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Dynamic Model of Dengue Hemorrhagic Fever in Makassar City

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ABSTRACT
Introduction: Estimating the incidence of Dengue Hemorrhagic Fever (DHF) in the future is critical to anticipate the incidence of DHF. This study aims to estimate dengue fever incidence in Makassar City in the next 20 years (2020-2040) using a dynamic systems approach.
Methods: This study uses the Research and Development (R&D) method with a dynamics system approach in Makassar City. The sample in this study is data on dengue cases in Makassar City from 2012 to 2016. The right policy scenario in reducing dengue cases is carried out using Interpretative Structural Modeling (ISM). The PowerSim program is used to analyze the dynamic model of DHF incidence.
Results: The results showed that the critical elements of DHF prevention were jumantik, 3M Plus, early warning systems, and counseling. Based on a dynamic model simulation for 20 years in Makassar City by applying the jumantik scenario, 3M Plus, early warning systems, counseling, and the combined procedure, the estimated average dengue incidence has decreased by 2.3%, 27.7%, 52.2%, 11.71, respectively. % and 95.7%.
Conclusion: The incidence of dengue fever in Makassar City can be controlled by combining the jumantik program, 3M Plus, early warning systems, and counseling.

Keywords: DHF, Dynamic Model, ISM

1. INTRODUCTION

Tropical diseases are still a public health problem in the world, including in Indonesia. The high incidence of tropical diseases, such as Dengue Hemorrhagic Fever (DHF), malaria, and tuberculosis, is global warming (1-3). DHF is an infectious disease caused by the dengue virus and transmitted by mosquitoes from the genus Aedes, mainly

Aedes aegypti or Aedes albopictus (4). Each year, there are about 100-400 million dengue infections. Of the world's population at risk of dengue exposure, nearly 75% live in the Asia-Pacific region.

The number of sufferers and the area of DHF distribution increases along with the increase in mobility and population density. This disease is endemic in more than 100 tropical and sub-tropical countries (6). The incidence of DHF is influenced by geographic conditions and ecological factors (7-8). Monitoring of dengue virus transmission can be done through serotype detection and mapping (9). Positive deviance approaches and Community-Based Total Sanitation (STBM)) approach change hygiene and sanitation behavior through community empowerment (10-11). Also, strengthening the institutional system can help reduce dengue cases (12).

South Sulawesi Province, which has a variety of topographical conditions, causes each region's climatic conditions to be different. Makassar City is a dengue-endemic area with an increasing number of sufferers every year. The number of DHF sufferers in all puskesmas in Makassar City in 2013 was 265 cases with an incidence rate (IR) of 19.6 per 100 000 population, of which there were 11 deaths. In 2014, DBD IR in Makassar City increased to 20 per 100,000 people (13).

The low ability to anticipate the incidence of DHF is due to, among others, the time, place, and incidence rate cannot be adequately predicted, the unavailability of indexes and regional vulnerability maps based on the time of occurrence, and the unavailability of a reliable prediction model for the incidence of dengue fever. Therefore, in this study, a dynamic model was built based on risk factors that substantially influence the incidence of dengue in theory.

Based on the description above, the researchers are interested in conducting research and developing the incidence of DHF through a dynamic model of DHF cases in Makassar City.

2. METHOD

Research Location and Design

The location of this research is located in Makassar City, South Sulawesi Province. The research location is based on considerations because the city of Makassar is a dengue-endemic area. This study uses the Research and Development (R&D) method through a dynamics system approach.

Population and Sample Research

This study's sample is the aggregate data on dengue incidence recorded at the Makassar City Health Office in 2012-2016.

Data collection

This study uses secondary data from the Makassar City Health Office and Makassar City's Meteorology, Climatology, and Geophysics Agency. The data collected were in the form of data on morbidity, data on mortality, data on the cure of DHF, and climatological data.

Data analysis

Dynamic modeling begins with building a flow chart of the DHF incidence estimation model. To obtain the right policy scenario in reducing dengue cases, Interpretative Structural Modeling (ISM) is used. In implementing the ISM model, interviews were conducted with stakeholders from academia, practitioners, and the government to gather ideas for controlling the incidence of DHF in Makassar City. The data obtained were based on interviews, then analyzed using ISM through the PowerSim program..

