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Health behavior analysis in prevention of *dengue Hemorrhagic* fever based on the health belief model at the Matali Sub-district community in Kotamobagu city, North Sulawesi Province of Indonesia

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Abstract

Background: A disease of *Dengue Hemorrhagic* Fever (DHF) is caused by *dengue* virus infection, generally occurred in the optimal condition area for its transmission by the *Aedes aegypti* mosquitos with optimal climate and temperature (10°C) around tropical and subtropical areas.

Objective: This study was conducted to describe the knowledge, attitude, and action of community perception factors based on six elements of health belief model (6-HBM) and community behavior factors based on ten activities in eradicating mosquito nests (10-EMN) including both factor correlations to reach good public health status at Matali Sub-district community.

Methods: Observations on community perceptions of the 6-HBM were given five choices of scores to answer the questions facing the issue of *dengue hemorrhagic* fever. Observations on community behavior factors in the10-EMN were involving two choices of scores to answer questions on the activity preventing the *dengue* fever issue. The correlation of both factors was analyzed by the *Chi-square test*.

Results: This study showed that average score above 3.51 can be considered to the public who agreed the perception of *Dengue hemorrhagic* Fever prevention efforts based on the HBM involving only four elements for higher perception to act. Furthermore, the health behavior based on the EMN program was involving higher activities of seven elements including P1, P2, P3, P5, P6, P7, and P8 with high percentages ranging 68 to 98 percents communities. There was also significant correlation between community perception of the HBM and community participation involving the elements of EMN to prevent the *dengue hemorrhagic* fever in Matali Sub-district community.

Conclusion: The implementation of the health belief model combined with the elements of eradicating mosquito nests would be the prominent efforts in prevention of extraordinary events of *dengue hemorrhagic* fever transmitted by the *Aedes aegypti* mosquito around the people community environmental habitat areas.

Keywords: Dengue hemorrhagic fever; Community behavior; Health belief model prevention; Matali Sub-district

1. Introduction

Dengue Haemorrhagic Fever (DHF) is a disease caused by dengue virus infection. DHF generally occurs in areas that have optimal conditions for *dengue* virus transmission (tropical and subtropical areas with optimal climate and temperature (10°C) for the habitat of the *Aedes aegypti* mosquito [1]. DHF is classified as an infectious disease that can be characterized by sudden high fever without a clear cause accompanied by red spots on the skin. The *dengue* virus is transmitted to humans through the bite of the *Aedes aegypti* mosquito that causes DHF [2].

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The cases of *Dengue hemorrhagic* Fever (DHF) in Kotamobagu City of North Sulawesi, Indonesia throughout 2024 have reached 162 cases with one death on the extraordinary events due to dirty condition of community habitat areas [3]. The Gogagoman Community Health Canter recorded the highest number of cases with 78 patients. Meanwhile, Motoboi Kecil Community Health Canter recorded 21 cases, Kotabangon Community Health Canter 44 cases, Bilalang Community Health Canter 9 cases, and Upai Community Health Canter 10 cases [4]. The Matali Sub-district community is included in the health referral group at Motoboi Kecil Community Health Center in terms of community health care including Health Insurance Administration Agency (HIAA) membership certificates.

The main symptoms of *Dengue hemorrhagic* fever include high fever and nosebleeds. However, a diagnosis of this fever must be based on laboratory results. Therefore, the symptoms of *Dengue Haemorrhagic* fever and nosebleeds require laboratory results before a diagnosis is confirmed. The recovery rate for *Dengue Haemorrhagic* fever patients is much higher than the death rate, and children are the most vulnerable group to the disease [4]. The emergence of *Dengue hemorrhagic* fever can be explained through the concept of the epidemiological triangle, including the presence of an agent, host and environment [5].

Like other mosquito species, the *Aedes aegypti* mosquito undergoes complete metamorphosis: egg – larva – pupa – mosquito. The egg stage hatches into a larva within approximately 2 days after being submerged in water. The pupal stage lasts between 2 and 4 days. The development from egg to adult mosquito takes approximately 9 to 10 days. Furthermore, the lifespan of a female *Aedes aegypti* mosquito can reach 2-3 months [6]. The mosquito life cycle consists of eggs, larvae, pupae, and adult mosquitoes, as shown in Figure 1 [7]. The eggs are black, approximately 0.80 mm in size, and oval in shape, floating singly on the surface of clear water or attached to the walls of water containers. Eggs can survive for approximately 6 months in dry places [5].

The *dengue* virus is transmitted from person to person through the bite of the *Aedes aegypti* mosquito. *Aedes aegypti* is the primary vector, but other species, such as *Aedes albopictus, Aedes polynesiensis, Aedes scutelaris*, and *Aedes niveus*, are also considered secondary vectors. Except for *Aedes aegypti*, all have their own limited geographic distribution. Although they are excellent hosts for the *dengue* virus, they are generally less efficient vectors than *Aedes aegypti*. A causative agent of *dengue* fever is the *dengue* virus from the genus *Flavivirus* (Group B arbovirus), a member of the *Togaviridae* family. Humans are susceptible to *dengue* virus infection. Several factors influence the human population, including age, gender, nutrition, population size, mobility, and the environment. Environmental factors influencing the onset of *dengue* include geographic location and season [8].

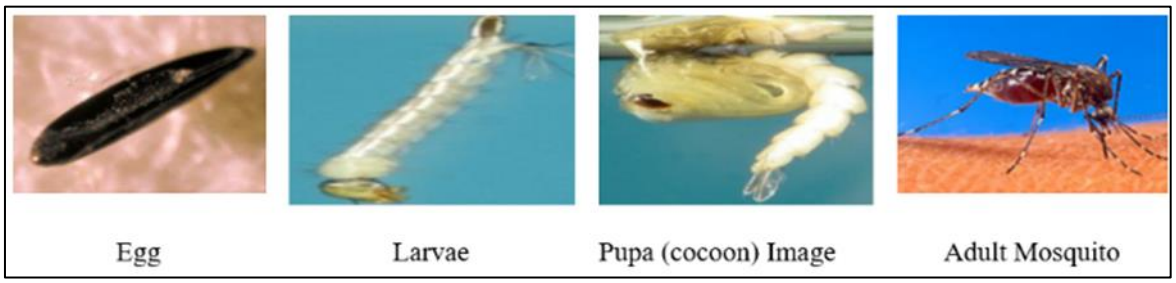


Figure 1 The stages in the mosquito life cycle consist of eggs, larvae, pupae, and adult mosquitoes

