

## Original Research Article

# Spatial analysis of dengue hemorrhagic fever in Talaud Islands regency

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## ABSTRACT

**Background:** The number of dengue hemorrhagic fever (DHF) cases in Indonesia from January to February 2016 was 8,487 with 108 deaths. DHF is an infectious disease that continues to increase from 2014 until 2016 in Manado city. DHF cases in Talaud Islands Regency from 2014 to 2016 were 143 cases. Regional spatial analysis would simplify the distribution of DHF cases in high-risk areas. To be aware of the DHF outbreak cycle, it is necessary to model spatial risk factors based on geographic information systems (GIS) to tackle and eradicate DHF cases by region.

**Methods:** This study aimed to analyze the spread of DHF in Talaud regency based on age, sex, population density and area height. The design of this research is qualitative analytic by using an ecological study approach. The research scope was 19 districts in Talaud regency. Secondary data are used which consists of case number, age, sex, population density, and area height taken from the Talaud district health office with 66 DHF cases in 2018-2019 and analyzed using the GIS approach through spatial analysis.

**Results:** Based on the number of DHF cases that is most in the age group of 5-11 years. Male gender is more likely to suffer from DHF than female. Spatial description of the condition of the altitude in the Talaud Islands regency at risk of suffering from DHF is >50 meters above sea level. Spatial description of population density with most DHF cases is not densely populated area with less than 1,620 inhabitants per km.

**Conclusions:** The health office of Talaud islands regency needs to actively promote health by providing information about eradicating mosquitoes.

**Keywords:** Dengue hemorrhagic fever, Distribution, Spatial analysis

## INTRODUCTION

Dengue hemorrhagic fever (DHF) is a disease caused by a virus that has rapidly spread in various countries in recent years. Dengue virus is transmitted by female mosquitoes from *Aedes aegypti* and *Aedes albopictus* species. This mosquito can also transmit chikungunya disease, yellow fever and Zika infection. The dengue virus is widespread throughout the tropics affected by rainfall, temperature and rapid urbanization flows.<sup>1</sup>

Currently, DHF is endemic in more than 100 countries including Africa, America, the Eastern Mediterranean, Southeast Asia and the Western Pacific. The Americas, Southeast Asia and the Western Pacific are the most affected areas by the dengue virus. Number of cases in America, Southeast Asia and the Western Pacific passed 1.2 million in 2008 and more than 3.2 million in 2015. In 2016, the number of reported cases continued to increase. In 2015, there were 2.35 million cases of dengue fever

reported in America which resulted in 1,181 deaths (WHO, 2016).<sup>1</sup>

The ministry of health of the republic of Indonesia records the number of DHF cases in Indonesia in January to February 2016 with total numbers of 8,487 DHF cases with 108 deaths.<sup>2</sup> The largest group experiencing DHF in Indonesia at the age of 5-14 years reached 43.44% and aged 15-44 years reached 33.25%.<sup>3</sup> The high prevalence of DHF among others is influenced by the increasing density and mobility of the population, various kind of transportation within the city and between regions and the distribution of DHF-mosquitoes in housing/settlements.<sup>4</sup>

DHF is an infectious disease that continues to increase from 2014 until 2016 in Manado city.<sup>5</sup> DHF cases in Talaud Islands Regency from 2014 to 2016 were 143 cases.<sup>6</sup> Regional spatial analysis would simplify the distribution of DHF cases in high-risk areas. To be aware of the DHF outbreak cycle, it is necessary to model spatial risk factors based on geographic information systems (GIS) to tackle and eradicate DHF cases by region.

According to North Sulawesi provincial health office data, there were 2,217 cases in North Sulawesi province in 2016 and 17 people died as a result of DHF. Incidence rate (IR) of DHF cases is 91.9 per 100,000 population with case fatality rate (CFR) of DHF cases 0.8%. DHF cases in Manado city in 2016 amounted to 567 cases and 6 people died with IR 133.2 per 100,000 population and CFR 1.1%.<sup>6</sup>

Spatial analysis as part of regional-based disease management, is an analysis and description of disease data geographically in terms of population, distribution, environment, behavior, socio-economy, cases of disease events, and relationships between these variables. The term spatial development in its use, in addition to meaningful space and time, with all living things and inanimate objects in it, such as climate, temperature, topography, weather, and humidity.<sup>7</sup> Disease events can be explained as a regional spatial phenomenon that has the same characteristics. Variables that make up the weather and climate, namely temperature, humidity, wind and other spatial conditions will form daily local conditions that can affect the source of disease, environmental risk factors, population and disease events.<sup>8</sup>

