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Strategy to control and eradicate dengue hemorrhagic fever vectors in Bali

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ABSTRACT

Dengue hemorrhagic fever cases in Bali have increased in the past decade. Control and eradication efforts must be optimized. In order to create dengue-free zones, accurate information and a comprehensive strategy for accelerating dengue vector management are required. This paper is based on empirical, field, and epidemiological studies and program evaluations guided by the health belief model approach. In this regard, Bali's lesson on dengue cases fluctuated from 2018 to 2020. The incidence and death rates are increasing, especially during the COVID-19. Many factors affect the disease agent, the host, and the environment. The SIGAP strategy is a policy brief that is studied and implemented to accelerate dengue vector control in Bali, which includes: awareness of the importance of 4M-Plus (draining, closing, reusing used goods, and monitoring) and mosquito nest control; integration of dengue information services; using natural insecticides and larvicides; observing and reporting the presence of vectors to the larva monitoring officer; and regular monitoring weekly. Implementing the SIGAP strategy can reduce dengue vectors and speed up the process of getting rid of dengue disease in Bali.

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1. INTRODUCTION

Dengue virus infection until now has not been controlled and continues to increase, especially in Bali province. Based on health profile data in 2020, the number of incidents reached 12,173 cases, with an incidence rate of 280.7 and a case fatality rate of 0.2% (26 people) [1]. When viewed from 2018-to 2020, the number of dengue cases has increased three times from the previous year [2]. Furthermore, in the last decade, the province of Bali has been one of the top 10 contributors to the highest dengue hemorrhagic fever cases in Indonesia [3], [4]. In the COVID-19 pandemic, Bali was recorded to occupy the second position after West Java with the highest cases, and Buleleng Regency accounted for the highest cases in Indonesia [1], [5].

Aedes (stegomyia) aegypti and *Aedes (stegomyia) albopictus* mosquitoes are the main vectors that cause dengue and strive for control by various sectors but have not yet achieved maximum results. Control of dengue-causing vectors such as mosquito nest eradication and 4M-Plus (draining, closing, reusing used goods, and monitoring) is less desirable by the community [6]. This happens because many people are reluctant to control independently and use insecticides and larvicides for practicality [7], [8]. However, this method is ineffective in controlling mosquitoes because excessive use leads to resistance. [9], [10]. While the larva monitoring officer (JUMANTIK) has been deployed to assist in monitoring the presence of eggs, larvae, and imago in order to break the chain of mosquito breeding at the household level, this effort has encountered

weaknesses due to limited resources in each region, resulting in monitoring failing to operate as expected, particularly during the COVID-19 pandemic, which discourages a larva monitoring officer (*juru pemantau jentik*/JUMANTIK) from visiting homes [11]–[13]. A larva monitoring officer (JUMANTIK) is assigned or hired to keep an eye on the vectors that cause dengue fever, from eggs to imago, as part of the public health center's (PHC) plan to get rid of mosquito nests in each area. The local government has implemented a one-house, one JUMANTIK program [14], but this effort has not received a response, and its application needs to be evaluated further.

Responding to these problems, efforts are needed to prevent vector explosions, household-based control, and integrate eradication in dealing with dengue hemorrhagic fever endemic diseases in the community-based Bali. In line with this, the policy briefs and unique strategy are designed to accelerate the decline in dengue incidents in the province of Bali by utilizing the potential of local wisdom and optimizing vector control with the SIGAP strategy. The SIGAP strategy is an acronym for "One community-based dengue virus infection eradication movement." It comprises five parts based on their importance and the program's motto, introduced and used to control dengue vectors in Bali. These results convey specific policies, factual data, and strategies the Bali provincial government can apply to control and eradicate dengue vectors in Bali. Based on empirical evidence, epidemiological data, field studies, and annual case evaluations, this policy briefs aims to develop a SIGAP strategy to accelerate Bali's control and eradication of dengue vectors. The hope is that policymakers can use this strategy to immediately carry out vector control based on local wisdom to overcome the explosion of dengue virus infection in the community and realize a dengue-free Bali.

2. RESEARCH METHOD

This paper is based on empirical studies, field studies, epidemiological studies, and evaluation programs that have been applied to dengue vector control, especially in Bali Province. Considering the implementation of the SIGAP strategy as an effort to control and eradicate dengue vectors in the province of Bali using the health belief model approach [15]. The health belief model is used in a survey based on empirical studies, field studies, epidemiological studies, and program evaluations conducted by previous research. The health belief model is used in predicting changes in health behaviors to achieve the achievement of promotional and preventive health programs in the community. The key factors focus on perceived severity, perceived vulnerability, perceived benefits, perceived barriers, gestures to action, and self-efficacy.