Community behavior on Indonesian government program was evaluated through the programs of ten activities eradicating mosquito nests (10-EMN) consisting of Draining (1), Covering (2), Burying Stagnant Water (3), changing the water in flower vases, once a week (4), repairing drains and gutters (5), covering holes in bamboo pieces and other pipes (6), sprinkling larvae-killing poison (*larvicidation*) (7), spreading larvae-eating fish such as tin-heads (8), sleep under mosquito nets and other protective equipment of install wire mesh on air vents/vents in the house (9), and using mosquito repellent (10) [5]. The public perception through the *health belief model* (HBM) maintaining environmental cleanliness must be carried out continuously to reduce the spread of *dengue* fever [9]. In addition, the *health belief model* (HBM) the *health belief model* (HBM) was based on six perceptions (6-HBM) including perceived susceptibility (1), perceived severity (2), perceived benefits (3), perceived barriers (4), self-efficacy (5), and cues to action (6) [10].

Based on the description above, the research on "the analysis of health behavior in the prevention of *Dengue Haemorrhagic* fever based on the *Health Belief Model* (6-HBM) theory in the Matali sub-district Community, Kotamobagu City", is still very necessary to be carried out as a contribution to scientific studies in the prevention of *Dengue Haemorrhagic* Fever (DHF) in the territorial habitat of the community, especially the Matali sub-district, Kotamobagu City of Indonesia, which remains healthy and prime to live life and increase the average life expectancy of humans in

North Sulawesi above 72 years. The objective of this study was to describe the knowledge, attitude, and action of public health perception factors based on the six elements of *health belief model* (6-HBM) and public health behavior factors based on ten activities in eradicating mosquito nests (10-EMN) by looking the correlation between these both perception and behavior factors in local community supporting public health and preventing DHF to maintain a very good health status at Matali Sub-district in Kotamobagu city, North Sulawesi of Indonesia.

2. Methodology

2.1. Research Location

This descriptive qualitative public health research method attempts to describe or depict in detail or in depth the public health behavior [11] to determine the Public Health Status (very good, good and less good) regarding the spread of *dengue hemorrhagic* fever (DHF) at Matali Sub-district, East Kotamobagu District in Kotamobagu City, North Sulawesi province of Indonesia (Figure 2). Public Health Research on the Community population in developing Health behavior was taken from a sample of the community in Matali sub-district, East Kotamobagu District, Kotamobagu City and focused on two factors for the development and prevention of DHF, namely (a) Behavioral factors enabling support (enabling Factor) in the eradication of *dengue* fever (10-PSN) and (b) Perception factors as determinants (deciding factor) in the form of Knowledge, Attitudes, and Health Actions based on the Health Belief Model (6-HBM).

2.2. Research Method

Observations on public health perceptions based on six perceptions of the Health Belief Model (6-HBM) were given five choices of scores to answer questions on each public perception in facing the issue of *dengue* fever with a description of strongly disagree (score 1), disagree (score 2), doubtful (score 3), agree (score 4) and strongly agree (score 5). Observations on public health behavior factors based on ten activities in program of eradicating mosquito nests (10-EMN) were only two choices of scores to answer questions on each activity in preventing the issue of *dengue* fever with a description of the answers of Yes (score 1) and No (score 0). The results of all answer scores collected on the respondent sample were tabulated for further analysis of data and narratives of public health conditions in the Matali sub-district area, divided in six neighborhoods (Neighborhood-I, Neighborhood-II, Neighborhood-III, Neighborhood-IV, Neighborhood-V, and Neighborhood-VI).

2.3. Research Population and Sample

The sample size in this study was determined using the Slovin formula [12] as follows:

$$n = \frac{N}{1+(N\ x\ e^2)}$$

Where: n = number of sample elements/members, N = number of population elements/members (population of Matali Sub-district), e = error level (note: commonly used values are 1% or 0.01, 5% or 0.05, and 10% or 0.1). With a population of around 3,887 people at Matali Sub-district [13], the sample size to be included in the study as respondents is 10% or 0.1. Thus, the sample size is:

$$n = \frac{3{,}887}{1+(3{,}887\ x\ e^2)} = \frac{3{,}887}{1+(3{,}887\ x\ 0.1^2)} = \frac{3{,}887}{1+(38.87)} = \frac{3{,}887}{39.87} = 97.49$$

n = 97.49 rounded up to 98 people.

The placements of the neighborhood (*Rukun Wilayah, RW*) were carried out in the regional area of Matali Sub-district by involving enabling factors and deciding factors [14]. The method used in the observation is the purposive sampling method by determining the Matali Sub-district (the most densely populated) as a sample in the East Kotamobagu District. Field data collection was carried out using public health behavior analysis techniques in the Matali Sub-district in the prevention of *dengue* fever based on 10-PSN and 6-HBM. The plot design uses the RW plot as a plot on a total combination of 6 RW which form a larger area [14, 15] in the Matali Sub-district (Figure 2).