To be aware of the DHF outbreak cycle, it is necessary to model the spatial risk factors of DHF epidemiology based on GIS. The results of spatial modeling in the form of maps of regional vulnerability to DHF, are expected to be used as valuable input in the planning of programs to eradicate DHF cases and to produce effective and efficient decision making.<sup>9</sup> Spatial analysis research has been carried out to see the distribution of dengue cases by Kurniawati et al (2014) on spatial analysis of DHF displacement in Jember Regency illustrates the map of

disease distribution according to characteristics of people, place, and time, rainfall, population density, and larval free rate (ABJ).<sup>10</sup> Spatial analysis research has also been carried out by Sunaryo et al (2014) about the Spatial Distribution of DHF in Banyumas regency, central java province based on location, altitude, land use, and population density and case patterns based on rainfall.<sup>11</sup>

Until now, there is no detailed spatial pattern is known about the distribution of dengue cases in Talaud Islands regency. This study aims to analyze the spatial distribution of dengue cases in Talaud Islands regency in 2018 until March 2019.

## METHODS

This study was a qualitative research with Geographic Information System (GIS) approach that has the ability to visualize, explore, sort out data, and analyze data spatially. In this study the variables in the form of age and gender were analyzed univariately while the population density and height variables were analyzed spatially in the case of DHF. This study was conducted in the Talaud Islands Regency from May to August 2019. The population in this study was DHF cases in the Talaud Islands Regency. The sample of this study used total sampling, namely all DHF patients seeking treatment in the Talaud Islands Regency in 2018, amounting to 66 patients.

Criteria for inclusion sample was DHF cases in Talaud Islands in the year 2018-2019, while the criteria for exclusion is incomplete address of DHF data report. Researchers used the DHF register report data obtained from the Talaud Islands regency and using a quick bird map (google earth) printed on A2 paper and Google map. Univariate analysis was used to obtain a description of the distribution and frequency of DHF based on individual characteristics such as age and gender. Spatial analysis was carried out to see the pattern of dengue fever distribution based on population density and altitude. Some spatial data will be analyzed by digitizing to produce a distribution image based on the data that has been collected and this analysis process is carried out with the application ArcMap 10.1.

## RESULTS

Talaud Islands is nautical area with approximately 37,800 km<sup>2</sup> (96.79%) of sea and a land area of 1251,02 km<sup>2</sup> so the total area of the Talaud Islands regency amounting to 39,051.02 km<sup>2</sup>. There are 3 islands in the Talaud Islands Regency namely Karakelang Island, Salibabu Island and Kabaruan Island. Talaud Islands regency has 19 districts, 11 sub-districts and 142 villages located on 7 islands out of 17 islands. Subdistrict with the largest land area is North Beo Subdistrict of 1.44.85 km<sup>2</sup> or 11.58% is the land area of Talaud Islands regency, while the sub-district with the smallest land area is the sub-district of Miangas at 2.39 km<sup>2</sup> or 0.19% of the Talaud Islands regency.

### Univariate analysis

Distribution of DHF cases based on age. Data obtained from the Talaud Islands district health Office, the highest age of DHF cases in 2018 were found in the age group of 5-11 years, namely 19 people (59.4%). While the lowest age of DHF cases is in the age group of 0-4 years, namely 14 people (40.6%) (Table 1).

**Table 1: Distribution of DHF cases based on age.**

Age group	N	%
0 - 4 years	14	40.6
5 - 11 years	19	59.4
Total	33	100

Source: Talaud Islands District Health Office in 2018

### Distribution of DHF cases based on sex

Data obtained from the Talaud Islands District health office in 2018 revealed that there were more male namely 17 people (51.5%) than female which was 16 people (48.5%) (Table 2).

**Table 2: Distribution of DHF cases based on sex.**

Gender	N	%
Male	17	51.5
Female	16	48.5
Total	33	100

Source: Talaud Islands District Health Office in 2018

### Spatial analysis

Distribution of DHF cases in 2018. Spatial description of the distribution of DHF cases in 2018 based on the results of research conducted in Talaud Islands regency, there were 33 patients spread in several districts in Talaud regency. Most cases were in Melonguane district with 16 cases and then followed by East Melonguane district with 5 cases (Table 3).

