


Analysis of dengue virus vector control causing dengue hemorrhagic fever (DHF) in high and low case

Devi Oktafiani¹, Intania Riska Putrie², Fakhriah M. Samiun³

^{1,2}Department of Biochemistry, Faculty of Medicine, Tadulako University, Palu , Sulawesi Tengah, Indonesia

³Program Studi Kedokteran, Faculty of Medicine, Tadulako University, Palu , Sulawesi Tengah, Indonesia

Article Info	ABSTRACT
Keywords: DHF, Vector, Mosquito, Control	Dengue Hemorrhagic Fever is still a global public health problem, especially in tropical and subtropical regions, including Indonesia as one of the dengue-endemic countries. Central Sulawesi is one of the endemic areas of dengue fever in Indonesia. DHF cases in Central Sulawesi Province are recorded to fluctuate every year and the morbidity rate tends to increase. In the Palu city area, Birobuli Selatan Village is the area with the highest cases, while in the Nunu Village, no dengue cases were detected. Data about vector management practices in areas without dengue fever cases are required to reduce dengue cases in areas with high dengue fever cases, and this data will help lower the incidence of dengue fever in high dengue fever cases. This research method is to use a questionnaire to look at the habits of people in areas with low cases and high cases in controlling disease vectors. People who reside in locations with a high caseload and places with zero cases served as the samples. Sampling used a purposive sampling method. Data analysis used the chi-square test. The research results showed that in the group of areas with high cases, there were differences in 3M habits ($p=0.021$), use of mosquito nets ($p=0.000$), plants around the house ($p=0.000$), and residential density ($p<0.05$). Meanwhile, there is no difference in the use of mosquito repellent and abate in the two regions. This research concludes that there are differences in people's habits regarding activities or activities in controlling mosquito vectors that cause dengue fever in areas with high cases and low cases.
This is an open access article under the CC BY-NC license 	Corresponding Author: Devi Oktafiani Department of Biochemistry, Faculty of Medicine, Tadulako University Jalan Soekarno Hatta, Km.09, Mantikulore, Palu, Sulawesi Tengah devioktafiani.fk.untad@gmail.com

INTRODUCTION

Dengue hemorrhagic fever is still a global public health problem, especially in tropical and subtropical areas, including Indonesia, which is one of the endemic countries for dengue hemorrhagic fever. Dengue Hemorrhagic Fever (DHF) is a disease caused by the dengue virus which is transmitted by vector. Dengue fever can appear throughout the year and attacks all ages. This disease is closely related to environmental conditions and community

behavior (Dinas Kesehatan Kota Palu et al., 2021). Dengue fever is still a public health problem in developing countries.

Central Sulawesi is one of the endemic areas for dengue fever in Indonesia. In Central Sulawesi Province, recorded dengue cases vary from year to year, with the morbidity rate and spread of infected areas increasing. Of the 13 districts/cities that reported dengue case data as of December 2020, there were 1,190 cases (IR: 40.31 per 100,000 population) and the number of deaths was 12 people (CFR: 1.01%)(Dinas Kesehatan Provinsi Sulawesi Tengah, 2021). In the Palu city area, the distribution of dengue fever in each Village is different, there are some areas with higher dengue infection than other Villages. The population of the city of Palu is greater than Donggala and Sigi. This also contributes to the presence of DHF vector habitats, with more DHF vector habitats in the city of Palu than in other regions. DHF cases have increased in Palu, Donggala, and Sigi for various reasons. First, the increase in DHF cases was caused by the emergence of many DHF vectors in *Aedes* after high tides and liquefaction. In addition, many wastes such as cans and plastics were found, which possibly gets to be an unused holder territory for DHF vector mosquitoes to breed. Numerous DHF cases were moreover unreported properly since the individuals within the locales did not have access to health services. Adherence to dengue management rules in Indonesia will offer assistance decrease the frequency and mortality rates of DHF(Koraag, 2021).

Based on the 2021 Palu City Health Profile, the South Birobuli sub-district is the area with the highest cases, while in the Nunu sub-district, no dengue fever cases were detected in 2021(Dinas Kesehatan Kota Palu et al., 2021). Controlling the *Aedes aegypti* mosquito vector is one effort to reduce the incidence of dengue fever. Infection occurs in tropical areas due to the interaction of host, agent, and environment. These three factors influence each other. To control the incidence of dengue fever epidemics, efforts are made to control the vector of the disease. This vector control is related to people's understanding and living habits that are clean and free of mosquito larvae.

