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**Original Research Article**

# Relationship analysis of protection strategy and the number of containers with the existence of *Aedes aegypti* larvae at Tebing Tinggi city in 2022

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## ABSTRACT

**Background:** Dengue hemorrhagic fever (DHF) is an endemic disease in Tebing Tinggi, the number of DHF cases in 2022 reached 175. Protection strategy and the number of landfills are risk factors for the presence of *Aedes aegypti* mosquito larvae. This study aimed to analyze the relationship between protection strategy and the number of containers in the presence of *Aedes aegypti*.
**Methods:** This type of research was an analytic survey with a cross-sectional research design. The study population was all families living in 5 sub-districts in Tebing Tinggi city with 500 houses selected using a cluster sampling technique. Primary data collection used a questionnaire containing questions on protection strategy and location points, also observation sheets containing the type of landfills, and the number and presence of larvae. Data were analyzed by Chi-Square test.
**Results:** The results showed that *Aedes aegypti* larvae were found in 144 houses and 14% of families had made protection strategies, 41% of houses had more than 4 containers. Protection strategies against the presence of grass bushes within a radius of 100 meters from the house and the number of landfills had a relationship with the presence of *Aedes aegypti* mosquito larvae ($p<0.05$).
**Conclusions:** Tebing Tinggi city is an area that has a high potential risk of DHF. Suggestions for increasing DHF protection strategy and eliminating resting places and breeding places are important for empowering jumantik at the family level as well as providing ongoing assistance and education.

**Keywords:** Containers, DHF, Protection strategy

## INTRODUCTION

Dengue hemorrhagic fever (DHF) is an endemic disease in more than 100 countries around the world, especially in tropical and sub-tropical regions. Dengue hemorrhagic fever (DHF) is an infectious disease caused by the Dengue virus via the *Aedes aegypti* and *Aedes albopictus* mosquitoes.[1] The first DHF case in Indonesia was reported in Surabaya in 1968. Since it was first discovered, this case has continued to increase every year.

According to the Ministry of Health, in 2021 there were 73,518 cases of DHF with 705 deaths. When compared to cases in 2022, based on records from the Directorate of Disease Prevention and Management from January 2022 to September 2022 there were 87,501 cases with 816 deaths, this indicates an increase in cases of dengue fever in Indonesia.[2]

Data from the health profile of the province of north Sumatra showed that cases of dengue fever in north Sumatra in 2019 totalled 7,584 cases with 37 deaths. there

are 42 cases, in 2021 there will be 87 cases, and in 2022 there will be 175 cases.[3-5]

The existence of *Aedes aegypti* mosquito larvae tends to be influenced by factors that contribute to increasing *Aedes aegypti* mosquito breeding such as the number of containers and the existence of resting places and breeding places for *Aedes aegypti* mosquitoes.[6,7] Eradication of mosquito nests such as environmental modification and manipulation activities as well as various protection strategy determine the level of larval density in DHF endemic areas.[8] The purpose of this study was to analyze the relationship between protection strategy and the number of landfills with the presence of Aedes Aegypti mosquito larvae in Tebing Tinggi city in 2022.

The priority strategy as an effort to prevent and control DHF is to increase empowerment and community participation in eliminating resting places and breeding places for *Aedes aegypti* mosquitoes. The Ministry of Health has launched the jumantik one house one movement in order to optimize the eradication of mosquito nests (PMN) 3M plus program in the community.[9,10]

Potential factors of the home environment as a breeding ground for *Aedes aegypti* mosquitoes around community settlements such as water reservoirs, and standing water that is accommodated in vessels has the potential to increase dengue cases.[11,12] Other factors such as the presence of empty land overgrown with grass bushes are a place that has a resting place and breeding place for *Aedes aegypti* mosquitoes and has the potential to become a breeding place for mosquitoes.[8,13] Places such as coconut shells or tree fronds are predicted to become water reservoirs and increasing breeding places. Community habits and behavior such as raising larvivorous fish and cultivating mosquito-repellent plants can also be one of the supporting factors for the presence of mosquito larvae in the houses.[14,15] This factor should be a concern for all parties, especially in DHF-endemic areas. The role of the family in eliminating mosquito breeding places with protection activities is very important.

## METHODS

This study was an analytic survey with a cross-sectional study design in which DHF risk factors and impacts were measured at one time. The study was conducted in Tebing Tinggi city with 5 sub-districts. The time of research was from August to November 2022.

