could minimize dengue fever risk regardless of household density. Adequate sanitation conditions, including effective waste management systems, might also reduce dengue transmission risk in densely populated residential areas.

The Association Between the Habit of Hanging Clothes and the Incidence of Dengue Hemorrhagic Fever

Based on the chi square analysis, the results showed a p-value of 0.771 ($p > 0.05$), indicating that there was no statistically significant association between the habit of hanging clothes and the incidence of dengue hemorrhagic fever (DHF). The Odds Ratio was 1.135, suggesting that respondents who had the habit of hanging clothes had 1.135 times higher odds of developing dengue fever compared to those who did not have this habit. The findings of this study were consistent with those reported by Octaviani (2022), which showed that there was no statistically significant association between the habit of hanging clothes and the incidence of dengue hemorrhagic fever ($p = 0.74$; OR = 0,89). The proportion of respondents who had the habit of hanging clothes for more than two days per week was higher in the control group (64.5%) compared to the case group (61.7%).

These findings differed from a study conducted by Susilowati and Cahyati (2021), in the working area of Wonokarto Public Health Center, which found that the habit of hanging clothes was significantly associated with dengue fever incidence ($p = 0.000$). In that study, respondents who had the habit of hanging clothes were 12 times more likely to develop dengue fever than those who did not hang clothes. Similar results were also reported by Apriyani and Yulianus (2022), in the working area of Air Putih Public Health Center, where the chi square test yielded a p-value of 0.05, indicating a significant association between the habit of hanging clothes and dengue fever incidence.

The habit of hanging clothes indoors, particularly in dark and humid areas, has often been associated with an increased risk of dengue transmission. Although hanging clothes do not directly serve as mosquito breeding sites, this practice can create favorable resting conditions for Aedes aegypti mosquitoes. Clothes hung indoors, especially in dark and humid locations such as bedrooms or bathrooms, may serve as ideal resting and hiding places for Aedes aegypti, which typically seek dark and humid environments to rest during the daytime. Improper handling of clothing after use, which is a daily necessity, has often been overlooked. The habit of hanging clothes may increase the number of mosquitoes indoors, as mosquitoes tend to rest on hanging clothes (Umpenawany, 2020). This behavior may consequently elevate the risk of dengue transmission by increasing the frequency of mosquito bites, thereby increasing the likelihood of dengue virus transmission. In addition, mosquitoes hiding behind hanging clothes may be more difficult to detect and eliminate using insecticides, complicating mosquito control efforts. A lack of awareness regarding the association between hanging clothes and dengue fever may also lead to suboptimal prevention practices. Therefore, avoiding the habit of hanging clothes indoors could serve as an effective measure to reduce Aedes aegypti populations, thereby preventing and reducing dengue fever transmission.

CONCLUSION

Based on the results of the data analysis, it was concluded that among the five independent variables examined 3M Plus practices, frequency of water container cleaning, presence of mosquito larvae, household density, and the habit of hanging clothes three variables showed statistically significant associations with the incidence of dengue hemorrhagic fever, namely 3M Plus practices, frequency of water container cleaning, and the presence of mosquito larvae. In contrast, household density and the habit of hanging clothes did not show significant associations with dengue fever incidence. Among all variables analyzed, 3M Plus practices were identified as the variable most strongly associated with dengue fever incidence, indicating that consistent implementation of 3M Plus practices played a crucial role in the prevention and control of dengue hemorrhagic fever.

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