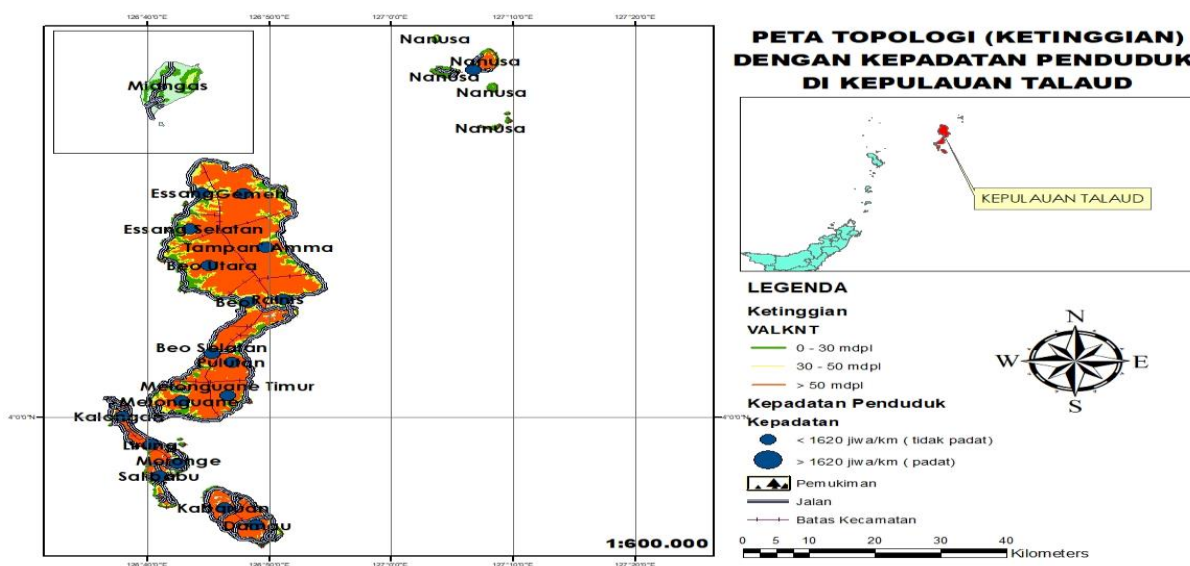
**Table 2: Distribution of DHF cases based on districts.**

District area	Number of cases
West Melonguane	5
Kiama	6
Melonguane	16
Sawang	4
Tarun	2

Source: Talaud Islands District Health Office in 2018

### Distribution of altitude topology with population density in Talaud Islands regency

The spatial description of the distribution of DHF cases in 2018, based on the results of research conducted in Talaud Islands Regency, the altitude for the distribution of DHF cases was divided based on the life ability of *A. aegypti* mosquitoes that is <1000 meters above sea level. The altitude in Talaud Islands regency was based on the 2016 Indonesian earth map. The average altitude of Talaud Islands regency is <1000 meters above sea level., which was >50 meters above sea level.



**Figure 1: Topology (altitude) map with population density in Talaud islands regency.**

Gradations for the color orange indicates area with altitude of >50 meters above sea level, yellow indicates area with altitude of 30-50 meters above sea level, and green color indicates area with altitude of 0-30 meters

above sea level. While the population density in the Talaud Islands regency is <1620 individuals per km<sup>2</sup> so from 19 districts shows that the Talaud Islands regency is not densely populated.

This is in line with the results by Handayani et al in the Padang city showing that the altitude of the places at risk is divided into 2 parts: dwellings at risk less than 50 m and dwellings at no risk more than 50 m. Handayani also stated that the highest population density was in the District of South Padang with population of 10,000.<sup>11</sup>

#### Distribution of DHF cases based on gender

The highest distribution of DHF cases based on female gender was in Melonguane district with 14 cases or 42.5% of the incidence of DHF in women. Whereas, most of the males were in Melonguane district with 16 cases or

48.4% of DHF cases. It is also can be seen that most cases occurred in female and the highest number of cases was in the Melonguane district.