The population in this study were all families living in 5 sub-districts in Tebing Tinggi city, with a total of 36,285 households. The required sample size for this study was calculated using the Slovin formula, the number of samples collected was 500 houses. Samples were taken in 5 districts using the cluster sampling technique. The samples were distributed to sub-districts in 5 districts in Tebing Tinggi.

Primary data collection used a questionnaire with Kobotoolbox which contains questions on protection strategy and location points, and observation sheets containing the type of landfills, number, and presence of larvae using digital images and secondary data from the profile of the Tebing Tinggi health office in 2022.

Univariate data analysis carried out to analyze each variable includes protection strategy including protection from the presence of bushes, the presence of larvivorous fish, the presence of mosquito repellent plants, the behavior of mowing the lawn, the number of landfills, and the presence of larvae. Bivariate analysis was conducted with the chi-square test with a significance of 95% to analyze the relationship between the protection strategy and the number of landfills with the presence of *Aedes aegypti* mosquito larvae.

## RESULTS

Research conducted on risk factors and the presence of larvae in 500 house samples obtained the following data distribution:

### *Univariate*

The results of the protection strategy analysis carried out by the community in Tebing Tinggi city can be seen in (Table 1).

**Table 1: Table of the protection strategy.**

| protection strategy | | Frequency | Percentage |
|---|---|---|---|
| **Grass bushes with a radius of 100 m from the house** | No | 253 | 50.6 |
| | Yes | 247 | 49.4 |
| **Raising larvivorous fish** | No | 451 | 90.2 |
| | Yes | 49 | 9.8 |
| **Mow the lawn in the yard** | No | 193 | 38.6 |
| | Yes | 307 | 61.4 |
| **Cultivate mosquito-repellent plants** | No | 313 | 62.6 |
| | Yes | 187 | 37.4 |
| **Number of containers** | ≤4 | 295 | 59 |
| | >4 | 205 | 41 |
| **The presence of larvae** | No | 144 | 28.8 |
| | Yes | 356 | 71.2 |

Based on Table 1, it showed that the house with the presence of grass bushes within <100 m radius from the house reached 49.4%. The number of houses that raise larvivorous fish was only 9.8%.

In addition, it was found that there were 61.4% had the habit of mowing the lawn in the yard. Houses that had mosquito repellent plants were 37.4%. Houses that had

landfills under 4 was 59%. There 28.8% of houses with the presence of larvae.

***Bivariate***

The results of the chi-square test to see if there was a relationship between protection strategy and the number of containers with the presence of larvae in Tebing Tinggi city in 2022, it can be seen in Table 2.

Based on Table 2, showed that the results of the chi-square test regarding the relationship between protection strategy and the presence of larvae, result was p value =0.032, meaning that there was a relationship between the presence of grass bushes with a radius of <100 from the house and the presence of *Aedes aegypti* larvae. While other protection variables did not have a significant relationship. The number of landfills was related to the presence of larvae (p<0.05).

**Table 2: Chi-square test results for variable protection and number of landfills with the presence of larvae.**

| Variables | The presence of larvae | | | | Total | | P value |
|---|---|---|---|---|---|---|---|
| | No | | Yes | | | | |
| | N | % | N | % | N | % | |
| **Grass bushes with <100 m radius from house** | | | | | | | |
| No | 191 | 38.2 | 62 | 12.4 | 253 | 50.6 | 0.032 |
| Yes | 165 | 33.0 | 82 | 16.4 | 247 | 49.4 | |
| **Mow the lawn in the yard** | | | | | | | |
| No | 131 | 26.2 | 62 | 12.4 | 193 | 38.6 | 0.193 |
| Yes | 225 | 45.0 | 82 | 16.4 | 307 | 61.4 | |
| **Raising larvivorous fish** | | | | | | | |
| No | 326 | 65.2 | 125 | 25.0 | 451 | 90.2 | 0.104 |
| Yes | 30 | 6.0 | 19 | 3.8 | 49 | 9.8 | |
| **Cultivate mosquito-repellent plants** | | | | | | | |
| No | 216 | 432 | 97 | 194 | 313 | 626 | 0.162 |
| Yes | 140 | 280 | 47 | 94 | 187 | 374 | |
| **The presence of larvae** | | | | | | | |
| ≤4 | 233 | 46.6 | 62 | 12.4 | 295 | 59.0 | 0.000 |
| >4 | 123 | 24.6 | 82 | 16.4 | 205 | 41.0 | |