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3. RESULT

Key Elements in the Prevention of DHF

The analysis of 14 sub-elements of DHF prevention in Makassar City based on interviews with stakeholders shows that the sub-elements that have a considerable driving power in the DHF prevention program are the jumantik program 3M plus, the early warning system, and the program. the extension (Figure 1).

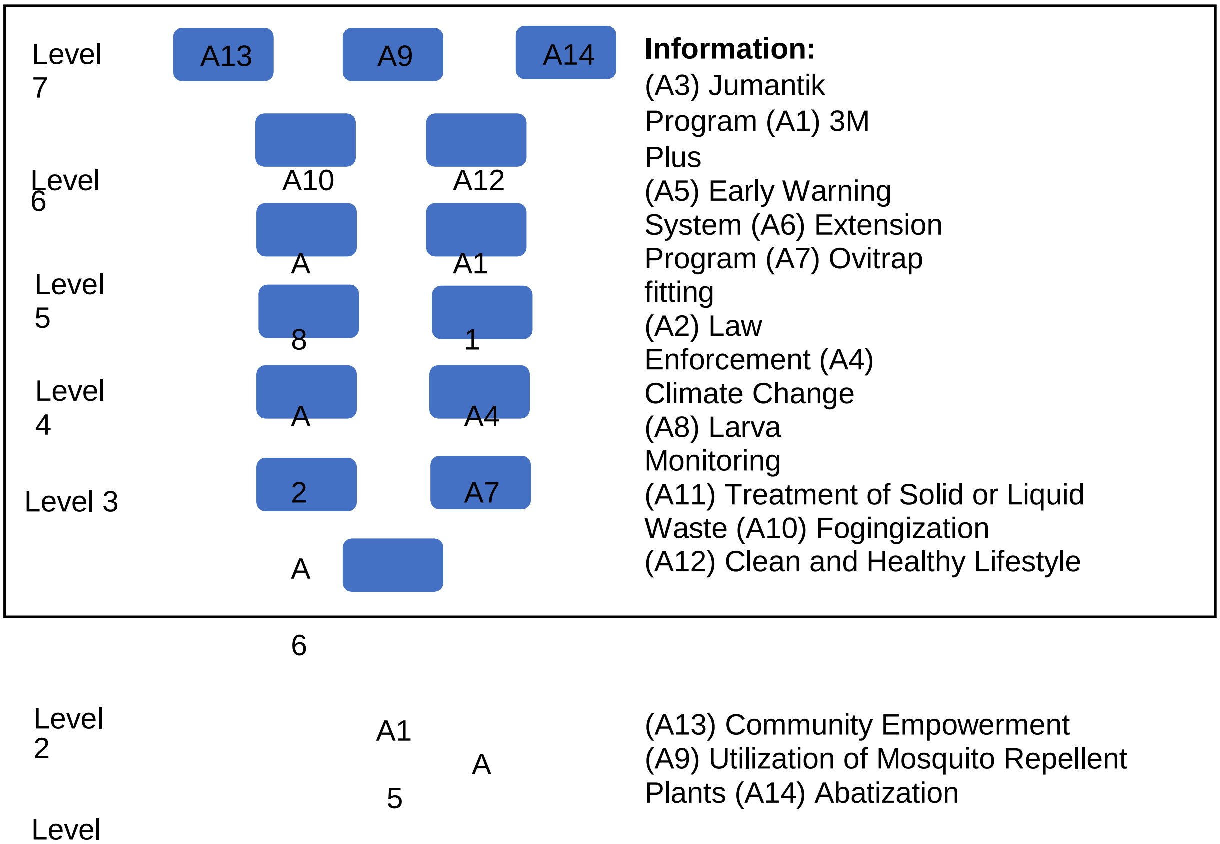

Figure 1.

