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A Dynamic Model Approach to Estimating Events Dengue Hemorrhagic Fever in Gowa District

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Abstract

Introduction: Dengue Hemorrhagic Fever (DHF) is a public health problem in tropical and subtropical countries. The low ability to anticipate the incidence of DHF is due to the unavailability of a reliable prediction model for dengue fever incidence. This study aims to estimate dengue fever incidence in Gowa Regency in 2020-2040 using a dynamic model approach.

Methods: This study uses the Research and Development (R&D) method with a dynamic systems approach. The research was conducted in Gowa Regency with the research sample in dengue case data in Gowa Regency in 2014-2018. Interpretive Structural Modeling (ISM) is carried out to determine the right scenario in controlling dengue cases. The prediction model for dengue fever was analyzed using the PowerSim program.

Results: The jumantik program, 3M Plus, early warning systems, and counseling are crucial elements of DHF prevention in the Gowa Regency. The estimated average incidence of dengue fever for 20 years in Gowa Regency has decreased based on dynamic model simulations by implementing the Jumantik scenario (70.8%), 3M Plus (78.9%), early warning systems (86.2%), extension (73, 81%) and the combined scenario (99.14%).

Conclusion: The prevention and control of dengue fever in the Gowa Regency is more effective by combining jumantik, 3M Plus, early warning systems, and counseling programs.

Keywords: DHF, Dynamic Model, ISM

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) and malaria are tropical diseases with high prevalence rates, especially DHF. The condition is caused by the dengue virus and

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transmitted by mosquitoes of the genus Aedes.[1-3] The actual number of DHF cases is underreported, and many patients are misclassified. A total of 1.3 billion of the population at risk of dengue fever live in 10 countries in the WHO regional area in Southeast Asia, which are dengue-endemic areas, including Indonesia.[4] The province with the highest DHF morbidity rate in 2014 was Bali at 204.22 per 100,000 population. The Incidence Rate (IR) of DHF in South Sulawesi in 2014 was 34.59 per 100,000 people.[5]

Increased mobility and population density led to an increase in the number of sufferers and the area of DHF distribution. The incidence of DHF is influenced by geographical conditions, global warming, ecological factors, and climatic factors that play an essential role in mosquito biology.[6-8] Monitoring of dengue virus transmission in dengue-endemic areas can be done through serotype detection and mapping.[9] Can be done by strengthening the institutional system, changing the hygiene behavior of the community through a positive deviance approach that focuses on the action of the local community and the application of Community-Based Total Sanitation (STBM).[10-12]

One of the dengue-endemic areas in South Sulawesi is Gowa Regency. Gowa Regency, with a population of 605,876 people, has 18 sub-districts with 167 villages. Of these 167 villages, 46 were recorded as endemic, 38 were in the sporadic category, and 24 were categorized as non-endemic / potential. The most endemic villages were found in Bajeng District with 14 villages, then Somba Opu District with 9 towns and Pallangga District with 8 villages.[13]

The unavailability of regional vulnerability maps and reliable models for predicting dengue fever incidence causes a low ability to anticipate the incidence of dengue. Therefore, researchers are interested in researching by making a dynamic model for predicting the incidence of DHF in Gowa Regency. The prediction model for dengue fever is expected to estimate the incidence of dengue in the future and as an early warning in preventing the incidence of dengue.

METHOD

Research Location and Design

This research was conducted in one of the South Sulawesi Province districts, namely Gowa Regency, a dengue-endemic area. The design of this research is Research and Development (R&D) with a dynamics system approach.

Population and Sample Research

This research sample is dengue case data in the working area of the Gowa Regency Health Office in 2014-2018.

Data collection

The data used in this research is secondary data. Data obtained from the Health Office of Gowa Regency includes data on morbidity, mortality data, and dengue recovery data. In contrast, climate data is obtained from the Meteorology, Climatology and Geophysics Agency of Gowa Regency.