Based on the study conducted by Sucipto et al in Semarang district, it was found that DHF cases were mostly occurred in males, amounting to 71.4% of cases.<sup>12</sup> While the results of the same study by Lobud al in the working area of the Kotobangon health center showed that the most DHF case group is male respondents at 56.7% than women with p value of 0.121 so there is no association between gender and the incidence of DHF.<sup>13</sup>

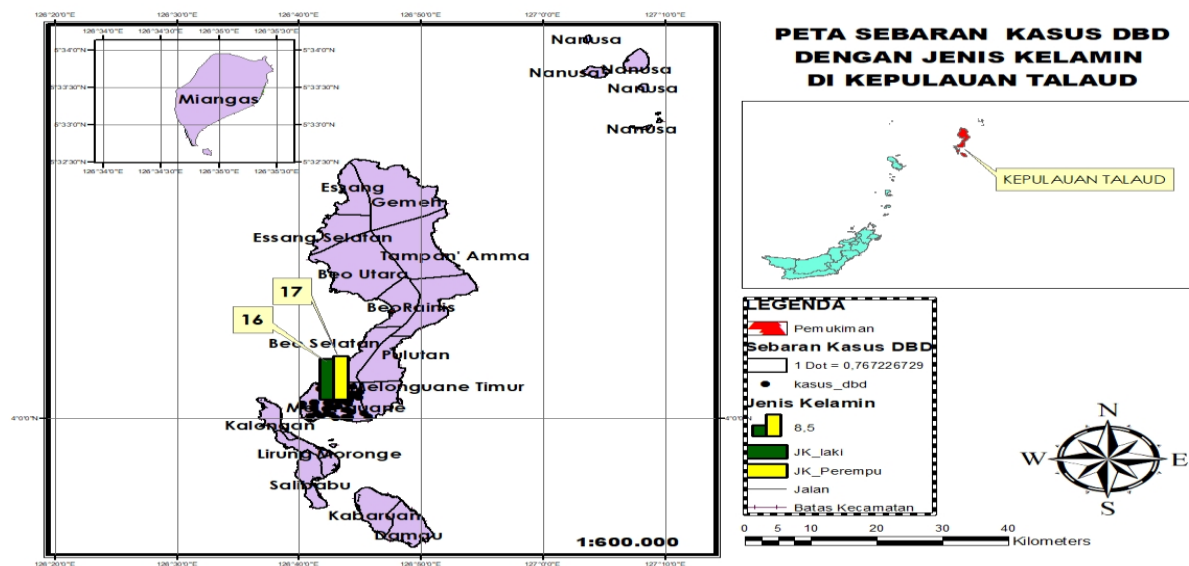


Figure 2: Map of distribution of DHF cases based on gender in Talaud islands regency.