Population growth, unplanned and uncontrolled urbanization, the absence of effective mosquito vector control in endemic areas, a lack of mosquito-bite prevention measures, a lack of public knowledge about dengue fever, and improved transportation facilities are all factors that contribute to the spread of the disease. Palu is the capital of Central Sulawesi province, which is rapidly expanding due to population mobility, the construction of new settlements, and transportation infrastructure, resulting in the expansion of dengue disease in Palu City (Widjaja, 2011).

Analysis of controlling the presence of the *Aedes aegypti* mosquito vector is important for knowing the presence of mosquitoes and preventing them. This study aims to compare the factors that cause areas with minimal dengue cases and high dengue cases in terms of vector control in their communities. It is hoped that the existing indicators for high cases of dengue fever will decrease and in areas with minimal cases of dengue fever they will be used as a reference for other areas where there are still high cases of dengue fever as well as as basic literature and policies for overcoming broodstock and community habits.

METHODS

This research is a descriptive-analytical study using a cross-sectional study approach. A total of 100 correspondents in the Nunu Village and South Birobuli Village areas were collected. Respondents were taken using the consecutive sampling method. The type of data used in this research is primary data. Data collection was carried out in March-July 2023 in the two Villages. Data was obtained from a questionnaire that contained questions about habits in controlling mosquito vectors and collecting data on the home environment. The data contains 3M habit factors, biological environmental factors, and chemical factors. Data was transferred into a statistical-based application by passing the data management stage according to the following steps: cleaning, coding, editing, and processing. The research results were analyzed using SPSS *chi-square*.

RESULTS AND DISCUSSION

Palu City is the city with the highest density and mobility in Central Sulawesi because it is the center of the capital city of Central Sulawesi. Based on surveillance data on the spread of dengue fever cases in 46 Villages, it is concluded that the entire Palu City area is classified as an endemic area for dengue fever (Dinas Kesehatan Kota Palu et al., 2021) The data distribution of respondents in the South Bureaubuli Village and Nunu Village includes 49 women and 51 men aged 20-50 years, 80 respondents, 17 respondents aged over 50 years, and 3 respondents aged under 20 years. The data is presented in Table 1.

Table 1. Sample distribution based on age and gender in South Birobuli Village and Nunu Village

Characteristics	N	Percentage (%)
Age (year)		
<20	3	3
20-50	80	80
>50	17	17
Sex		
Male	51	51
Female	49	49

Dengue vector control in the high case area (South Birobuli) showed that half of the respondents only drained the bathtub once a week, and a small portion only changed the water without scrubbing the bathroom tub. More than half (29 respondents) did not close the water reservoir, and 37 respondents did not use antiseptic/abate powder on the water. Almost all plants are around the house in respondents in high case areas. Complete data can be seen in Table 2. In this low-case area, not a single respondent was infected with dengue fever. Dengue vector control in areas with low cases shows that half of the respondents drain the bathtub three times a week, all respondents drain the bathtub by rubbing the walls of the bathtub, more than half (28 respondents) close the water reservoir and 34 respondents use mosquito nets or ventilation screens. More than half of respondents do not have plants around the house. Complete data can be seen in Table 2.

DHF cases in Palu City fluctuate every year and are spread across all Villages in Palu City with the highest cases in the South Bureaubuli Village and no cases in the Nunu Village. Based on research reports (Hermania & Cahyati, 2023), the number of dengue fever cases in 2021 is a total of 332 cases, this data is slightly higher compared to cases in Palu City, namely 305 cases.

There are several methods for vector control, including biological and chemical interventions, as well as environmental modification. The dengue vector is a mosquito that can or has the potential to be a source of transmission of dengue fever.