**Table 3: Analysis of the proportion of protection and the number of containers with larvae in the city of Tebing Tinggi in 2022.**

| Risk factors | The presence of larvae | | | | | | OR 95% CI | P value |
|---|---|---|---|---|---|---|---|---|
| | No | | Yes | | Total | | | |
| | F | % | F | % | F | % | | |
| **Protection** | | | | | | | | |
| Good | 44 | 62.9 | 26 | 37.1 | 70 | 100 | 0.65 | 0.115 |
| Not good | 310 | 72.1 | 120 | 27.9 | 430 | 100 | 0.38-1.11 | |
| **Number of containers** | | | | | | | | |
| <4 | 231 | 78.3 | 64 | 21.7 | 295 | 100 | 2.41 | <0.001 |
| ≥4 | 123 | 60.0 | 82 | 40.0 | 205 | 100 | 1.62-3.57 | |

**Table 4: Results of larva density: HI, CI, BI and LFI with the number of cases in 5 sub-districts in Tebing Tinggi city.**

| Village | House index (HI) | Container index (CI) | Breteau index (BI) | Larvae free index (LFI) | Cases/Village |
|---|---|---|---|---|---|
| **Tebing Tinggi** | 34% | 13,4% | 50% | 66% | 9 |
| **Rambung** | 35% | 10,8% | 49% | 65% | 3 |
| **Bandar Sakti** | 32% | 13,1% | 49% | 68% | 4 |
| **Tanjung Marulak** | 13% | 6,5% | 20% | 87% | 21 |
| **Persiakan** | 34% | 11,8% | 40% | 66% | 8 |

Table 2 also showed the results of the chi-square test regarding the relationship between the number of containers and the presence of larvae, p value =0.001 with ($p<0.05$) then $h_0$ is rejected, meaning that there was a relationship between the number of containers and the presence of *Aedes aegypti* larvae in Tebing Tinggi city in 2022.

The proportion of larvae presence in respondents with good protective behavior was 37.1%, while the proportion of larvae presence in respondents with poor protective behavior was 27.9%. The test results obtained a p value =0.115, meaning that there was no significant difference in the proportion of larvae presence between respondents who had good and poor protective behavior. From the analysis results also obtained odds ratio (OR) was 0.65 meaning that in this study good protective behavior was protective. Respondents who behaved less protectively had a 0.65 times lower risk of having larvae at home than those who behaved well. It was explained that respondents who behaved well had a 1.54 times higher risk of having larvae at home. This explained that in addition to the protection factor carried out by the community, there were other factors such as climate and other factors that affect the presence of larvae in the houses.

The proportion of larvae presence in respondents who had less than 4 containers was 21.7%, while the proportion of larvae presence in respondents who had more than 4 containers was 40.0%. The test results obtained a p value <0.001, there was a significant difference between the proportion of larvae present in respondents who had less than 4 containers and more or equal to 4. The results of the analysis also obtained an odds ratio (OR) value of 2.41 meaning that respondents who had containers more than or equal to 4 have a 2.41 times higher risk of having larvae compared to containers less than 4 (Table 3).

From the analysis result of the presence of larvae in table 4, the largest house index value was in Rambung sub-district with a percentage of 35%, the largest container index, was in Tebing Tinggi sub-district with a percentage of 13.4%, the largest Breteau index was in Tebing Tinggi with the percentage 50% and the largest larvae free index was in the Tanjung Marulak Sub-district with the percentage 87% can be seen in Table 4.

The zoning map illustrated that five sub-districts in Tebing Tinggi city were in the red zoning of the risk of transmission based on protection activities, which means that the majority of people in the five sub-districts of Tebing Tinggi city have poor protective behavior as an effort to prevent the breeding of *Aedes aegypti* mosquito larvae. Where the community was still not optimal in implementing a protection strategy including protecting the cleanliness of the home environment from the presence of grass bushes within a radius of 100 meters from the house, raising larvivorous fish, cultivating mosquito-repellent plants, and the habit of mowing the lawn in the yard can be seen in Figure 1.