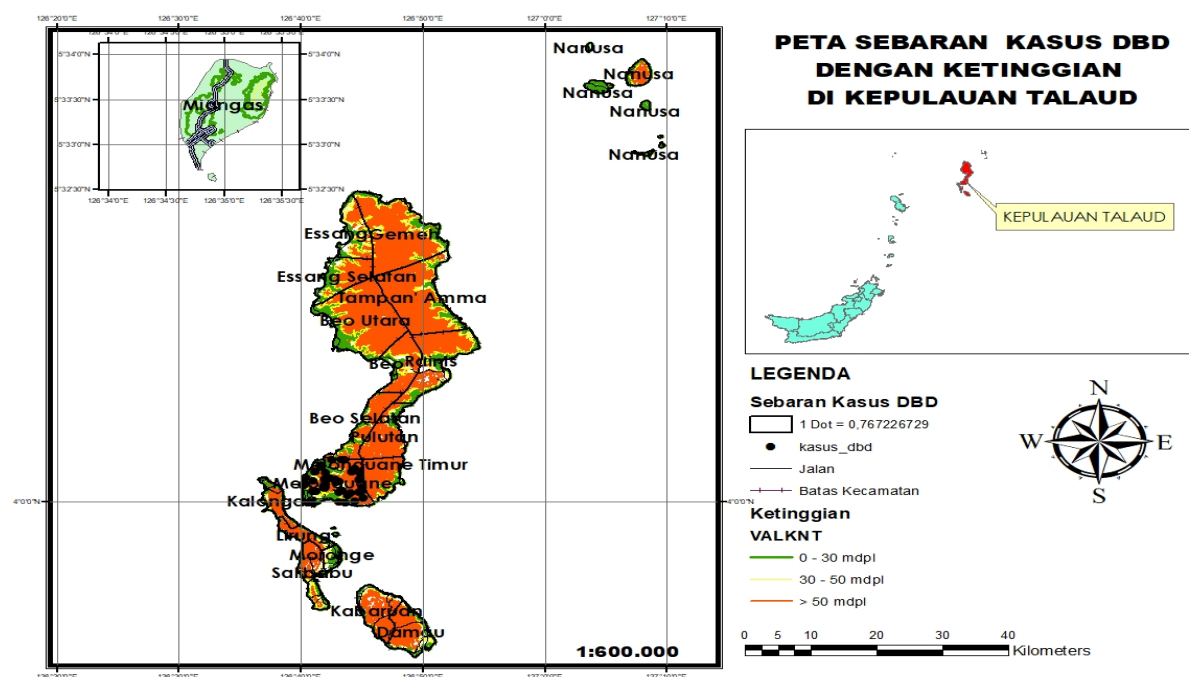


Figure 3: Map of distribution of DHF cases based on area altitude in Talaud islands regency.



*Distribution of DHF cases based on area altitude in Talaud islands regency*

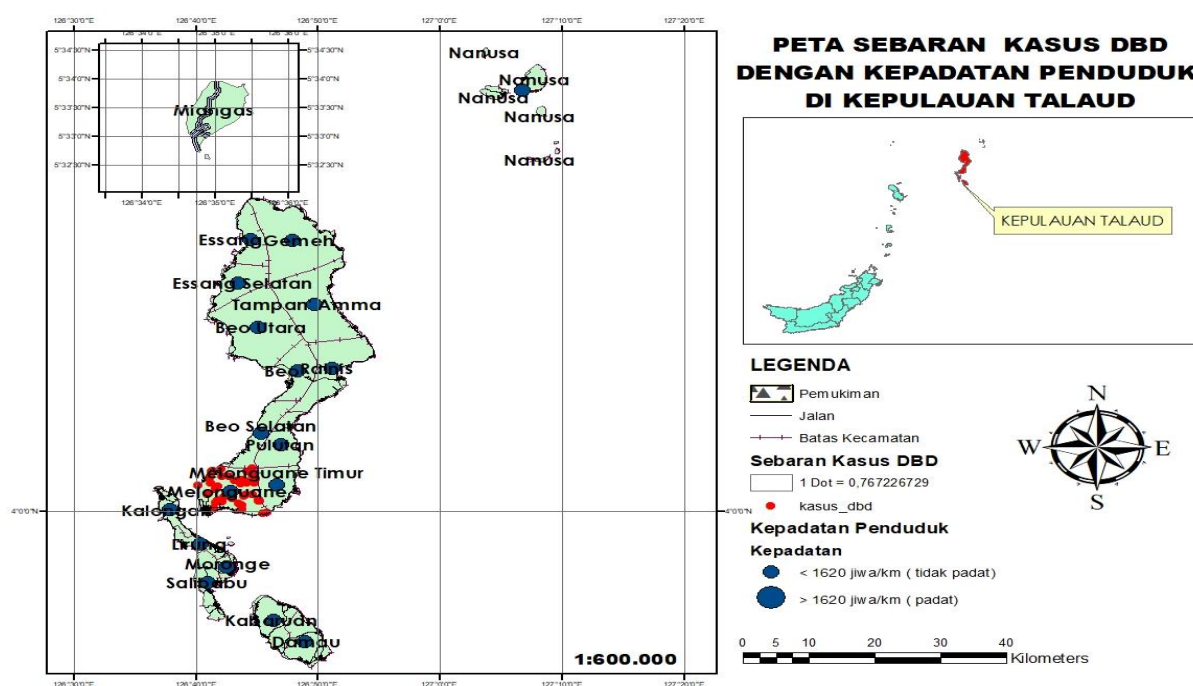
The highest distribution of DHF cases based on altitude with gradation for green indicates area with altitude of 0-30 meters above sea level, yellow indicates area with altitude of 30-50 meters above sea level and orange indicates area with altitude of >50 meters above sea level so the distribution of altitude based on the highest DHF cases is in Melonguane district with altitude of 0-30 meters above sea level and >50 meters above sea level while the distribution of altitude based on the lowest DHF cases is at altitude of 30-50 meters above sea level.