Table 2. Control of dengue vectors in Nunu and South Birobuli Villages

Variable	Category	Birobuli Selatan	Nunu	<i>p-value</i>
		n(%)	n(%)	
Drain the bath	1 x per week	25 (50)	3 (6)	0.000
	2 x per week	11 (22)	21 (42)	
	3 x per week	14 (28)	26 (52)	
Hoow to drain the bath	Rubbed	45 (90)	50 (100)	0.021
	Just throw away the water	5 (10)	0 (0)	
Close the water reservoir	Yes	21 (42)	28 (56)	0.230
	None	29 (58)	22 (44)	
Use of mosquito nets/ventilation screens	Yes	9 (18)	34 (68)	0.000
	No	41 (82)	16 (32)	
Use of abate/antiseptic	Yes	13 (26)	10 (20)	0.635
	No	37 (74)	40 (80)	
Plants around the house	Yes	49 (98)	20 (40)	0.000
	None	1 (2)	30 (60)	

(*p*-value: significant <0.05)

In this research, the mosquito breeding places observed were used items around the house that have the potential to become nesting places for mosquitoes, bathtubs, and other water reservoirs. In Villages with high cases, the habit of throwing away and burying used items was found to be lower than in areas with low cases. There is a significant difference (0.000 and 0.021) between Nunu District and South Birobuli District in these activities. In line with research by Rahmania et al. in 2018 activities to eradicate mosquito nests could reduce the incidence of dengue fever in Lampung (Rahmania & Indriyani, 2018) The habit of throwing rubbish or used items into open trash cans. This is a bad way of disposing of rubbish because it has the potential to become a breeding ground for *Aedes sp.* mosquitoes (Sofia & Sahputri, 2022).

Public knowledge about dengue virus infection influences the way individuals perceive the severity of dengue fever and their susceptibility to the disease (Pujiyanti et al., 2014). The optimal implementation of Mosquito Nest Eradication (PSN) cannot be

separated from the respondents' knowledge of vector bionomics. Respondents who had good knowledge of vector behavior identified mosquito breeding sites as targets for vector control measures. One of PSN's activities is emptying and cleaning water tanks. The aim is to prevent *Ae. Aegypti* attached to the walls of the water tank is damaged and cannot develop into mosquito larvae (Raude et al., 2012).

The media played a major role in increasing household understanding of dengue and "dengue mosquitoes," but little awareness was raised about vector density reduction initiatives.(Quintero et al., 2014) In Colombia and Ecuador, where the large tanks used for household water storage and washing were primarily productive, vector production (measured through pupal indices) was favored when water containers were outside, uncovered, unused, and—particularly during the dry season—rainwater filled (Quintero et al., 2014)

3M Plus activities include emptying, covering, burying, and scrubbing bathtubs and not piling up used items which can become a breeding ground for mosquitoes (Sapphira et al., 2022). Biologically, controlling mosquito vectors is by keeping fish that eat larvae. In this study, no biological control was observed. Other controls can also use bioinsecticides to control dengue fever mosquito vectors(Sumekar & Nurmaulina, 2016). Genetic engineering is the newest vector control used to create deadly genes(Halomoan & Suwandi, 2017). Destroying larvae from the chain of transmission is the most effective and efficient way to control dengue fever vectors (Nanda et al., 2023)

Chemically, PSN DHF is usually done by sprinkling abate powder in water reservoirs. The application of abate larvicide to water storage containers is one of the most commonly used dengue fever vector control methods (George et al., 2015). This can increase the risk of *Aedes aegypti* living and breeding in water reservoirs. In these two Villages, the use of abates is less common in the community, but in Nunu Village (low cases) this is offset by the habit of draining more frequently than in the community in South Birobuli Village. The use of insecticide-treated curtains in research (Darwin et al., 2013) can control the presence of the *Aedes aegypti* mosquito. In this research, the habit of respondents in case Villages was to use mosquito nets or window screens to ward off mosquitoes, although insecticide use was not observed on the nets.

Vector control remains the main method for preventing dengue infection. Environmental intervention is a sustainable and safe method because the risk of environmental contamination and toxicity is limited (Buhler et al., 2019). Control of dengue fever is becoming increasingly challenging due to urbanization, population growth, increased international travel, and lack of implementation of vector control programs in dengue-endemic countries. Environmental conditions in resource-limited settings such as weak infrastructure and poor sanitation also contribute to dengue transmission (Guzman & Kouri, 2002). Currently, the main vector control methods used by most government-funded dengue control programs are the treatment of water storage containers with larvicide (generally temephos) and/or spraying insecticides in peridomestic spaces(Overgaard et al., 2018).