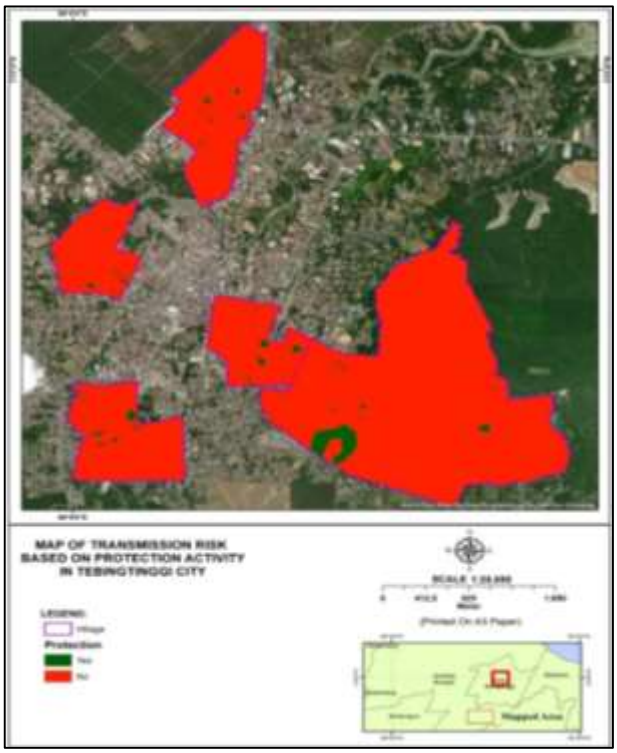


**Figure 1: Zoning map of transmission risk based on protection activities in Tebing Tinggi.**

## DISCUSSION

Tebing Tinggi city is a DHF endemic area in north Sumatra province, Indonesia. Tebing Tinggi is a densely populated area with a home environment that has the potential to become a breeding area for the *Aedes aegypti* mosquito.

Prevention of DHF can be done by early protection against the presence of Aedes aegypti mosquito larvae. Various protection measures that can be taken include monitoring and anticipating activities by clearing the home environment of the presence of grass bushes within a radius of 100 meters, raising larvivorous fish, cultivating mosquito-repellent plants, and mowing the lawn.[16-18]

The existence of grass bushes with a radius of 100 meters from the house was one of the protection activities related to the presence of larvae in Tebing Tinggi city. According to a previous study conducted by Tri Wahono in 2022 on the characteristics of mosquito larvae habitat, the *Aedes aegypti* mosquito as the main vector that transmits dengue fever can live in stagnant water with a neutral pH value and normal water temperature (24-28°C), and contact with the ground.[8,19] While the potential vector is *Aedes albopictus*, this type of Aedes mosquito tends to prefer bushes around the house.[6,15]

The habit of mowing the lawn in the yard had no relationship with the presence of *Aedes aegypti* mosquito larvae in Tebing Tinggi city. Mowing the lawn is one of the good things in keeping the home environment neat and clean, this action needs to be continuously improved by the community to prevent disease transmission from the environment and improve public health status.[15,20]

The utilization of fish as natural predators of mosquito larvae is one way of biological control that is easy for the community to do. This biological control method can reduce the density of mosquito larvae and does not cause problems for environmental health.[16,17,21] However, the results of the study showed that the majority of the people in Tebing Tinggi city did not raise larvivorous fish since the respondents did not like to raise fish and did not have a place to raise fish. People who raise fish tend to put fish in ditches or gullies. The *Aedes aegypti* mosquito prefers clear and clean water to breed and does not come into direct contact with the ground so it did not reduce the risk of *Aedes aegypti* mosquito larvae presence.[19,22] According to Sri Harsono's research in 2019, out of 50 respondents, there were 33 houses used as research subjects to keep Siamese fighting fish in their homes, it was proven that mosquito larvae were no longer in the house and they had been eaten by the fish.[21] This research was also supported by a previous study by Mutmainah in 2017, Siamese fighting fish predators had the power to eat up to 89 larvae within six hours. Raising larvivorous fish had also been implemented in Palembang to control dengue larvae and obtain effective results.[17,23,24]