In this paper, the SIGAP strategy is formulated by considering five key components, including: i) finding and collecting information related to at-risk and targeted populations; ii) formulating consequences if the program and strategy launched do not run well and optimally; iii) formulating the relevant parties involved in carrying out the strategy launched; iv) identifying obstacles and formulating solutions to them; and v) providing demonstrations and efficacy of the implementation of the proclaimed strategy. This study comes from the exploration of scientific articles that have been published, especially strategic efforts that can support the eradication of dengue in Bali province while still prioritizing the validity of data and fulfilling scientific and cultural rules and customs of local communities. The entire dataset is presented in the form of narratives and graphs.

3. RESULTS AND DISCUSSION

3.1. Dengue hemorrhagic fever cases were discovered in Bali between 2018 to 2020

A study of Bali health profile data in 2021 obtained that the prevalence of dengue hemorrhagic fever increased throughout 2018-2020 [1]. The highest peak is in 2020 and is known to have increased during the COVID-19 pandemic. Areas with high endemicity infected with dengue are Buleleng, Badung, Denpasar city, and Gianyar District as shown in Figure 1. The high number of cases in this region is due to population density and the dominance of tourist areas. High levels of mobilization and sanitation in various areas are poorly controlled, and climate support (weather, temperature, humidity, and high rainfall) [3], [9], [16]. Recent research states that there are similar signs and symptoms between dengue hemorrhagic fever and COVID-19, so the COVID-19 pandemic in Bali is a high-risk factor for infection with these two diseases [17]–[19]. Fluctuations in cases in nine districts/cities in Bali Province cannot be separated from the lack of community participation in tackling this disease. People prefer to overcome COVID-19 disease because of its high-speed transmission compared to dengue hemorrhagic fever [18], [20], [21].

Figure 2 shows the study's findings regarding morbidity and death during the last three years. The incidence rate and case fatality rate both fluctuated significantly [1]. According to the report, the morbidity rate did not meet the national target of less than 49 per 100,000 population between 2018 to 2020 [1], [2]. This is because of many new instances discovered during the year. The expectation is that with adequate control and collaboration among many parties, vector agents of dengue hemorrhagic fever such as *Aedes spp., Aedes (stegomyia) aegypti*, and *Aedes (stegomyia) albopictus* will be able to be controlled and eradicated [22], [23].

Additionally, there was a higher risk of death from dengue hemorrhagic fever in Bali Province due to inadequate care or other disorders [24], [25].

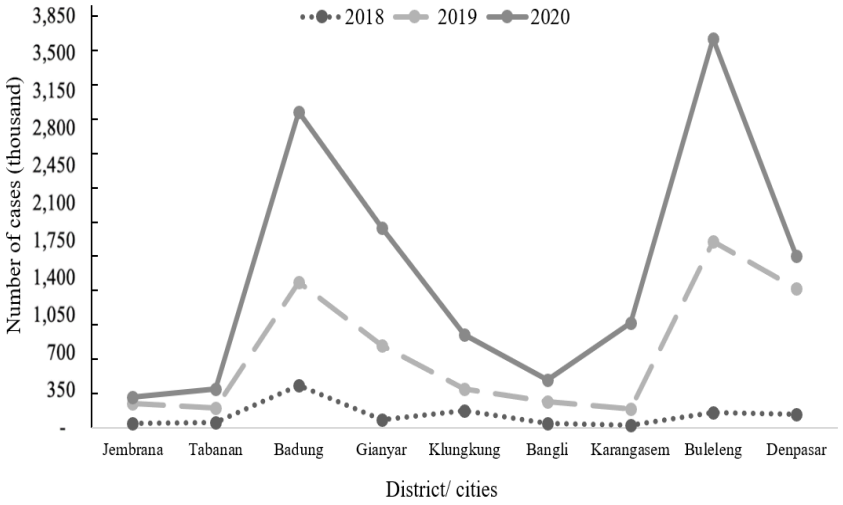

Figure 1. Prevalence of dengue hemorrhagic fever cases in Bali Province from 2018 - 2020