The existence of mosquitoes that cause dengue fever includes intrinsic factors, such as high ecological plasticity and strong competitive talents, and extrinsic factors, such as globalization, lack of supervision, and lack of efficient control (Paupy et al., 2009). *Aedes* sp. mosquitoes. have strong ecological plasticity allowing its rapid adaptation to a very wide range of habitats. For example, although this mosquito has adapted to the human environment and prefers to live in suburban environments, it has also been identified in very dense urban areas (Paupy et al., 2009). South Birobuli is an area that has a dense population. Larval breeding sites are extensive and range from natural sites (e.g. bamboo stumps and tree holes) to artificial containers (Paupy et al., 2009). High-risk container types for dengue vector development include those that are outside, infrequently used, uncovered, typically filled with rainwater, and, in the case of Asia, shaded by vegetation. (Quintero et al., 2014)

The mosquito that causes dengue fever also depends on vegetation density. In this research, the vegetation observed was the plants in the houseyard. This vegetation tends to provide sufficient shade and humidity, providing a place for mosquitoes to rest and breed (Cheong et al., 2014; Huynh & Minakawa, 2022; Satoto et al., 2017).

Apart from the factors mentioned above, residential density in certain areas is another factor in the high number of dengue fever cases. In this study, there was a significant difference in residential density in the high case and the low case, where complete data is shown in Table 3.

Table 3. Residential density data in South Birobuli and Nunu Villages

Palu City DHF Case	Residential Density (number of people /m ²)		<i>p-value</i>
	Not good (<15)	Good (>15)	
Low case	33	17	0.000
High case	10	40	

(p-value: significant <0.05)

Table 3 is data on residential density in two Villages that have low dengue cases and high dengue cases in Palu City. This table is in line with research (Majid et al., 2020; Satoto et al., 2017) that higher residential densities have greater opportunities for mosquitoes to transmit disease, considering the habit of mosquitoes biting many times over a short flight distance (Istiqamah et al., 2020; Satoto et al., 2017). Population density has a major contribution to the relationship between humans and mosquito vectors, where densely populated areas allow mosquito vectors to find lots of food and resting places for mosquitoes (Higa, 2011). Mosquito density is directly proportional to the number of people in the house, so transmission and spread of the DEN virus occurs locally (Rodrigues et al., 2015). Population density can influence the number of dengue cases. A large number of people in a specific location will aid in the development of dengue fever by facilitating and speeding up the transmission of the virus from the vector. Densely inhabited places typically have poor environmental hygiene and are heavily reliant on community activity. Unfavorable environmental conditions can promote vector breeding (Apriyandika et al., 2015) Apart from the vector control habits above, rainfall, air pressure, humidity, wind

speed, bioclimatic zones, seasonal variations, and nominal year have a significant influence on the spread of dengue fever (Faruk et al., 2022)

CONCLUSION

There are significant differences in people's habits regarding activities or activities to control mosquito vectors that cause dengue fever in areas with high cases and low cases, namely the activity of draining bathtubs, environmental factors, namely the presence of plants around the house and the use of mosquito nets. It is vital to disseminate information on vector control factors to the community in areas with high dengue fever cases in order to control the *Aedes aegypti* mosquito vector and minimize the number of dengue fever cases in Palu City.

ACKNOWLEDGEMENT

Thank you to Daftar Isian Pelaksanaan Anggaran (DIPA) BLU, Ministry of Education and Culture, Research and Technology, Tadulako University Number: 6805/UN28/KU/2023 who funded this research.