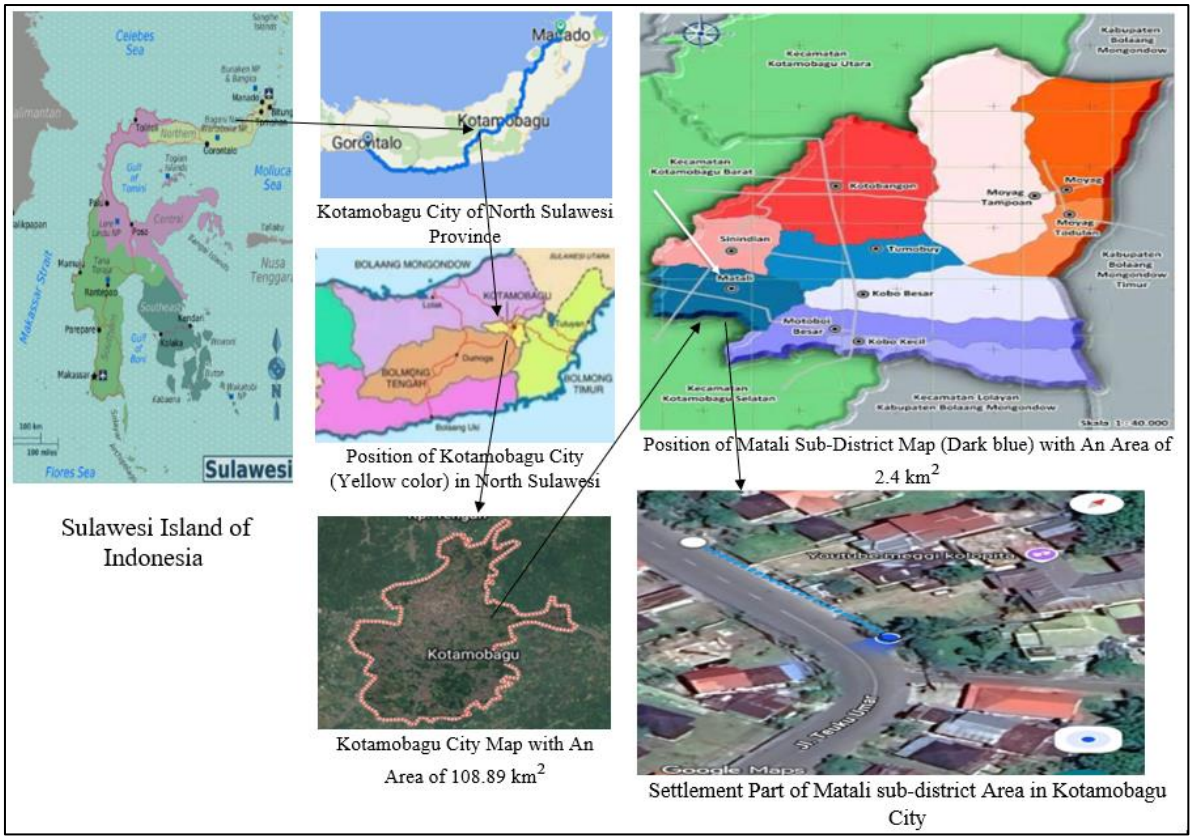


Figure 2 Map of Kotamobagu City, North Sulawesi Province of Indonesia

2.4. Statistical Analysis

Balanced factors indicate a close relationship (having a strong relationship) between the elements in the activities (**10-EMN**) to complement each other along with the elements of Knowledge, Attitude, and Action which are combined in the health belief model or *Health Belief Model* (**6-HBM**) to change behavior to prevent, treat or eradicate the spread of *Dengue Haemorrhagic* Fever (DHF) in an area inhabited by many people so that the community remains in a healthy and prime physical condition.

The analysis technique for testing the balance of each element of the health behavior factor and the health perception factor, the results of observations (actual) compared with the expected results, can be calculated using the *Chi-square test* analysis [16], with the formula:

$$\text{Chi square } (X^2) \text{ value} = X^2_{Calculated} = \sum \frac{f_o^2}{f_e} - \text{N};$$

Where, $\text{N} = \sum f_{o.ij}$

$\mathcal{X}^2$ = *Chi-square* distribution value,

f_o = frequency of observation results (O) from the fist cell-$_{ijk}$, and

f_e = frequency of expectation (E) on fist cell-$_{ijk}$

$$f_e = \frac{(\sum f_{o.i}) \times (\sum f_{o.j})}{\sum f_{o.ij}}$$

$\sum f_{o.i}$ = total frequency of observation results from the *i-th* row;

$\sum f_{o.j}$ = total frequency of observation results from the *j-th* column.

The O_{ij} value was the frequency value of the number of individuals/people as a result of field observations in the research area conducted regarding their relevant activities in the category of health elements based on 10-EMN and 6-HBM at Matali Village, Kotamobagu.

The E_{ij} value was an Expected value (f_e) obtained through the formula:

$$\text{The } E_{ij} \text{ value} = f_e = \frac{(\Sigma f_{o.i}) \times (\Sigma f_{o.j})}{\Sigma f_{o.ij}}$$

In this study, data can also be analyzed using software from the statistical program function (*fx*) (**CHISQ.DIST**) in Microsoft Excel. Degrees of Freedom (DF) = (Row - 1) x (Column - 1). The probability values of Chi-Square test (X^2 test) table 0.05 {DF} and Chi-Square (X^2 test) table 0.01 {DF} can be obtained directly from the results of the Chi-Square test (X^2 test) analysis [16].

3. Results

3.1. Public Perception of the Health Belief Model

The Health Belief Model (**HBM**) has been adapted to suit diverse medical and cultural contexts in communities to influence public health through community-based health promotion and prevention programs. The HBM has six elements representing community perceptions of Vulnerability, Severity, Benefits, Barriers, Self-Efficacy, and Cues to Action.

The scores of 5 scales including score 5 (Strongly agree), score 4 (Agree), score 3 (Undecided), score 2 (Disagree) and score 1 (Strongly disagree), were implemented in the community of Matali sub-district by involving sample of 98 respondents in Matali sub-district, East Kotamobagu District of Kotamobagu City. The results of a survey involving sample of 98 respondents in Matali sub-district showed an average score varying between 2.40 and 3.93 for the six elements in the HBM theory (Table 1).

It can be seen that the Barriers and Self-Efficacy perception elements show an average score of 2.4 and 3.0 for each of these elements, except in Neighborhood IV for the barriers and self-efficacy elements with a score of 3.21 and 3.73, and in Neighborhood IV specifically for the perception of self-efficacy with a score of 3.44. This indicates that the barriers and self-efficacy elements are still not widely agreed upon, and there are still doubts among the public in responding to *Dengue* fever prevention efforts. An average score above 3.50 can be considered that the public has an agreed perception of *Dengue* Fever prevention efforts based on the health belief model (HBM) theory with six elements as the basis for perception to act.

Table 1 Average Community Perception Score in each neighborhood group in Matali Sub-district, East Kotamobagu District, regarding health beliefs based on the Health Belief Model (HBM)

Neighborhood group	Vulnerability	Severity	Benefits	Barriers	Self-Efficacy	Cues to Action
I	3.80(n = 16)	4.05(n = 16)	4.17(n = 16)	2.49(n = 16)	3.12 (n = 16)	3,97 (. = 16)
II	3.84(n = 16)	3.98(n = 16)	3.67(n = 16)	2.40(n = 16)	2.52 (n = 16)	3.23 (n = 16)
III	3.82(n = 17)	4.02(n = 17)	3.87(n = 17)	2.61(n = 17)	2.88(n = 17)	3.56 (n = 17)
IV	4.15(n = 16)	4.29(n = 16)	4.40(n = 16)	3.21(n = 16)	3.73(n = 16)	4.22 (n = 16)
V	3.12(n = 17)	3.54(n = 17)	4.00(n = 17)	2.31(n = 17)	3.00(n = 17)	3.50 (n = 17)
VI	3.96(n = 16)	4.88(n = 16)	4.43(n = 16)	1.88(n = 16)	3.44(n = 16)	4.00 (n = 16)
Average in Matali Sub-district	3.61(n = 98)	3.87(n = 98)	3.93 (n = 98)	2.40(n = 98)	3.00(n = 98)	3.60(n = 98)

Description: Public perception scores for HBM: Score 5 (Strongly agree), Score 4 (Agree), Score 3 (Undecided), Score 2 (Disagree), and Score 1 (Strongly disagree), all involving 98 respondents.