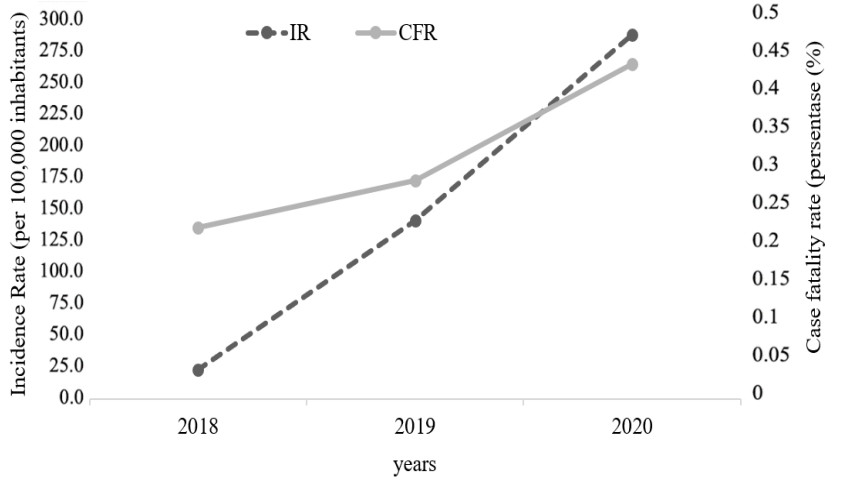

Figure 2. Incidence rate and case fatality rate of dengue disease in Bali in 2018-2020

3.2. Dengue vector control strategy points in Bali Province based on empirical evidence

Efforts to control and eradicate dengue hemorrhagic fever in Bali Province have carried out a comprehensive policy realization at every level of society. However, it has not yet achieved maximum results, especially in efforts to prevent, promote health, and control dengue vectors. The dengue vehj ctor control strategy points in Bali Province are based on empirical evidence, epidemiological studies, and laboratory and field studies to improve the effectiveness and direction of accelerating dengue vector control in Bali Province by using the SIGAP strategy described as follows.

3.2.1. Realize the importance of 4M-Plus and mosquito nest eradication

At this point, strategic efforts are needed to prevent and control dengue hemorrhagic fever disease before the transmission season through the "Dengue Conscious Movement (RADAR-U)" and the importance of eradicating mosquito nets at the household level. The strategy of awareness of the importance of 4M-Plus (draining, closing, reusing used goods, and monitoring) plus raising fish, growing natural insecticide plants, and mosquito nest eradication can be done by forming RADAR-U cadres at the Banjar level through sekaa teruna-

teruni (STT), in the village through family welfare empowerment (PKK) and local district office [11], [26]. In addition, the formation of RADAR-U cadres can cooperate with the education sectors of both elementary schools and higher education to improve the knowledge, attitudes, practices, and concerns of the younger generation to participate in eradicating dengue vectors in their respective residences. The implementation of the formation of the RADAR-U cadre is one of the latest information extensions related to the efforts made to improve people's abilities and knowledge in the eradication of dengue vectors. RADAR-U cadres provide up-to-date and periodic reports to cadre coordinators, then submitted to the local health office as evaluation material to provide the RADAR-U program to the community [27], [28].

Furthermore, through the local health service, public policy stakeholders, and regional stakeholders, the provincial government needs to make awig-awig or local legislation based on local wisdom in each village to form RADAR-U cadres to accelerate dengue eradication programs awig-awig, or village regulation, is used as a foundation for community compliance in carrying out and community participation in eradicating dengue vectors. Similar research has been applied in Thailand by forming village and regional level legislation to tackle dengue vectors. Binding regulations make it easier to provide direction and attract public interest in carrying out planned programs [29], [30]. In addition, it is essential to approach community leaders to participate in tackling the vector of dengue, which causes it to be passed on to the community both verbally and non-verbally. This aligns with the health belief model that focuses on public trust in public figures [31], [32].

3.2.2. Integrated dengue information services

At this point, the government is expected to establish integrated information services ranging from home to provincial levels to report RADAR-U cadres, larval monitors, dengue hemorrhagic fever control information, and the most recent case data throughout Bali province. Information Services actively advocates for accelerating the eradication of dengue hemorrhagic fever vectors. This is owing to the ease with which sites may be accessed and the overwhelming popularity of information services and social media. This makes it easier to convey messages to encourage people's knowledge, attitudes, and practices to participate in controlling dengue vectors in Bali. Fuadzy's *et al*. [27] demonstrates that the function of information services significantly simplifies changing people's habits and promotes mosquito eradication measures in the community, increasing their effectiveness when applied to dengue vector management. The combined data may be used to map and improve home survey services to aid in optimizing one JUMANTIK house in Bali [14], [33].

According to the Bali Provincial Health Office's website, there will be a procurement of the albovirosis reporting system (SIARVI), which will substantially support this plan for accelerating dengue vector elimination beginning at the home level. With the establishment of this program, the community and government collaborate in monitoring mosquito nests regularly, carrying out community-led activities, collecting data on vector-borne diseases, and assisting larvae monitors in generating factual reports [34]. Further, Aizah [35] disclosed that the LAJENA application (mosquito flick free number reporting) enables the one-house, the one-JUMANTIK program to monitor their respective residences periodically [33], [36]. The LAJENA is an online mosquito larva-free reporting application designed to support Indonesia's JUMANTIK one house one movement. Thus, the critical need for dengue information services in Bali province, particularly to combat dengue hemorrhagic fever vectors in the population, is highly plausible.