REFERENCE

1. Apriyandika, D., Awalia Yulianto, F., Feriandi, Y., Dokter, P., & Fakultas Kedokteran, D. (2015). Hubungan Kepadatan Penduduk dengan Kejadian Demam Berdarah Dengue di Kota Bandung tahun 2013. *Prosiding Pendidikan Dokter*, 2, 740–745.
2. Buhler, C., Winkler, V., Runge-Ranzinger, S., Boyce, R., & Horstick, O. (2019). Environmental methods for dengue vector control – A systematic review and meta-analysis. In *PLoS Neglected Tropical Diseases* (Vol. 13, Issue 7). Public Library of Science. <https://doi.org/10.1371/journal.pntd.0007420>
3. Cheong, Y. L., Leitão, P. J., & Lakes, T. (2014). Spatial and Spatio-temporal Epidemiology Assessment of land use factors associated with dengue cases in Malaysia using Boosted Regression Trees. *Spatial Spatiotemporal Epidemiologi*, 10, 75–84.
4. Darwin, A., Pujiyanti, A., & Heriyanto, B. (2013). Model Pengendalian Terpadu Vektor Demam Berdarah Dengue di Kota Salatiga. *Journal Vectora*, 1(Juni).
5. Dinas Kesehatan Kota Palu, Iva Nur Anifa, Sk., ANGGOTA Asrul Sy Deluma, S., Listi Sintiadewi, S., Rusnah KONTRIBUTOR Bidang Pencegahan Pencegahan Penyakit, Mk., Kesehatan Masyarakat, B., Pelayanan Kesehatan, B., Pelayanan, B., Daya Kesehatan di Lingkup Dinas Kesehatan Kota Palu Puskesmas se-Kota Palu Badan Pusat Statistik Kota Palu Dinas Kependudukan, S., & Sipil Kota Palu BMKG Kota Palu REDAKSI Dinas Kesehatan Kota Palu Jalan Balai, C. (2021). *PROFIL KESEHATAN KOTA PALU*.
6. Dinas Kesehatan Provinsi Sulawesi Tengah. (2021). *Profil Kesehatan Provinsi Sulawesi Tengah*. <http://dinkes.sultengprov.go.id>
7. Faruk, M. O., Jannat, S. N., & Rahman, M. S. (2022). Impact of environmental factors on the spread of dengue fever in Sri Lanka. *International Journal of Environmental Science*

- and Technology*, 19(11), 10637–10648. <https://doi.org/10.1007/s13762-021-03905-y>
8. George, L., Lenhart, A., Toledo, J., Lazaro, A., Han, W. W., Velayudhan, R., Runge Ranzinger, S., & Horstick, O. (2015). Community-Effectiveness of Temephos for Dengue Vector Control: A Systematic Literature Review. *PLoS Neglected Tropical Diseases*, 9(9). <https://doi.org/10.1371/journal.pntd.0004006>
 9. Guzman, M. G., & Kouri, G. (2002). Dengue: an update. *Lancet Infectious Disease*, 2(1), 33–42.
 10. Halomoan, J. T., & Suwandi, J. F. (2017). Pengendalian Vektor Virus Dengue dengan Metode Release of Insect Carrying Dominant Lethal (RIDL). *Majority*.
 11. Hermania, C., & Cahyati, W. (2023). Kejadian DBD di Kota Semarang Tahun 2019-2021. *HIGEIA (Journal of Public Health Research and Development)*, 7(3), 376–385.
 12. Higa, Y. (2011). Dengue vectors and their spatial distribution. In *Tropical Medicine and Health* (Vol. 39, Issue 4 SUPPL., pp. 17–27). <https://doi.org/10.2149/tmh.2011-S04>
 13. Huynh, T. T. T., & Minakawa, N. (2022). A comparative study of dengue virus vectors in major parks and adjacent residential areas in Ho Chi Minh City, Vietnam. *PLoS Neglected Tropical Diseases*, 16(1). <https://doi.org/10.1371/JOURNAL.PNTD.0010119>
 14. Istiqamah, S. N. A., Arsin, A. A., Salmah, A. U., & Mallongi, A. (2020). Correlation study between elevation, population density, and dengue hemorrhagic fever in Kendari city in 2014–2018. *Open Access Macedonian Journal of Medical Sciences*, 8(T2), 63–66. <https://doi.org/10.3889/oamjms.2020.5187>
 15. Koraag, M. E. (2021). *INCIDENCE OF DENGUE HEMORRHAGIC FEVER AFTER THE EARTHQUAKE IN CENTRAL SULAWESI INDONESIA*. 37–44. <https://doi.org/10.17501/24246735.2020.6105>
 16. Majid, N. A., Razman, M. R., Zarina, S., Zakaria, S., & Nazi, N. M. (2020). *Dengue Vector Density Incident and Its Implication to Urban Livability*. <https://doi.org/10.21203/rs.3.rs-33464/v1>
 17. Nanda, M., Nur Ismail Berutu, A., Daffa Ash-shiddiq, M., Oktavia Berutu, W., & Kesehatan Masyarakat, F. (2023). Analisis Penerapan Manajemen Pengendalian Vektor Demam Berdarah Dengue (DBD) di Lingkungan 19 Kelurahan Belawan Bahagia. *VISA: Journal of Visions and Ideas*, 3(2), 425.
 18. Overgaard, H. J., Pientong, C., Thaewongiew, K., Bangs, M. J., Ekalaksananan, T., Aromseree, S., Phanitchat, T., Phanthanawiboon, S., Fustec, B., Corbel, V., Cerqueira, D., & Alexander, N. (2018). Assessing dengue transmission risk and a vector control intervention using entomological and immunological indices in Thailand: Study protocol for a cluster-randomized controlled trial. *Trials*, 19(1). <https://doi.org/10.1186/s13063-018-2490-1>
 19. Paupy, C., Delatte, H., Bagny, L., Corbel, V., & Fontenille, D. (2009). *Aedes albopictus*, an arbovirus vector: From the darkness to the light. *Microbes and Infection*, 11(14–15), 1177–1185. <https://doi.org/10.1016/j.micinf.2009.05.005>
 20. Pujiyanti, A., Andriyani, D., Balai, P., Penelitian, B., Vektor, P., Penyakit, R., Hasanudin, J., 123 Salatiga, N., & Kecamatan, A. (2014). PENGENDALIAN VEKTOR DEMAM