Data analysis

The DHF incidence estimation model's flow chart is made as the first step in dynamic modeling. Interpretive Structural Modeling (ISM) is carried out to determine the right scenario in controlling dengue cases. First, ideas for managing the incidence of DHF in the Gowa Regency were carried out through interviews with academics, practitioners, and related

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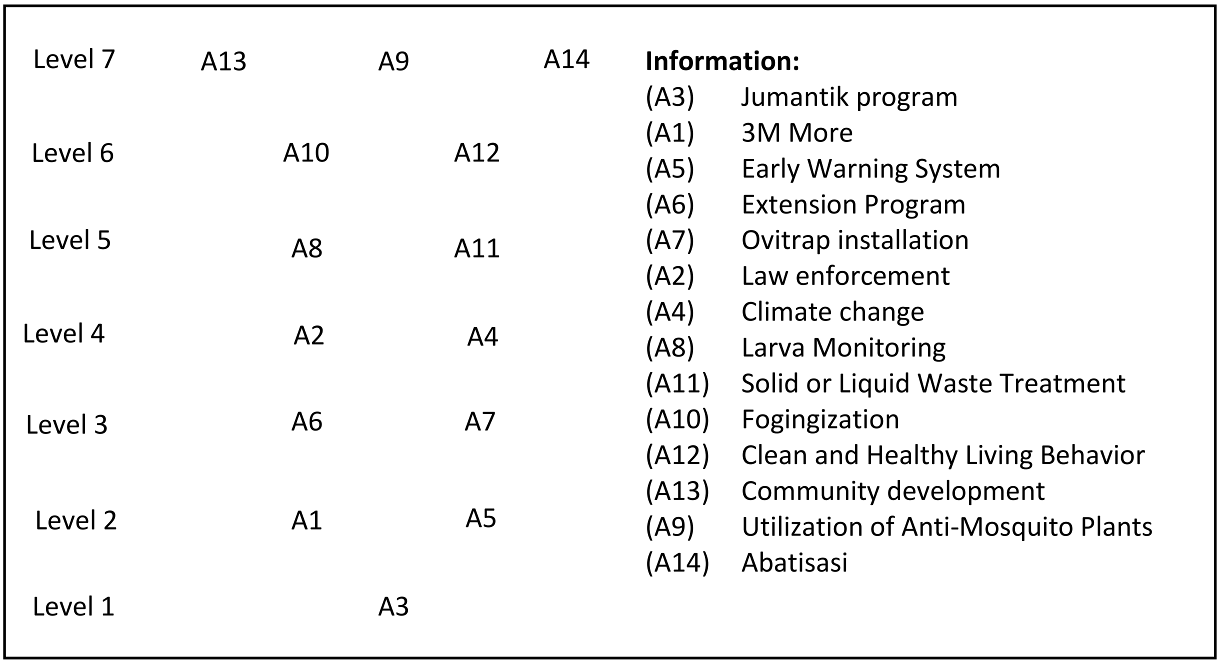
governments. Furthermore, the interview data were analyzed using ISM through the PowerSim program.

RESEARCH RESULT

Key Elements in the Prevention of DHF

The sub-elements that have a significant driving force in the DHF prevention program based on the analysis of 14 sub-elements of DHF prevention in Gowa Regency are the jumantik program, 3M plus, early warning systems, and extension programs (Figure 1).



Picture 1.
Hierarchy Diagram of Sub-element of DHF Disease Prevention in Gowa Regency

Do Nothing Scenarios

The dynamic model's simulation results predicting dengue incidence in 2020-2040 in Gowa Regency in the do-nothing scenario show a decrease in dengue cases. The number of DHF cases in 2020 was 233 cases and decreased to 127 points in 2040, with a total percentage decrease in cases of 45.4% (Figure 2).

Jumantik scenario

Estimation of the average incidence of DHF based on dynamic model simulation results using the Jumantik scenario for 20 years (2020-2040) in Gowa Regency shows a decrease in cases of 70.8%. The number of DHF cases in 2020 was 233 cases, decreasing to 68 points in 2040 (Figure 3).