3.2. Community Participation in *Dengue* Fever Prevention

The *Dengue Hemorrhagic* Fever (DHF) prevention method, including the program involving ten activities of eradicating mosquito nests (10-EMN) has been implemented by the community in the process of preventing DHF cases [18], which includes: Draining water reservoirs at least once a week (EMN-1), Tightly covering water reservoirs (EMN-2), Burying, collecting, utilizing, or disposing of used items that can collect rainwater, such as used cans, used plastic, and others (EMN-3), Change the water in flower vases, bird feeders, and other areas once a week (EMN-4), Repair clogged or damaged drains and gutters (EMN-5), Cover holes in bamboo, tree trunks, and other areas with soil (EMN-6), Sprinkle larva-killing poison (larvicidation), especially in water reservoirs that are difficult to drain or in areas with water shortages (EMN-7), Spread larva-eating fish, such as scads, in water reservoirs around the house (EMN-8), Sleep under mosquito nets/install wire mesh over air vents in the house (EMN-9), and Use mosquito repellent (EMN-10). Observations on public health behavior based on the ten activities (10-EMN) were conducted in the Matali Sub-district community, East Kotamobagu District of Kotamobagu City with the help of questionnaires to 98 sample respondents in six Neighborhoods, including Neighborhood 1 (16 respondents), Neighborhood 2 (16 respondents), Neighborhood 3 (17 respondents), Neighborhood 4 (16 respondents), Neighborhood 5 (17 respondents), and Neighborhood 6 (16 respondents). The percentage figures for community participation in each element of 10-EMN (as a government program) in each neighborhood (I, II, III, IV, V, VI) and overall, in Matali Sub-district are presented in Table 2.

Table 2 Number of Communities Carrying Out Dengue Fever Prevention in each neighborhood in Matali Subdistrict, East Kotamobagu District, Kotamobagu City

10-EMN	**Neighborhood**						**Total Kel. Matali**
	I	**II**	**III**	**IV**	**V**	**VI**	
P1	15 (n=16) [93,75]	12 (n=16) [75,00]	12 (n=17) [70,59]	11 (n=16) [68,75]	12 (n=17) [70,59]	15 (n=16) [93,75]	77 n=98 [78.57]
P2	13 (n=16) [81,25]	11 (n=16) [68,75]	13 (n=17) [76,47]	11 (n=16) [68,75]	10 (n=17) [58,82]	14 (n=16) [87,50]	72 n=98 [73.47]
P3	14 (n=16) [87,50]	10 (n=16) [62,50]	13 (n=17) [76,47]	12 (n=16) [75,00]	16 (n=17) [94,12]	14 (n=16) [87,50]	79 n=98 [80.61]
P4	4 (n=16) [25,00]	8 (n=16) [50,00]	5 (n=17) [29,41]	5 (n=16) [25,00]	2 (n=17) [11,76]	3 (n=16) [18,75]	26 n=98 [26.53]
P5	6 (n=16) [37,50]	10 (n=16) [62,50]	10 (n=17) [58,82]	15 (n=16) [93,75]	14 (n=17) [82,35[	12 (n=16) [75,00]	67 n=98 [68.37]
P6	14 (n=16) [87,50]	12 (n=16) [75,00]	11 (n=17) [64,71]	12 (n=16) [75,00]	11 (n=17) [64,71]	11 (n=16) [68,75]	71 n=98 [72.45]
P7	12 (n=16) [75,00]	12 (n=16) [75,00]	14 (n=17) [82,35]	10 (n=16) [62,50]	15 (n=17) [88,23]	10 (n=16) [62,50]	73 n=98 [74.49]
P8	6 (n=16) [37,50]	11 (n=16) [68,75]	12 (n=17) [70,59]	3 (n=16) [18,75]	7 (n=17) [41,18]	3 (n=16) [18,75]	42 n=98 [42.86]
P9	16 (n=16)	16 (n=16)	17 (n=17)	16 (n=16)	15 (n=17)	16 (n=16)	96 n=98

	[100,0]	[100,0]	[100,0]	[100,0]	[88,23]	[100,0]	[97.96]
P10	8 (n=16) [50,00]	7 (n=16) [43,75]	10 (n=17) [58,82]	8 (n=16) [50,00]	8 (n=17) [47,08]	8 (n=16) [50,00]	49 n=98 [50,00]
Note: P1 = Draining stagnant water, P2 = Covering water reservoirs, P3 = Burying used water objects, P4 = Changing the water in flower vases (1x per week), P5 = Repairing water channels & gutters, P6 = Closing holes in bamboo pieces and other pipes, P7 = Sprinkle larva-killing poison (larvicidation), P8 = Spreading larva-eating fish such as tin-heads, P9 = Sleeping using mosquito nets and other tools (Installing wire mesh on ventilation at home), P10 = Using mosquito repellent. The numbers in large brackets (bold) are the percentage values of the actual data against n (number of respondents).							

The results of observations on the number of people who carry out *Dengue* Fever prevention in each neighborhood group in Matali Sub-district, can be seen in Table 2. The number of community respondent samples at the neighborhood group level varies between 16 respondents to 17 respondents per neighborhood group. Thus, to obtain real community participation figures in each neighborhood group with different numbers of respondents, community involvement in each element of eradicating mosquito nests (EMN) is converted into relative figures as a percentage of the community who apply the elements of this EMN.

The observations were assisted by distributing questions in the questionnaire related to public health behavior [19, 20] based on the 10-EMN. The answers of respondents who implemented the elements based on 10-EMN were given the number of 1 and the answers of respondents who did not implement the elements based on 10-EMN were given the number of 0. Thus, these numbers can facilitate the data tabulation process, where the community who implemented the elements based on 10-EMN will get the total results, both at the neighborhood level and the entire community in the Matali Sub-district.