The results of spatial analysis showed that the highest cases of DHF were mostly in areas with altitude>50 meters above sea level, namely Melonguane district. The

results of this study are in line with research by Handayani, et al (2017) in the city of Padang stating that the lower the altitude, the higher the DHF incidence rate with  $r=-0,659$  so that there is a significant association between DHF incidence and altitude ( $p=0.038$ ).<sup>11</sup>

*Distribution of DHF cases based on population density in Talaud islands regency*

The results of spatial analysis showed that the highest number of DHF cases were in Melonguane District with population density less than 1,620 inhabitants per km so it was not densely populated. Based on the results of research by Handayani et al (2017) in Padang city stated that the coefficient value of 0.360 with a significant value of 0.307 so there is no association between population density and the incidence of DHF.<sup>11</sup>



**Figure 4: Map of distribution of DHF cases based on population density in Talaud islands regency.**

## DISCUSSION

The age of the population based on DHF data from the District health office in 2018 can be divided into 2 groups, namely toddlers (0-4 years) and adolescents (5-11 years). Based on the results of the study, it shows that DHF cases of Talaud regency in 2018 were mostly suffered by adolescents (5-11 years) and toddlers (0-4 years) with 19 cases (59.4%) and 14 cases respectively (40.6%). DHF is mostly suffered by children and school adolescents (Maria et al). This is because the age of the children who go to school in the morning to evening when the *Aedes Aegypti* mosquito "operates" bites, namely at 07.00-10.00 AM and 04.00-06.00 PM. In addition, the characteristics of people based on sex are also needed in assessing a disease, in this case DHF.

Based on the sex, most DHF cases were male with a percentage of 51.5%. This is similar to Kurniawati (2015) with the result that boys are more in numbers of DHF cases than girls.<sup>10</sup>

In connection with the conditions and habits of children, namely being in the same school environment and in the same room, DHF can attack various age groups, both boys and girls. Activities carried out by children every day in the house, classroom or school building, from morning to evening and meeting other people around them further increase the risk of being bitten by the *Aedes Aegypti* mosquito, resulting in multibiting.<sup>14</sup>

Differences in site characteristics affect the incidence of a disease. Based on the results of the study, it shows that

there is an area with the highest prevalence rate of DHF cases, namely Melonguane sub-district which is the capital of Talaud regency and located in an area near the Port where the entry and exit of the population is high and alternating so that the average population settlement is the largest in Melonguane sub-district. Apart from Melonguane sub-district, there are also Kiama and West Melonguane sub-districts. These two sub-districts are located adjacent to the Melonguane sub-district. In these two sub-districts there are primary and secondary schools in each sub-district where children and toddlers receive daily education.

The population density figure in Talaud regency is 68.73 km<sup>2</sup> with <1620 people/km, which means that this Regency is not too densely populated because Talaud Regency is an archipelago where the exchange and change of population is very fast with the existence of seaports and air transportation.

The spatial description of the distribution of DHF sufferers in 2018, based on the results of research conducted in Talaud Regency, the altitude for the distribution of DHF cases is divided based on the life ability of *Aedes Aegypti* mosquitoes, which is <1000 masl.

The altitude in Talaud regency is based on the 2016 Indonesian earth map. The average height of Talaud regency is <1000 masl, which is >50 masl.

The distribution of the highest DHF cases based on the altitude is in Melonguane sub-district with an altitude of 0-30 masl and >50 masl, while the distribution of lowest DHF cases is at an altitude of 30-50 masl. Settlements at high altitudes make it very convenient for the *Aedes Aegypti* mosquito. The houses that are close to each other make the spread of DHF more frequently in the area because apart from the altitude, the distance between the houses that is close together makes it easier for mosquitoes to spread the dengue virus from one person to another.<sup>15</sup>

Another factor that also causes the increase in the spread of DHF cases is the cleanliness of the environment where household waste is still not properly managed, thus increasing the factor of DHF transmission. Public awareness about environmental cleanliness must be increased by implementing the 3M program (draining, burying and closing mosquito nests) in Talaud regency.

The results of this study indicate that this DHF disease cannot be resolved by simply reducing the number of residents and settlements, but it must be synchronized with the necessary prevention programs. Cross-sector collaboration with the health office of the Talaud Regency Government for the eradication of DHF and with the respective resources owned by Talaud regency.

## CONCLUSION

The Health Office of Talaud Islands regency needs to actively promote health by providing information about eradicating mosquitoes.

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*Ethical approval: Not required*

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