3.2.3. Utilize naturally occurring pesticides and larvicides

At this point, the public is expected to understand and be capable of using pesticides and larvicides appropriately, precisely, and measurably to reduce the occurrence of resistance in mosquitoes, particularly dengue vectors [37]. Dengue vector control in Bali can be accomplished using natural ingredients contained in Legiayu incense mixtures. According to indigenous wisdom, this incense is used not only during the ceremony but also as a vector control technique. Mertha Adnyana *et al.* [13] Legundi leaves, lemongrass leaves, and wood powder are combined to create legiayu incense. Legiayu incense can be used as a pesticide (smoke) to suppress adult *Aedes (stegomyia) aegypti* mosquito vectors (imago). In comparison, *Larvacides* (ash) suppress larvae throughout their first four stages. This incense can result in a 50-98% mortality rate in dengue vector imago after 15 minutes and 39 seconds of smoke exposure, whereas ash exposure lasts for six hours after delivery. This incense is made entirely of natural ingredients, non-toxic, and completely safe to use. Chronic toxicity tests conducted on the incense revealed that exposure to smoke for 90 days did not result in histological alterations in the mouse lung organs (*Mus musculus*) BALB/C strain. Incense was chosen because it fits the needs of the indigenous people, who utilize it as a method of ceremonial daily. The local government should promote the procurement of this incense, as it is used in the community and large-scale manufacturing incurs high costs. Procurement of raw materials must appeal to indigenous farmers and competent indigenous producers. Additionally, communities can give and nurture insect repellent plants that are effective as larva controllers and imago vectors of dengue virus infection [37].

3.2.4. Observe and inform JUMANTIK of the presence of vectors

At this point, the government and community work together to monitor and report the existence of dengue vectors both inside and outside the home, as well as larvae or adult mosquitoes in regions where dengue vectors avoid, such as bathtubs, used cans, used tires, and waterlogged containers [38]. Suppose the community discovers the existence of larvae, eggs, or mosquitoes in residence. In that event, they are expected to submit it to JUMANTIK, who is responsible for the region, so that it can be reported further via the available database. The dengue information service will facilitate officer mobilization for early prevention and control activities before communities become infected with the dengue virus and strengthen the region and household JUMANTIK's participation in dengue vector control [39], [40].

3.2.5. Periodic monitoring every week

At this point, the community in each household is expected to monitor and or monitor the presence or absence of dengue vectors in their respective homes periodically to minimize vector presence and increase people's awareness of dengue infection eradication [41]. Every week in the home region, monitoring is distributed to the public via social media and practical recommendations via the media [42], [43]. Periodic monitoring is planned to promote community involvement in vector control efforts so that they are not solely focused on the government's goal of achieving dengue-free zones [44]. At this stage, strategies such as the frequency of detecting larvae and or mosquito imago might aid in the implementation of policies emphasizing the need for parasite control periodically [36], [40].

3.3. Lessons learned

Lessons learned are unique techniques based on empirical studies, field investigations, epidemiological data, and the evaluation of health programs that may be used immediately to speed the elimination of dengue vectors, particularly in the province of Bali. In this policy briefs, the implementation phases of the SIGAP approach have been thoroughly described and examined in terms of their efficacy and benefits. The community and the government need to synergize to jointly carry out prevention, community and household-based health promotion, and manage the residential environment to avoid breeding or becoming a breeding place for vectors that cause dengue fever. The SIGAP strategy launched in these policy briefs is a summary, model, and item that must be carried out, synergize with each other, and influence one another so that it must be implemented dynamically and continuously. The SIGAP strategy that is carried out properly according to the priorities of each item is used as factual information in the investigation, control, and eradication of dengue vectors in Bali Province. With these policy briefs, we can make people aware of the eradication of dengue by paying attention to the rules and critical factors in the health belief model.

4. CONCLUSION

The incidence of dengue hemorrhagic fever in Bali province in 2018-2020 experienced a significant increase. During a pandemic, morbidity and mortality rates fluctuate and are caused by agent factors (mosquitoes), the environment, and hosts susceptible to disease. The eradication of dengue vectors in Bali Province should be conducted using SIGAP strategies (including realizing the importance of 4M-Plus and mosquito nest eradication, integrating dengue information services, and utilizing naturally occurring pesticides larvicides, observing and informing JUMANTIK of the presence of vectors and periodic monitoring every week). In the future, an evaluation of SIGAP tactics for eradicating dengue vectors and the development of novel mechanisms to expedite the eradication of dengue-causing vectors would be necessary.

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