3.3. The relationship between public health behavior based on the health belief model (6-HBM) and the program of ten activities based on 10-EMN

To analyze the relationship between public health based on the health belief model (6-HBM) and program of the ten activities based on eradicating mosquito nests (10-EMN), the observations have been conducted at the community level of Matali Sub-district using five score categories relating with the HBM theory, including score of 5 (Strongly agree), 4 (Agree), 3 (Undecided), 2 (Disagree) and 1 (Strongly disagree) which are applied to each element of the 6-HBM [21].

The elements in the HBM observed using these scores are HBM-1 (Perceived Vulnerability), HBM-2 (Perceived Severity), HBM-3 (Perceived Benefits), HBM-4 (Perceived Barriers), HBM-5 (Self-Efficacy), and HBM-6 (Cues to Action), involving a sample of 98 respondents affording to Prevent *Dengue* Fever at Matali Sub-district, East Kotamobagu District of Kotamobagu City. Simultaneously, observations were also made on community participation in the implementation of the *Dengue* Fever prevention program through the 10-EMN elements as a government program through the health promotion sector in central government agencies at the Indonesian Ministry of Health to the Health Service at the regional level.

The data obtained from the elements of the HBM-based factors and the elements of the EMN-based factors are data in the form of categorical data, so that the most relevant analysis model is a form of non-parametric data analysis, through the Chi-Square test analysis [16, 22], to find out the relationship between the two factors of the 6-HBM theory and the factors of the 10-EMN program. In addition to the observation data in the form of categorical data, the reason for the Chi-Square test analysis is that the elements in each factor of HBM and factor of EMN have a different number of elements [16, 23], consisted of six elements in the HBM factor and ten elements in the EMN factor. By combining the values of the two factors in the matrix, it can be analyzed using the Chi-square test as shown in Table 3.

Table 3 Matrix of the relationship between community perceptions based on the health belief model (HBM) and the average percentage of the number of communities actively preventing *dengue* fever by eradicating mosquito nests (EMN) in Matali Sub-district, East Kotamobagu District of Kotamobagu City

10- EMN	**HBM-1**	**HBM-2**	**HBM-3**	**HBM-4**	**HBM-5**	**HBM-6**	**Total**
EMN-1	59.242	63.485	64.113	38.971	48.870	58.770	333.451
EXPECTED	58.828	63.041	63.040	41.654	48.529	58.360	
EMN-2	55.396	59.364	59.951	36.441	45.698	54.956	311.807
EXPECTED	55.009	58.949	58.948	38.950	45.379	54.571	
EMN-3	60.778	65.133	65.778	39.983	50.139	60.296	342.109
EXPECTED	60.355	64.678	64.677	42.735	49.789	59.875	
EMN-4	20.004	21.436	18.040	13.159	16.502	19.844	108.985
EXPECTED	19.227	20.604	20.604	13.614	15.861	19.074	
EMN-5	51.551	55.243	55.790	33.911	42.526	51.141	290.162
EXPECTED	51.191	54.857	54.856	36.246	42.229	50.783	
EMN-6	54.627	58.540	59.119	35.935	45.064	54.193	307.478
EXPECTED	54.246	58.130	58.130	38.409	44.749	53.814	
EMN-7	56.165	60.188	60.188	36.947	46.333	55.718	315.540
EXPECTED	55.668	59.655	59.654	39.416	45.922	55.225	
EMN-8	32.316	34.631	34.631	21.258	26.659	32.059	181.555
EXPECTED	32.030	34.324	34.323	22.679	26.423	31.775	
EMN-9	73.862	79.152	79.152	48.588	60.931	73.274	414.959
EXPECTED	73.207	78.450	78.449	51.835	60.391	72.625	
EMN-10	37.700	40.400	40.800	50.000	31.100	37.400	237.400
EXPECTED	41.882	44.882	44.881	29.655	34.550	41.549	
Total Actual Data	501.644	537.570	537.562	355.194	413.823	497.652	2843.445
Chi Square (X^2) Total Column (Expected)	502.119	538.080	538.353	370.435	414.215	498.124	2861.327
Difference between Actual Data and Chi Square (X^2)							17.882
Degree of Freedom (DF) = (6-1) * (10-1) = **45** Chi-Square-value {DF,45}, [fx Excel] **CHISQ.DIST**, **p = 0.0000999; (p < 0,01)**							