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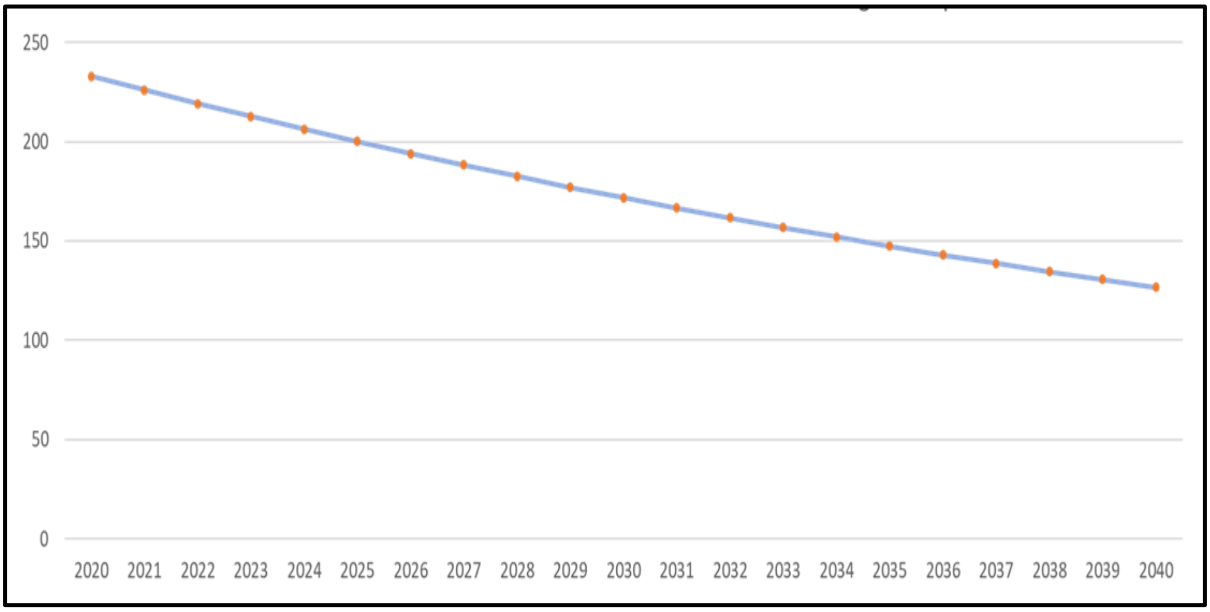
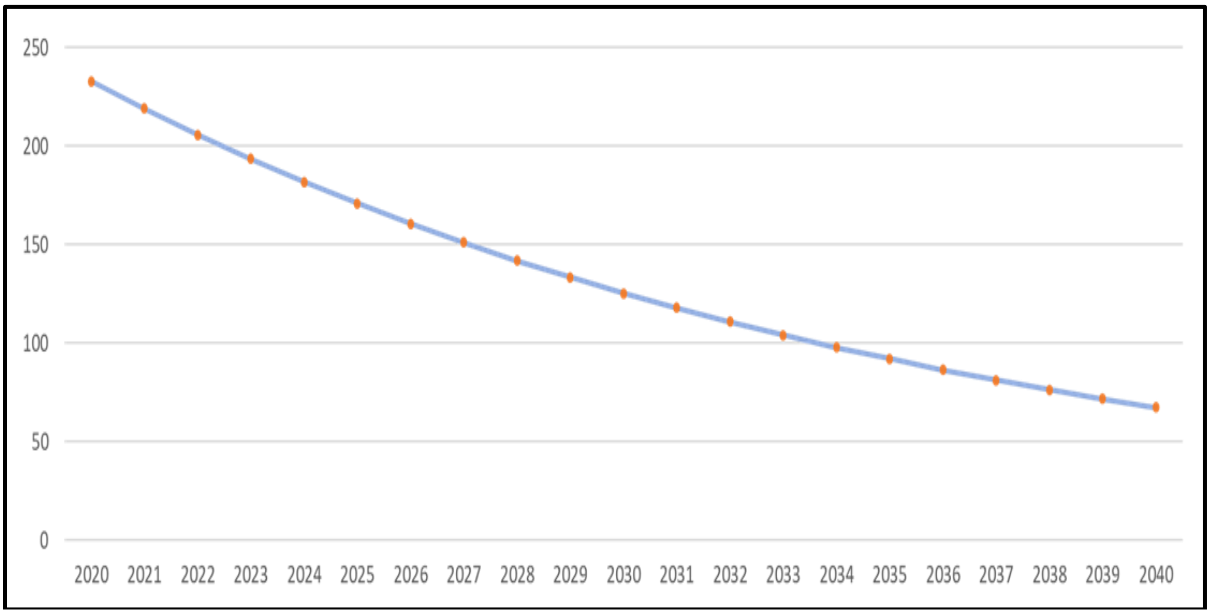