BERDARAH DENGUE PADA KOMUNITAS SEKOLAH DASAR DI KECAMATAN TEMBALANG, KOTA SEMARANG DENGUE VECTOR CONTROL BEHAVIOR IN PRIMARY SCHOOL COMMUNITY IN TEMBALANG DISTRICT, SEMARANG CITY. *Journal Vectora*, 6, 46–51.

21. Quintero, J., Brochero, H., Manrique-Saide, P., Barrera-Pérez, M., Basso, C., Romero, S., Caprara, A., De Lima Cunha, J. C., Beltrán -Ayala, E., Mitchell-Foster, K., Kroeger, A., Sommerfeld, J., & Petzold, M. (2014). *Ecological, biological and social dimensions of dengue vector breeding in five urban settings of Latin America: a multi-country study*. <http://www.biomedcentral.com/1471-2334/14/38>
22. Rahmania, N. A., & Indriyani, R. (2018). Tindakan Pemberantasan Sarang Nyamuk (PSN) dan 3M-Plus sebagai Upaya Pengendalian Vektor dalam Pencegahan Penyakit Demam Berdarah Dengue Action to Eradicate Mosquito Nest and 3M-Plus as Effort of Vector Control in Prevention of Dengue Hemorrhagic Fever (DHF). In *J Agromedicine / (Vol. 5)*.
23. Raude, J., Chinfatt, K. , Huang, P., Betansedi, C., Katumba, K., Vernazza, N., & Bley, D. (2012). Public perceptions and behaviours related to the risk of infection with Aedes mosquito borne-diseases:a cross-sectional study in Southerastern France. *BMJ Open*.
24. Rodrigues, M. D. M., Marques, G. R. A. M., Serpa, L. L. N., Arduino, M. D. B., Voltolini, J. C., Barbosa, G. L., Andrade, V. R., & De Lima, V. L. C. (2015). Density of Aedes aegypti and Aedes albopictus and its association with number of residents and meteorological variables in the home environment of dengue endemic area, São Paulo, Brazil. *Parasites and Vectors*, 8(1). <https://doi.org/10.1186/s13071-015-0703-y>
25. Saphira, N. P., Ngadino, & Sari, E. (2022). EVALUASI PROGRAM PENGENDALIAN VEKTOR DBD DI PUSKESMAS MEDOKAN AYU KOTA SURABAYA TAHUN 2022. *Jurnal Higiene Sanitasi*, 2(2).
26. Satoto, T. B. T., Diptyanusa, A., Setiawan, Y. D., & Alvira, N. (2017). Environmental factors of the home affect the density of Aedes aegypti (Diptera: Culicidae). In *JURNAL KEDOKTERAN YARSI (Vol. 25, Issue 1)*.
27. Sofia, R., & Sahputri, J. (2022). Vector Density Analysis of Dengue Hemorrhagic Fever in Tumpok Teungoh Village, Lhokseumawe City. *Open Access Indonesian Journal of Medical Reviews*, 2(5), 282–286. <https://doi.org/10.37275/oaijmr.v2i5.229>
28. Sumekar, D. W., & Nurmaulina, W. (2016). Upaya Pengendalian Vektor Demam Berdarah Dengue, Aedes aegypti L. Menggunakan Bioinsektisida. *Majority*, 5(2).
29. Widjaja, J. (2011). Keberadaan Kontainer Sebagai Faktor Risiko Penularan Demam Berdarah Dengue di Kota Palu, Sulawesi Tengah. *Aspirator*, 3(2), 82–88.