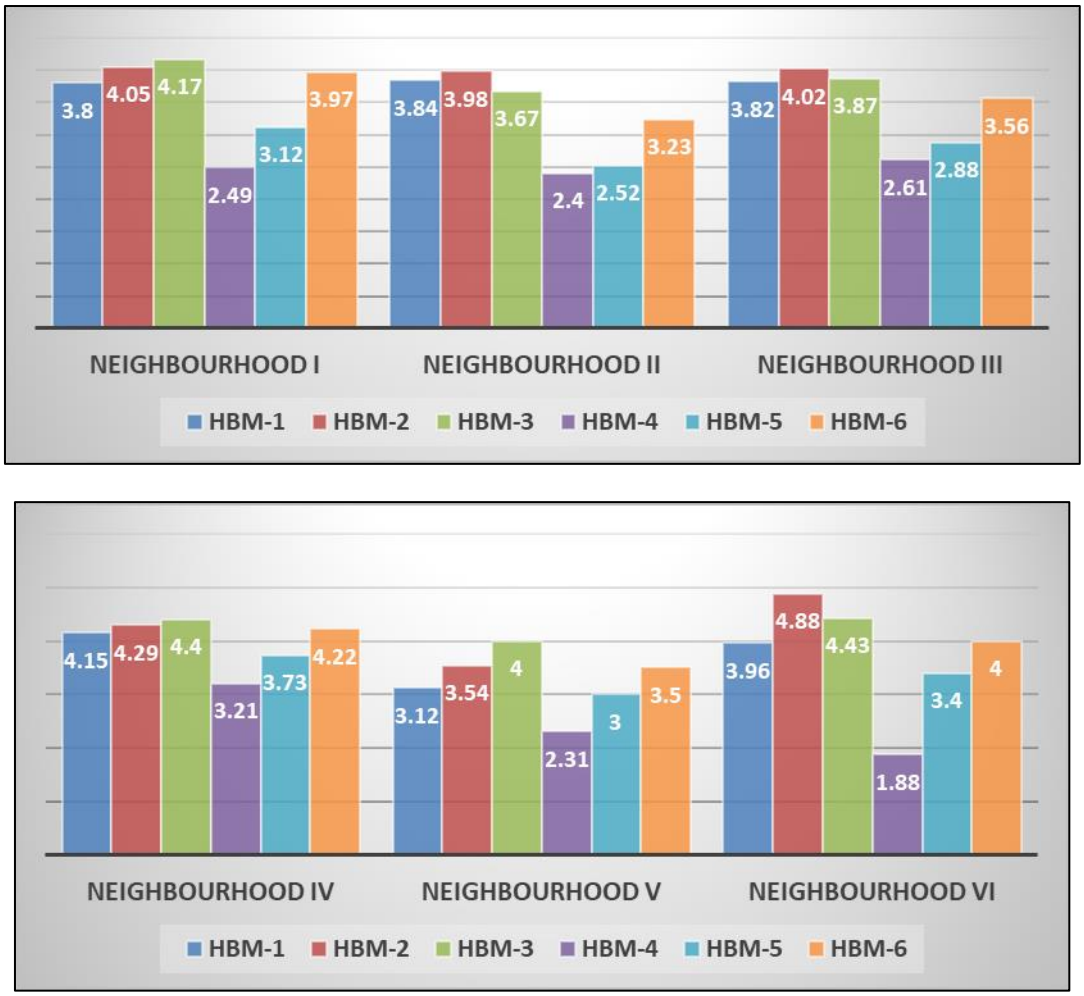
The numbers from the 6-HBM factor values remain categorical scores (1, 2, 3, 4, 5), while the numbers from the 10-EMN factor values are in categorical scores (1 = answer yes and 0 = answer no), then the sum of respondents who have a categorical score of 1 to the number of respondent samples of the *n-th* is changed into a numeric number in the form of a percentage or ratio of the number of respondents having a score of number 1 to the number of respondent samples of the *n-th*, as numeric data. Thus, the relationship between the two factors of 6-HBM theory and the 10-EMN program is a relationship between two factors that have categorical score data, where the relationship between the two factors with categorical score data (1, 2, 3, 4, 5) for the 6-HBM theory and numeric data (percentage) for the 10-EMN program can be analyzed in a matrix with the Chi-square test [16, 24] with the results as shown in Table 3.

4. Discussion

For the community of the six (6) neighborhood groups in Matali Sub-district, only the community in Neighborhood II still has an average score of 3.23 with the impression that they are still full of doubts about the perception of acting on efforts to prevent *Dengue* Fever. Meanwhile, five Neighborhoods (I, III, IV, V, VI) have had an average score of 3.50 to

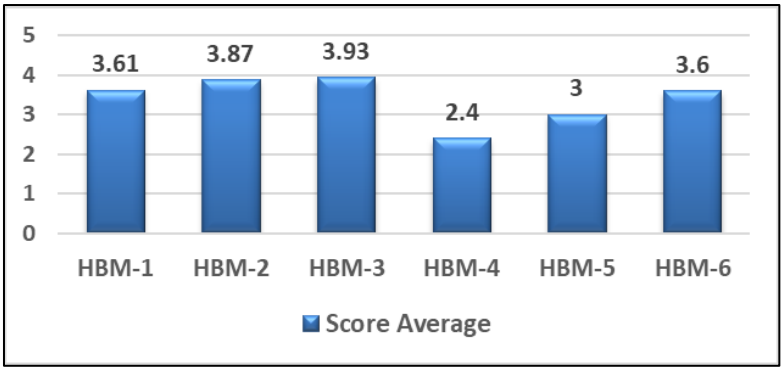
4.22 with the impression of agreeing to strongly agreeing on the perception of acting on efforts to prevent Dengue Fever. The average score of the six elements of perception based on the HBM theory has had an even trend in the six neighborhoods in Matali Village as seen in Figure 3. Perception of Barriers occupies the lowest score evenly across all neighborhood I to neighborhood VI with scores ranging from 1.88 – 3.21 which range from perceptions of disagreement to perceptions of full doubt (Figure 3).

With the distribution of community perception scores that are almost even in the six-neighborhood group above, two elements of the Barriers and Self-Efficacy elements, need to receive special attention in the implementation of HBM theory-based activities in efforts to prevent *Dengue* Fever. Overall, neighborhood group I to neighborhood group VI in Matali Sub-district, the Barriers and Self-Efficacy elements show an average score of 2.4 and 3.0, respectively for each element as seen in Figure 4. Community perception for Self-Efficacy (HBM-5) shows a score in the category of community hesitation in taking the initiative to prevent the possibility of DHF cases.



Note: HBM-1 (Perceived Vulnerability), HBM-2 (Perceived Severity), HBM-3 (Perceived Benefits), HBM-4 (Perceived Barriers), HBM-5 (Self-Efficacy), HBM-6 (Cues to Action). Community perception scores on the HBM: Score 5 (Strongly Agree), Score 4 (Agree), Score 3 (Undecided), Score 2 (Disagree), Score 1 (Strongly Disagree). Neighbourhoods I, II, IV, and VI each had 16 respondents, and Neighbourhoods III and V each had 17 respondents.