Picture 2.
Prediction Model of DHF in Gowa Regency 2020-2040
with the Do Nothing Scenario



Picture 3.
Prediction Model of DHF in Gowa Regency 2020-2040
with the Jumantik scenario

3M Plus Scenario

Estimating the average incidence of dengue fever in Gowa Regency shows a decrease in cases of 78.9% based on the dynamic model simulation results with the 3M Plus scenario for 20 years (2020-2040). The number of dengue cases in 2020 was 233 cases, while in 2040, it was 49 cases (Figure 4).

Early Warning System Scenarios

Figure 5 shows the estimated average incidence of DHF based on the results of a dynamic model simulation with an early warning system scenario for 20 years (2020-2040) in

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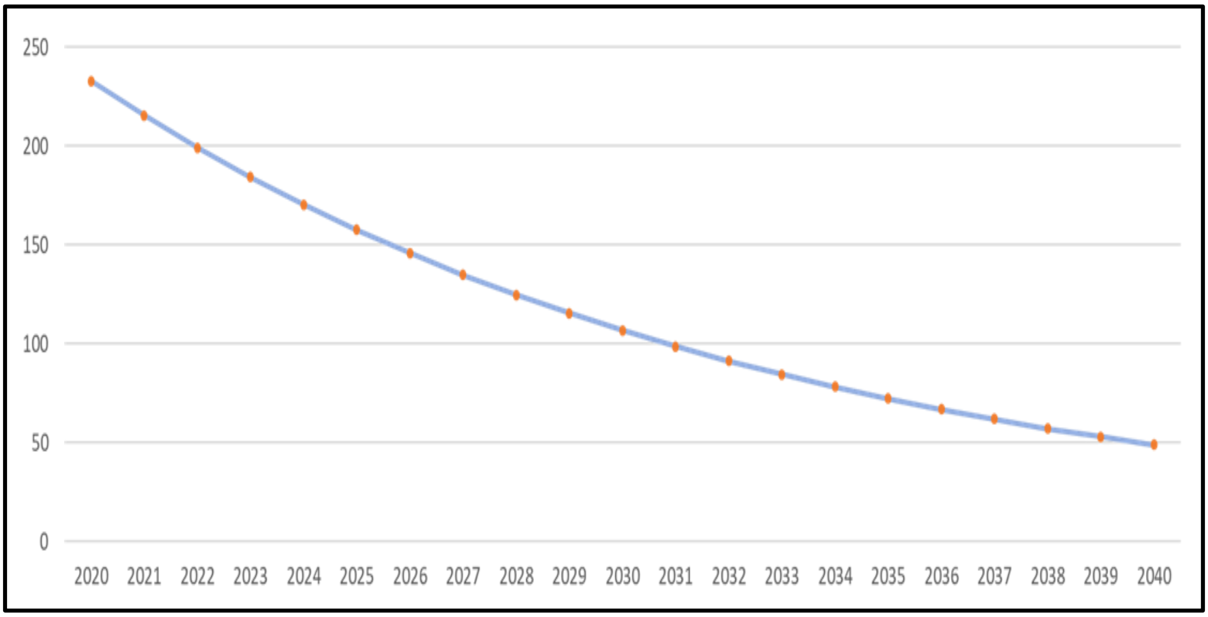
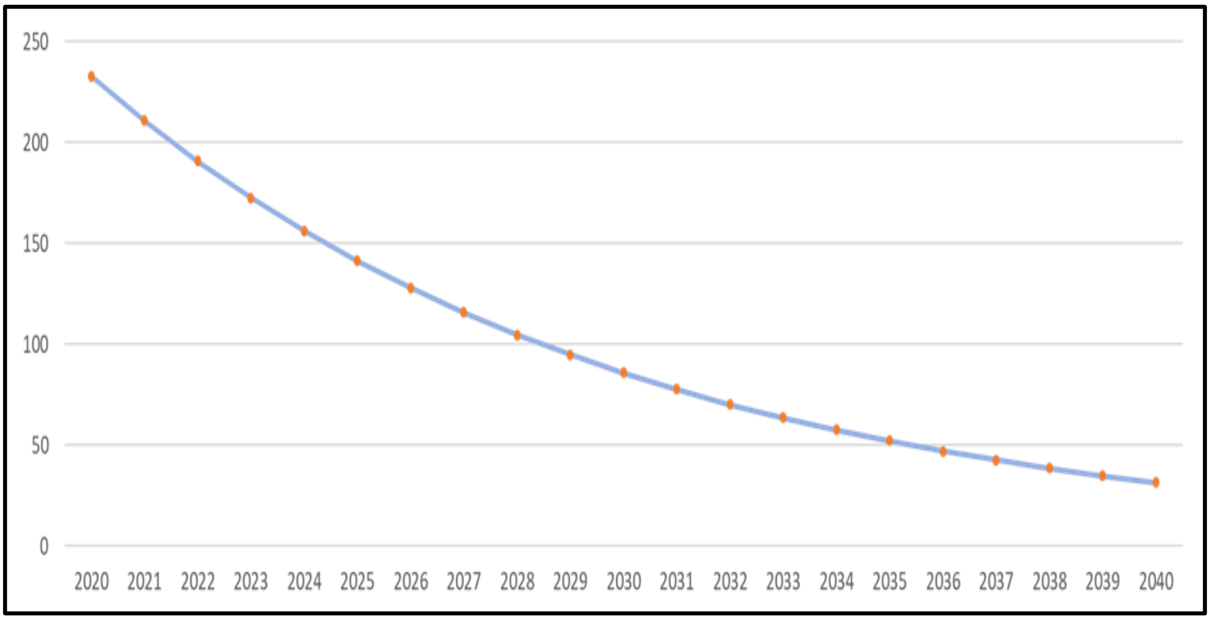
Gowa Regency, which has decreased by 86.2%. The number of dengue cases in 2020 was 233 cases, falling to 32 points in 2040.