Hierarchy Diagram of Sub-element of DHF Disease Prevention in Makassar City

Scenario Do Nothing

Estimation of the average incidence of DHF based on model simulation results indynamics for 20 years (2020-2040) in Makassar City in the do-nothing scenario, indicating an increase in DHF cases. The number of DHF cases in 2020 was 256 cases, while in 2040, there was an increase of 452 patients with a total percentage of 76.5% (Figure 2).

Jumantik scenario

Estimation of the average incidence of DHF based on dynamic model simulation results with the Jumantik scenario for 20 years (2020 - 2040) shows a decrease in cases of 2.3%. The number of DHF cases in 2020 was 256 cases, decreasing to 250 points in 2040 (Figure 3).

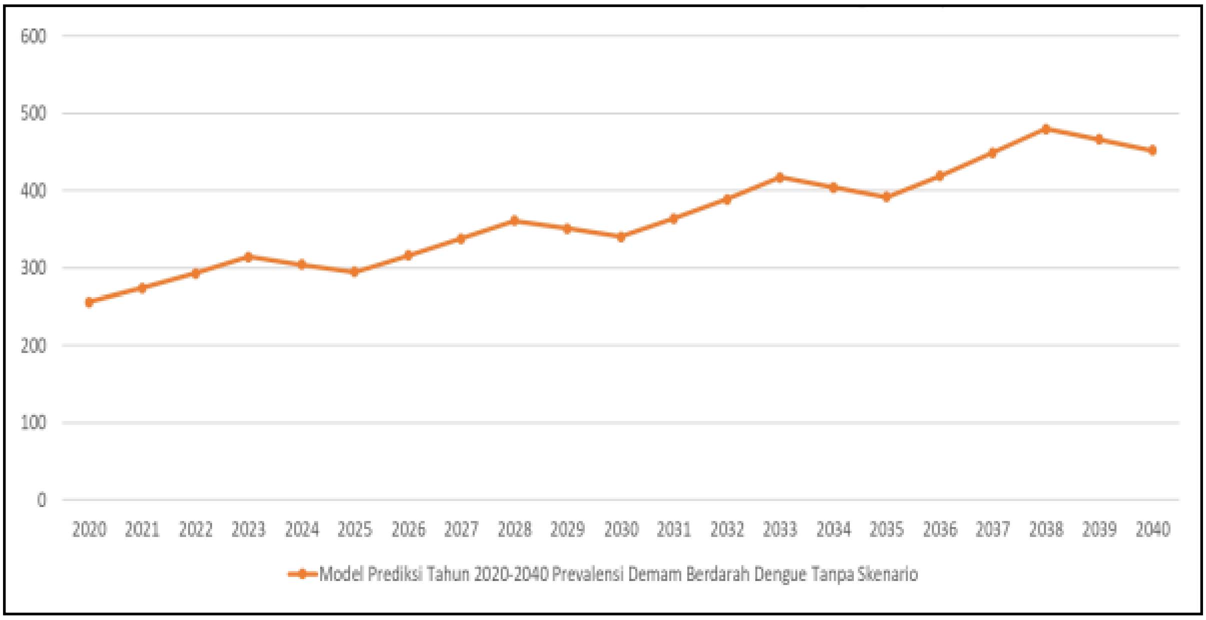

Figure 2.
Prediction Model of DHF in Makassar City 2020-2040 with Do Nothing Scenario