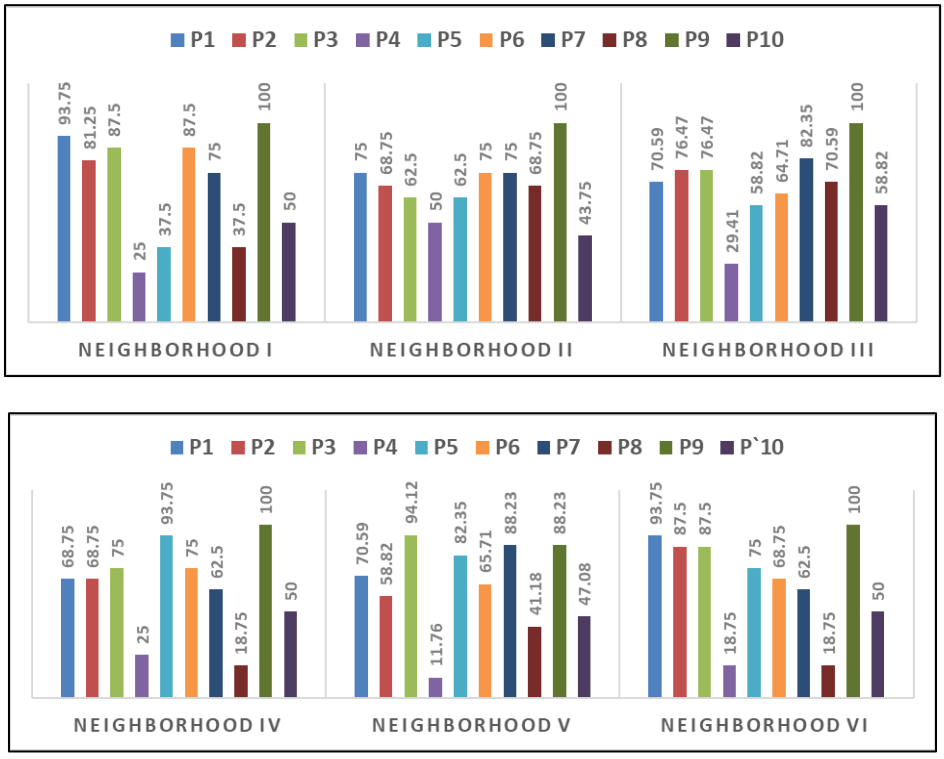
Figure 3 Bar chart showing the average community perception score of health beliefs based on the Health Belief Model (HBM) theory regarding *dengue* prevention efforts in each neighborhood in Matali Sub-district, East Kotamobagu District, Kotamobagu City



Description: HBM-1 (Perceived Vulnerability), HBM-2 (Perceived Severity), HBM-3 (Perceived Benefits), HBM-4 (Perceived Barriers), HBM-5 (Self-Efficacy), HBM-6 (Cues to Action). Public perception scores for the HBM: 5 (Strongly agree), 4 (Agree), 3 (Undecided), 2 (Disagree), 1 (Strongly disagree), involving 98 respondents.

Figure 4 Bar chart showing the average score of public perception of health beliefs based on the Health Belief Model (HBM) theory in Matali Sub-district, East Kotamobagu District, Kotamobagu City

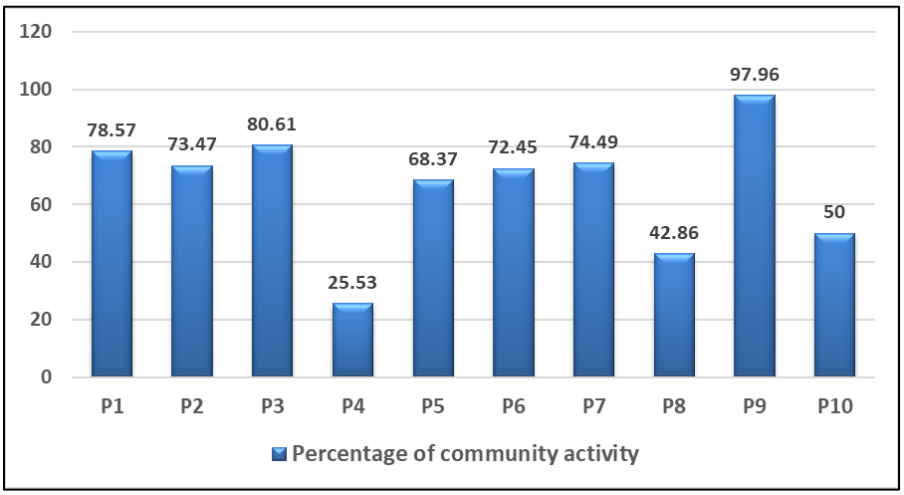
The percentage of the number of people in each neighborhood group in Matali Sub-district showed that activities of the P4 (changing the water in flower vases, 1x per week), P8 (spreading larvae-eating fish such as tin-heads small fish) and P10 (using mosquito repellent) have an average percentage of ranging between 26.53 - 50 percent, a figure below 50 percent (Figure 5). Activities carried out with the highest community involvement of over 60 percent were P9 (97.96%), namely sleeping using mosquito nets and other tools such as installing wire mesh on ventilation in the house, P3 (80.61%), namely burying used water objects, P1 (78.57%) namely draining stagnant water, P7 (74.49%), namely sprinkling poison to kill larvae (larvicidation), P2 (73.47%), namely closing water reservoirs, P6 (72.45%), namely closing holes in pieces of bamboo and other pipes, and P5 (68.37%), namely repairing water channels and gutters to avoid stagnant water (Figure 6).



Note: P1 = Draining standing water, P2 = Covering water reservoirs, P3 = Burying used water objects, P4 = Changing the water in flower vases (once a week), P5 = Repairing drains and gutters, P6 = Covering holes in bamboo pieces and other pipes, P7 = Spreading larva-killing poison (larvicidation), P8 = Spreading larva-eating fish such as tin-heads fish, P9 = Sleeping under mosquito nets and other means (installing wire mesh on ventilation in the house), P10 = Using mosquito repellent. Neighborhood group of I, II, IV and VI had 16 respondents, and Neighborhoods group of III and V had 17 respondents.

Figure 5 Bar Chart of Residents Percentage Doing *Dengue* Fever Prevention at Each Neighborhood in Matali Sub-district, East Kotamobagu District of Kotamobagu City

With the achievement of *Dengue* fever prevention efforts by the community in Matali Sub-district, which implements the seven elements of the EMN government program above 60 percent (Figure 6) evenly across the six existing neighborhoods, it can be estimated that Matali Sub-district will be able to prevent the emergence of extraordinary events of *Dengue* fever which will always be avoided through community health promotion by the government program through the Health Service and other government agencies or other related non-governmental organizations, starting from the neighborhood groups, at village and sub-district, district and city to provincial levels.



Note: P1 = Draining stagnant water, P2 = Covering water reservoirs, P3 = Burying used water objects, P4 = Changing the water in flower vases (once a week), P5 = Repairing drains and gutters, P6 = Covering holes in bamboo pieces and other pipes, P7 = Sprinkle larva-killing poison (larvicidation), P8 = Spreading larva-eating fish such as tin-heads small fish, P9 = Sleeping under mosquito nets and other devices (Installing wire mesh on ventilation at home), P10 = Using mosquito repellent.