Picture 4.
Prediction Model of DHF in Gowa Regency 2020-2040
with the 3M Plus Scenario



Picture 5.
Prediction Model of DHF in Gowa Regency 2020-2040
with Early Warning System Scenarios

Extension Scenarios

Figure 6 shows the estimated average incidence of DHF based on a dynamic model simulation with a scenario for 20 years (2020-2040) that experienced a decrease in cases. The number of dengue cases in 2020 was 233 cases, while in 2040, there were 61 cases, sharing a reduction in instances of 73.81%.

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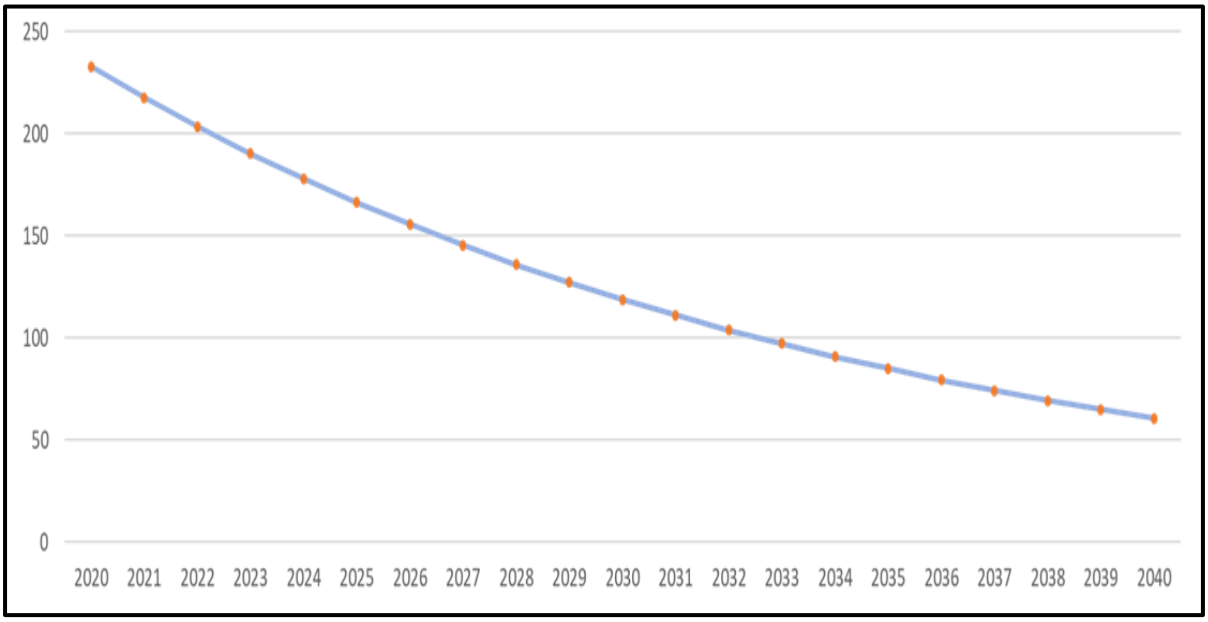
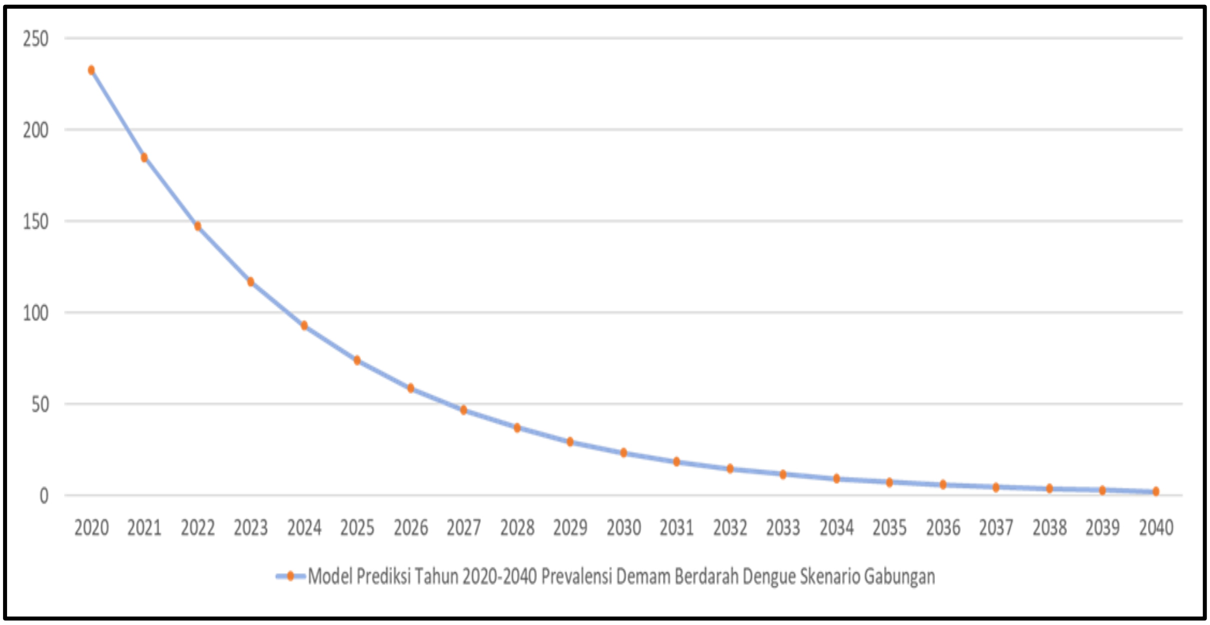


Picture 6.
Model Prediksi Kejadian DBD di Kabupaten Gowa Tahun 2020-2040 dengan Skenario Penyuluhan

Combined Scenarios

The dynamic model simulation results with a combined scenario (jumantik, 3M Plus, early warning system, counseling) for 20 years (2020-2040) in Gowa Regency show decreased dengue cases 99.14%. The number of dengue cases in 2020 was 233 cases, falling to 2 points in 2040 (Figure 7).