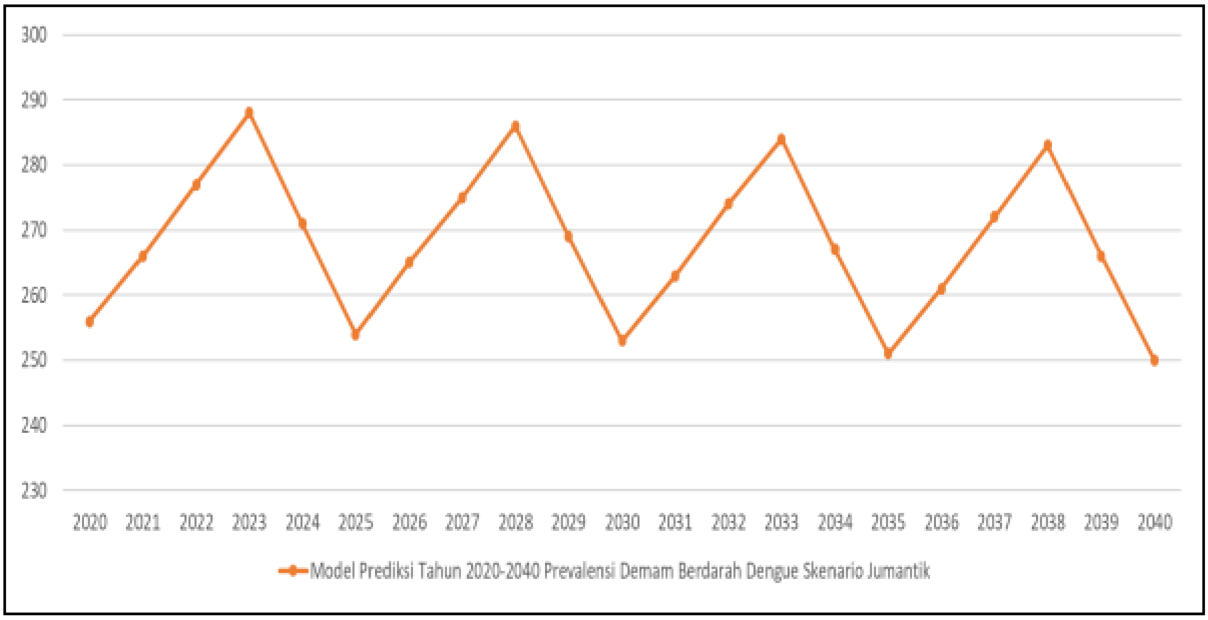

Figure 3.
Prediction Model of DHF in Makassar City 2020-2040 with the Jumantik Scenario

3M Plus Scenario

Estimating the average incidence of dengue fever in Makassar City based on the dynamic model simulation results with the 3M Plus scenario for 20 years (2020-2040) has decreased. The number of dengue cases in 2020 was 256 cases, while in 2040, there were 185 cases, a decrease of 27.7% (Figure 4).

Early Warning System Scenarios

Estimating the average incidence of dengue fever based on dynamic model simulation results with an early warning system scenario for 20 years (2020-2040) in Makassar City has decreased by 52.2%. The number of dengue cases in 2020 was 256 cases, falling to 122 points in 2040 (Figure 5).