Planting mosquito repellent plants has become the right and environmentally friendly step in repelling the *Aedes aegypti* mosquito.[25] Plants such as lavender and lemongrass are some of the plants that are recommended as natural mosquito repellent plants because they have a distinctive fragrance and contain chemicals that can keep mosquitoes away so that they can repel mosquitoes from the environment around where they live.[18,25-27] People in Tebing Tinggi only planted mosquito-repellent plants, namely lemongrass plants. Houses that grow citronella plants have fewer mosquito larvae than houses that did not grow citronella plants. The citronella plant produces an essential oil known as citronella oil. It contains two important chemical compounds, namely citronellal and geraniol which function as mosquito repellents.[18] Apart from these plants, another mosquito repellent plant is the Zodia plant (*Evodia sauveolens*) originating from Papua.[28] This plant has a fairly fragrant aroma which is liked by humans but can disturb the nerves of mosquitoes.[29] Usually the Zodia plant will emit a distinctive aroma when its leaves rub and shake.[30] The active compound linalool in this plant will block sensory function in mosquitoes.[31] Based on Minarti's study in 2022, 89% of 100 heads of households stated that zodiac plants were able to repel mosquitoes in Gandus village.[28]

Water storage containers had a role in the presence of *Aedes aegypti* mosquito larvae. Respondents who had more or equal to 4 containers have a 2.41 times higher risk of having larvae than those with less than 4 containers. This was in accordance with research conducted by Fatin Mawaddah in 2022, that houses which had containers that did not meet the standard were 7.48 times getting the risk of DHF.[15] The greater the number of water reservoirs in the home environment, the greater the risk of dengue fever because the more places to collect water, the greater the possibility of *Aedes aegypti* mosquitoes to breed.[32]

Based on the results of direct field observations, the majority of respondents had more than four water storage containers on the grounds that storing more water would make it easier to carry out daily needs. Especially housewives who do a lot of activities in the kitchen such as cooking and washing. In addition, the habit of storing water is one step that is used when water availability is limited. The number of containers that were more than 4 will be an opportunity to become a habitat for Aedes Aegypti mosquito larvae.[11,33,34] This is very reasonable because three-quarters of the mosquito's life cycle is in water. Therefore, the number of containers is very influential on the presence of Aedes larvae.[22] The main breeding sites for *Aedes aegypti* mosquitoes are water reservoirs such as puddles or vessels around a house or public places, usually not more than 500 m from the house.[35]

There was a connection between the water storage system and the presence of larvae, one of which was because the water containers were left open, especially the water reservoirs outside the home.[15] The majority of people in Tebing Tinggi city allowed water reservoirs outside the home to accommodate rainwater as a daily necessity such as watering plants, yards, and washing vehicles. Water containers that did not meet the standard and requirements will be an indication for the placement of *Aedes aegypti* mosquito eggs.

The types of water storage containers most used by the people of Tebing Tinggi city were bathtubs (40.2%), buckets (33.1%), and water dispenser reservoirs (9.4%) which were made of plastic-based materials. The using of the tub was considered better because the water used was always used up and was not allowed to linger, but people did not follow the requirements to drain the container properly.[33,34] In addition, many abandoned items were simply placed outside the house thus it became a place for adult mosquitoes to lay their eggs. The greater the number of containers, the greater the chance of the existence of *Aedes aegypti* mosquito larvae, therefore the number of containers is related to the presence of *Aedes aegypti* mosquito larvae in Tebing Tinggi city in 2022.[36-38]

The number of HI was 13-35%, CI was 6.5-13.4%, BI was 20-50%, and LFI 65-87%. The largest house index was 35% in Rambung sub-district, the largest container index was 13.4% in Tebing Tinggi sub-district, the largest

Breteau index was 50% in Tebing Tinggi and the highest larvae-free index was 87% in Tanjung Marulak village. Based on this data, all sub-districts in 5 sub-districts had the potential for DHF with LFI still under 95% and all sub-districts still having DHF cases.

## CONCLUSION

There were 144 community houses in Tebing Tinggi city where *Aedes aegypti* mosquito larvae were found. Protection against the presence of grass bushes with a radius of 100 meters from the house and the number of containers were variables that had a relationship with the presence of *Aedes aegypti* mosquito larvae with $p<0.05$. An odds ratio (OR) value of 0.65 was obtained, where good protective behavior was protective against the presence of *Aedes aegypti* mosquito larvae. The number of containers greater than or equal to 4 will have a 2.41 times higher risk of having larvae compared to the number of containers less than 4. The indicator values for larva density were HI was 13-35%, CI was 6.5-13.4%, BI was 20-50% and LFI was 65-87%.

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