Figure 6 Bar Chart of the Percentage Average of the Number of Communities Actively Doing *Dengue* Fever Prevention in Matali Sub-district, East Kotamobagu District of Kotamobagu City

As the maximum achievement for numerical data in percentage program of eradicating mosquito nests (EMN) is the number 100 percent (if those all respondents are involved in the program elements), while as the maximum achievement for categorical score data of the health belief model (HBM) is the score 5 (if those all respondents Strongly agreed). Thus, the interaction as combination of the numerical percentage and the categorical values of the two factors is the average number of the multiplication of the numerical percentage value with the categorical score value in the two factors (Byrkit, 1987).

The relationship between the two factors from the 6-HBM theory and the factors from the 10-EMN program which have a strong relationship ($P<0.01$) based on the Chi-square analysis (Table 3) can give meaning that the score value of the numbers chosen by the community according to the conditions in their neighborhood groups with an average score of 3 (doubtful or undecided perception) from the HBM theory factor is still in line with not being able to support the percentage of community involvement in implementing the elements of the 10-EMN program which have a low percentage of the three elements of P4 (Change the water in the flower vase with 1x per week), P8 (Spreading larvae-eating fish such as tin-heads small fish) and P10 (Using mosquito repellent.) as seen in Figure 7.

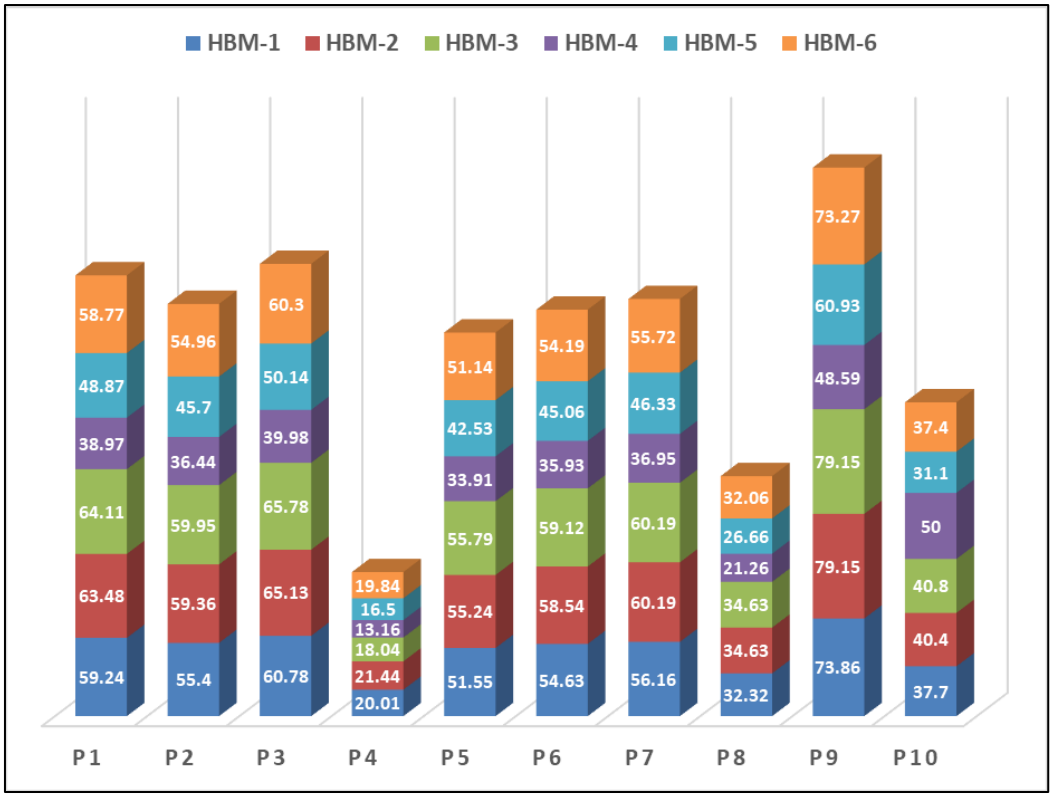


Figure 7 Bar-Chart of the Relationship between Community Perception Based on the Health Belief Model (HBM) Theory and the Average Percentage of the Number of Community Actively Carrying Out *Dengue* Fever Prevention in Matali Sub-district, East Kotamobagu District of Kotamobagu City

Based on the Chi-Square analysis, it showed that the actual data and expectations on the 10-EMN program activities and the 6-HBM theory by the community in Matali Sub-district get the value (p value = 0.000099) greater than the Chi-Square value (p *alpha* α = 0.01) with a degree of freedom {DF-45}, which indicated the significant relationship ($p < 0.01$) [25]. This result can give meaning that health behavior of community based on the 10-EMN program can be very significantly correlated ($p<01$) with the community perception of health based on the health belief model (HBM) theory of those communities in Matali Sub-district, East Kotamobagu District of Kotamobagu City in preventing cases of *Dengue* fever [26, 27]. Health behavior in preventing *Dengue* fever can be carried out based on community perceptions in health program behavior based on the strong combination between the health belief model (HBM) involving six elements (Figure 2) and the 10-EMN involving ten elements of eradicating mosquito nests to deal with cases of dengue fever which can be extraordinary events, namely they can appear/occur suddenly depending on dirty environmental conditions.

5. Conclusion

Health behavior of *dengue hemorrhagic* fever prevention was supported by the health belief model, mainly four elements of perceived vulnerability, perceived severity, perceived benefits, and perceived cues to action with the average impression score of over 3.6 referring to agree by community in Matali Sub-district area. In addition, this health behavior was completed by the community involving activities, mainly seven elements of P1, P2, P3, P5, P6, P7, and P8 with the percentages ranging from 68 to 98 percents communities of all six neighborhood groups in Matali Sub-district area. There was significant correlation between community perception based on the health belief model theory and community participation based on the government program involving ten elements of eradicating mosquito nests preventing the *dengue hemorrhagic* fever around the neighborhood group community in Matali Sub-district, East Kotamobagu District of Kotamobagu city. Therefore, the implementation of the health belief model combined with the main seven elements of eradicating mosquito nests would be the prominent efforts in prevention of extraordinary events of the *dengue hemorrhagic* fever transmitted by the *Aedes aegypti* mosquito around the people community environmental habitat areas.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors report no financial, personal, or institutional relationships that could be perceived as influencing the work described in this manuscript.

Statement of ethical approval

All in vivo procedures were approved by the Research Ethics Committee of the Health Ministry, Republic of Indonesia, through Kandou Centre Hospital, Manado (Approval No.: 383/EC/KEPK-KANDOU/XII/2025) and performed in line with National Institutes of Health recommendations for laboratory animal care and use.

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