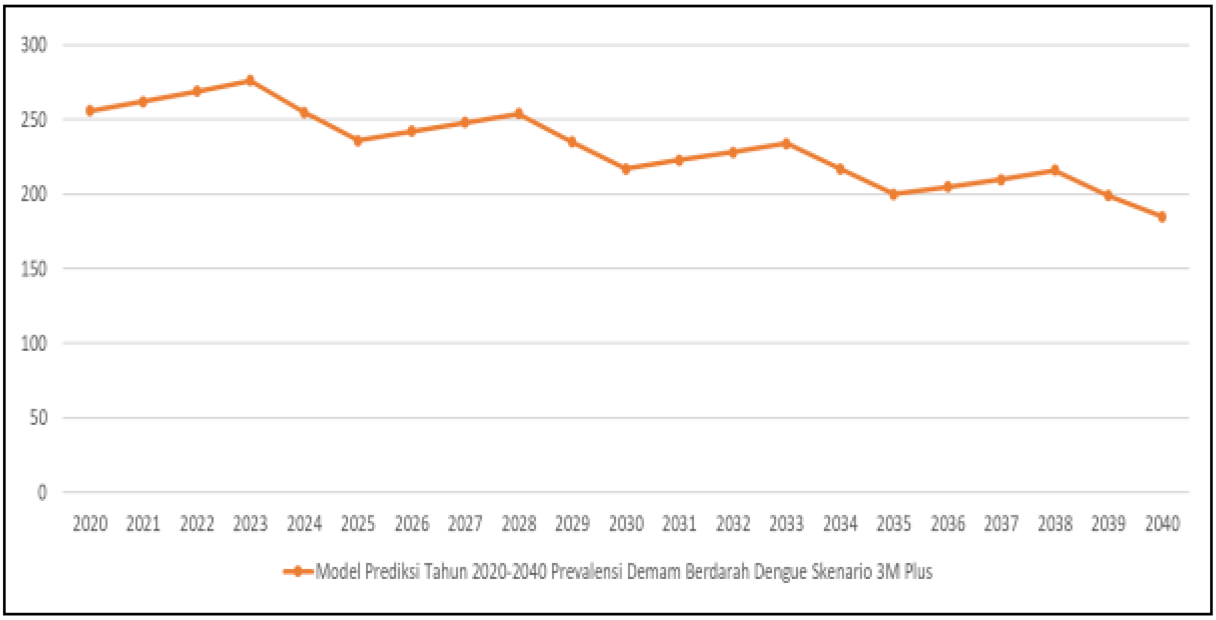

Figure 4.
Prediction Model of DHF in Makassar City in 2020-2040 with the 3M Plus Scenario

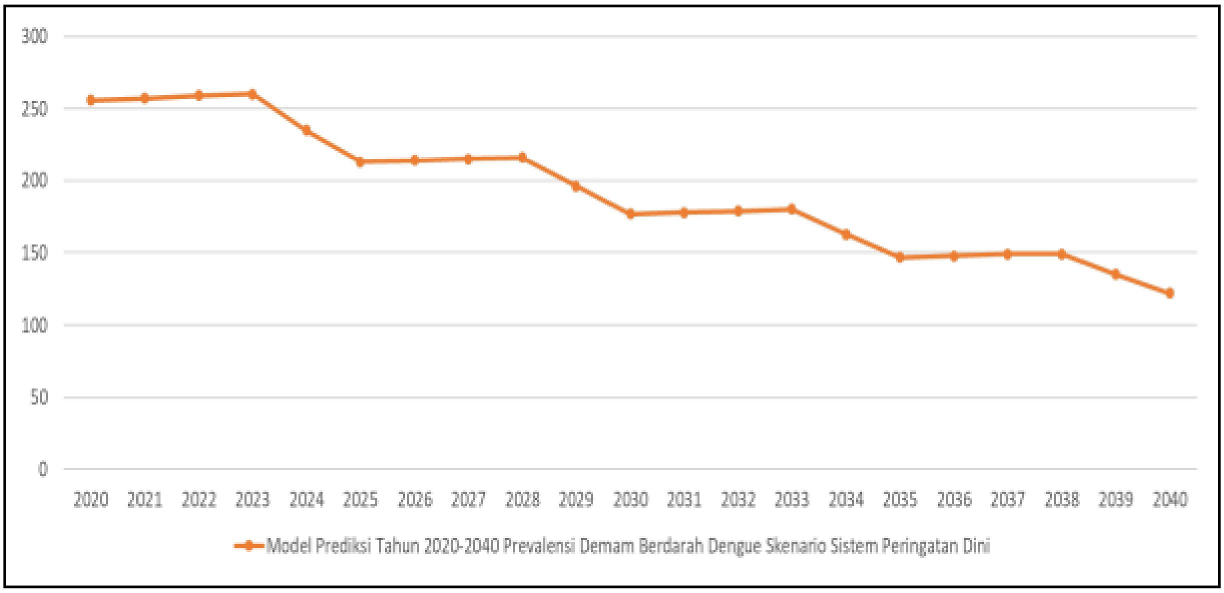

Figure 5.
Prediction Model of DHF in Makassar City 2020-2040 with Early Warning System Scenario

Counseling 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 256 cases, while in 2040, there were 226 cases, sharing a reduction in instances of 11.71%.