Picture 7.
Prediction Model of DHF in Gowa Regency 2020-2040 with Combined Scenarios

DISCUSSION

To reduce the incidence of dengue fever, an effective and efficient vector control strategy is needed. Some of these control efforts can break the chain of disease transmission.

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Based on the results of the analysis of 14 sub-elements of DHF prevention in Gowa Regency, it is found that the sub-elements that have a considerable driving power in the DHF prevention program in Gowa Regency are the Larva Monitoring Juru (Jumantik) program, 3M Plus, an early warning system. And counseling.

The government needs community participation in efforts to control dengue fever through periodic and continuous larva checks and community mobilization to eradicate mosquitoes. Therefore, to increase community participation, jumantik cadres are needed. Nurrochmawati's research results indicate that the existence of jumantik is a determinant of the incidence of dengue.[14] The role of jumantik is significant in the early alert system for dengue and is also the spearhead of dengue eradication. Community participation is a substantial component in DHF control because the Aedes mosquito vector dengue is found around settlements and where adult mosquitoes rest are mostly in the house. In his research, Wahidin found a relationship between increasing the role of jumantik and the incidence of dengue.[15] The DHF control program can be successful if supported by good community behavior and optimal performance of jumantik.[16]

In handling DHF, the role of the community to suppress this case is very decisive. Therefore, the Mosquito Nest Eradication Program (PSN) using 3M Plus needs to be carried out continuously throughout the year, especially during the rainy season. Draining water reservoirs, closing water reservoirs, burying used items that can hold water and have the potential to become a breeding ground for dengue-transmitting mosquitoes, and giving abate powder to water reservoirs are the 3M Plus PSN. Alhamda and Lestari's research found a relationship between the implementation of 3M Plus and dengue incidence. People who have implemented 3M Plus that are not good enough are at risk of suffering from dengue compared to people who have implemented 3M Plus well.[17-18] Health workers need to control the implementation of 3M Plus in the community.

In addition to the Jumantik and PSN 3M Plus programs, the early warning information system for dengue events can provide the most up-to-date and up-to-date data for DHF control.[19] The early warning information system for the occurrence of DHF includes recording data on the morbidity and mortality of DHF and information on the prevention, management, and treatment of dengue. Anticipating the incidence of dengue.[20]

Public knowledge about DHF, mainly how to prevent and treat it, is not yet fully good, so health education related to DHF is needed. Extension activities can add insight to the community about the importance of preventing and eradicating dengue cases. Siti's research evidence this: there is an effect of counseling related to dengue fever on increasing the knowledge and attitudes of parents of children with DHF in preventing DHF.[21] The results of Al-Zulfi's research in Malaysia showed the same results: significant differences in prevention behavior among respondents before and after being given health counseling.[22] This proves that there is a vital role of counseling in reducing DHF cases and the need for an increase in extension activities and interpersonal communication to increase knowledge, instill positive attitudes, and foster better DHF prevention practices in the community.[23]

The scenario that shows a significant reduction in dengue cases in Gowa Regency in 2020-2040 is a combination of all methods, namely the Jumantik procedure, 3M Plus, early warning systems, and counseling. To improve the early detection of dengue outbreaks and do strategic planning, the ability to predict the possibility of a dengue outbreak in an area is essential.

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CONCLUSION

The dynamic model approach that is most effective in estimating dengue fever incidence in Gowa Regency for the next 20 years (2020-2040) is a combination of the jumantik scenario, 3M Plus, early warning systems, and counseling. Therefore, combining several methods can be used as input and consideration in the planning and implementing prevention and control strategies for DHF events in Gowa Regency.

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