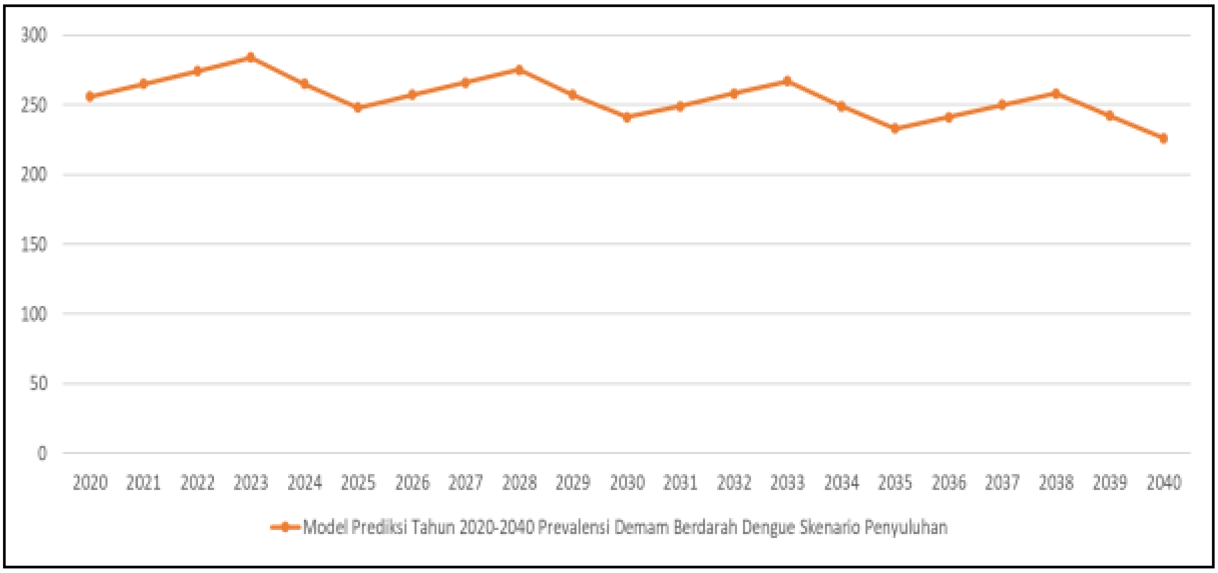

Figure 6.
Genesis Prediction Model of dengue in the city of Makassar Year 2020-2040 by the Counseling Scenarios

Combined Scenarios

Estimation of the average incidence of DHF based on the simulation results of a dynamic model with a combined scenario (jumantik, 3M Plus, early warning system, counseling) for 20 years (2020-2040) has decreased. The number of dengue cases in 2020 was 256 cases, while in 2040 it was 11 cases, a decrease of 95.7% (Figure 7).

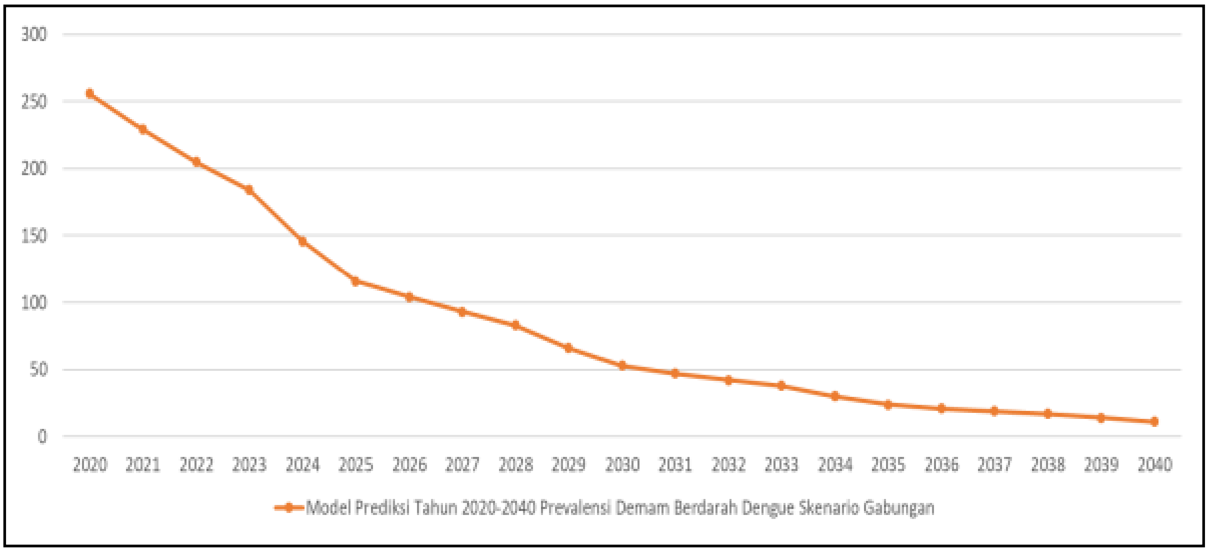

Figure 7.
Prediction Model of DHF in Makassar City 2020-2040 with Combined Scenarios

4. DISCUSSION

The sub-elements with a considerable driving power in the DHF prevention program in Makassar City are the jumantik program, 3M Plus, the early warning system, and counseling. The role of larva observer (Jumantik) is vital in the early alert system for dengue fever. Jumantik plays a role in monitoring the presence and inhibiting of the dengue infectious vector's early development. In this case, the community takes the part of jumantik cadres to control dengue (14). Community participation is the main component in maintaining dengue fever because the dengue fever vector, the Aedes mosquito larvae, are around settlements and where adult mosquitoes rest are mostly in the house. The results of Adnan's research in Jakarta show that the role of jumantik cadres in eradicating mosquito nests (PSN) is related to community behavior in efforts to prevent dengue disease (15). Jumantik cadres are expected to be active in monitoring their environment to reduce the number of dengue cases. Therefore, efforts are needed to increase jumantik activity through motivation carried out by the health department (16).

Prevention and control measures for DHF in environmental sanitation management that are implemented to suppress the habitat of Aedes aegypti mosquito larvae through PSN can be done with the implementation of 3M Plus.4 3M Plus PSN, namely draining water reservoirs at least once a week, closing the water container tightly, reusing used goods can accommodate water and has the potential to become a breeding ground for dengue-transmitting mosquitoes. The 3M Plus PSN is part of a Clean and Healthy Lifestyle (PHBS), which can be done every day and has a significant impact in eradicating and eliminating larvae before they grow into adult mosquitoes and control of DHF are carried out early (17). Gifari's research results indicate that the 3M Plus PSN is associated with dengue prevention behavior (18).

The information system for dengue fever early warning includes recording data on dengue patients, early warning to the public about dengue disease, and information on the prevention and eradication of dengue. With the early warning information system, it can provide accurate and up-to-date data to prevent DHF. The information generated can be used as an epidemiological tool for dengue outbreak early warning systems that enable prevention, control of mosquitoes and increase the readiness of health workers, health care facilities, and the community (19). Mahfudhoh's research found that the population's behavior influences the DHF eradication program's success in Indonesia, health workers, government early warning systems, mosquito resistance, and funding allocation (20).

Health education related to DHF will have a good impact on public knowledge, with this counseling will also have a positive effect on DHF prevention behavior changes. This counseling is expected to increase understanding of people's attitudes and skills so that the behavior of doing PSN is high, and ultimately the density of Aedes aegypti decreases (21-22). This is in line with research conducted by Zulaikhah, which found that there were significant differences in prevention behavior among respondents before and after being given health education. This shows that there is an essential role of education in reducing dengue cases (23).

The most effective scenario to reduce DHF cases in Makassar City in the next 20 years is to combine all procedures, namely the jumantik program, 3M Plus, early warning systems, and counseling. In contrast to the case of Rasmanto's research, which found that the most useful scenarios for controlling dengue fever were the abatization and fogging scenarios (24). This is not in line with the do-nothing scenario results, which show an increase in dengue cases in Makassar City. This could be due to the lack of massive DHF prevention programs such as less active health cadres and community participation in supporting DHF prevention programs.

5. CONCLUSION

The most compelling scene in the dynamic model of DHF incidence in Makassar City in 2020-2040 is a combination of techniques, namely a variety of the jumantik program, 3M Plus, early warning systems, and counseling. Therefore, the combined procedure can be used as a risk factor control strategy to reduce the rate of increase in dengue fever in Makassar City.

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