ORIGINAL RESEARCH ARTICLE

Analysis of the Influence of Environmental Health Interventions Based on The Health Belief Model (HBM) on the Risk Factors of Dengue Hemorrhagic Fever (DHF) Benteng Village, Indonesia

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DOI: 10.55489/njcm.140920233220

ABSTRACT

Background: Palopo city is one of the endemic areas of DHF, which during the last 5 years DHF morbidity rate has fluctuated. One solution could be environmental health interventions, which aim to enhance disease prevention behavior through positive views based on powerful health messaging. Assessment of entomological indices (Container Index, Breteau Index, and House Index) which is one of risk factors for DHF incidents to see level of density of Aedes sp. larvae can help determine focus of vector control. This study wants to see whether there is an effect of environmental health interventions based on Health Belief Model (HBM) theory on risk factors for DHF.

Methods: This research is an experimental study with a Quasy experimental design using One Group Pre-Post test design. The sampling technique is total sampling so that entire population is a sample of 71 houses. Data were analyzed using Mc Nemar test.

Results: Result indicated that perceived susceptibility (p value = 0.021), perceived severity (p value = 0.000), perceived benefits (p value = 0.001), perceived barriers (p value = 0.000) and behavior to prevent contact vector (p value = 0.015) were all influenced by environmental health intervention, the entomological index Container Index (CI) was in the low group of moderate, whereas Breteau Index (BI) and House Index (HI) were in the high category of moderate. This indicates that HBM-based environmental health interventions can lower the density of larvae.

Conclusion: Environmental health interventions based on HBM can be recommended as an effort to reduce the risk factors for DHF.

Keywords: Behaviour, Entomological Index, Density larvae

ARTICLE INFO

Financial Support: None declared

Conflict of Interest: None declared

Received: 12-07-2023, **Accepted**: 10-08-2023, **Published**: 01-09-2023

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How to cite this article: Alwi Paluseri AM, Ishak H, Manyullei S. Analysis of the Influence of Environmental Health Interventions Based on The Health Belief Model (HBM) on the Risk Factors of Dengue Hemorrhagic Fever (DHF) Benteng Village, Indonesia. Natl J Community Med 2023;14(9):568-574. DOI: 10.55489/njcm.140920233220

www.njcmindia.com | pISSN09763325 | eISSN22296816 | Published by Medsci Publications

INTRODUCTION

Indonesia is one of the DHF endemic countries where the number of people suffering from DHF is increasing from year to year. Based on data from the Ministry of Health of the Republic of Indonesia in 2021, the number of DHF sufferers in Indonesia is 73,518 cases with 750 deaths. The Riau Archipelago Province had the highest DHF Incidence Rate (IR) of 80.9 per 100,000 population, followed by East Kalimantan and Bali with 78.1 and 59.8 per 100,000 respectively population. [1]South Sulawesi Province is in the top 10 provinces with the highest DHF incidence rate in 2021, namely having a DHF IR of 40.0 per 100.000 population with a fairly high Case Fatality Rate (CFR) of 0.98%, close to 1%. CFR is considered high if it exceeds 1%.[1]

Palopo City is one of the cities in South Sulawesi Province where the DHF IR rate fluctuates. During the last 5 years (2017-2021), namely in 2017 there were 366 cases with an Incidence Rate (IR) of 221.9 per 100,000 population. In 2018 there was a decrease of 74 cases with an IR of 42.8 per 100,000 population. In 2019 there was an increase with 121 cases and an Incidence Rate (IR) of 65.54 per 100,000 population. In 2020 there was another decrease, namely 23 cases with an Incidence Rate (IR) of 12.45 per 100,000 population. And in 2021 it will increase again to 284 cases with Incidence Rate (IR) of 153.7 per 100,000 population. Benteng Sub-District is one of the sub-districts with an increasing number of DHF cases since the last 3 years (2020-2022) and is the sub-district with the highest number of DHF cases in 2022, namely 24 cases.[2] For this reason, researchers feel the need to carry out environmental health interventions to try to find appropriate and better solutions for controlling and minimizing the incidence and transmission of DHF. In addition, an assessment of entomological indexes (Container Index, Breteau Index, and House Index) has never been carried out, which is one of the risk factors for DHF to see the density of Aedes sp. Larvae, which can help determine the focus of vector control and eradication. It is hoped that the control program can be carried out more effectively and efficiently.

A psychological theoretical framework called the Health Belief Model (HBM) of perceptions of barriers, benefits, self-efficacy, and threats (seriousness and severity) can be modified based on the delivery of a message that will drive optimal behavioral change. In this framework, a person's perceptions and beliefs are believed to determine whether they are engaged in healthy behavior or not.[3] The greater the perception of the risk of disease, the greater are the measures to reduce the risk.[4] Wong and Abubakar (2013) who conducted research in Malaysia also found that the preventive activities of DBD vector control were influenced by the structures contained in the HBM.[5] A study by Attamimi et al (2018) found that there is a relationship between confidence factors in HBM in the form of severity, vulnerability, call for action and benefits felt against DBD disease prevention efforts in the Puskesmas Sukorame district of Mojokerto, Indonesia.[6]

These efforts can be coupled into an environmental health intervention, which is expected to be able to invite the community to jointly carry out prevention efforts aimed at how to compile effective health messages based on perceptions held to change one's behavior towards disease prevention, known as the Health Belief Model (HBM).[7] For this reason, this study wanted to see whether there was an influence of environmental health interventions based on the Health Belief Model (HBM) theory on the risk factors for DHF events in the Benteng City of Palopo Village.

METHODOLOGY

This research is experimental research with the research design used was Quasy experimental with the One Group Pre-Post test design which is measuring the risk factors for DHF events (Entomology Index and Behavior) before and after an intervention is carried out. The research location was RT 03 RW 06 Benteng Village, as one of the villages with a high incidence of Dengue Hemorrhagic Fever (DHF) in Palopo City, Indonesia. The study was conducted in February – March 2023.

Population and Sample: The population in this study were all houses and people in RT 03 RW 06 Benteng Village, totaling 82 houses and 272 people. The location was taken based on the results of initial observations that had been carried out together with the Community Health Center staff with the criteria of the RW and RT heads being willing to use their area as a research site and DHF cases were found in the area.

The sample in this study included the entire study population with the criterion that there were people who lived or occupied the house, men or women aged > 17 years and heads of families or family members who occupied the house domiciled in RT 03 RW 06 Benteng Village. So that the sample in the study that met the criteria was 71 houses and 71 people.

Research Instruments: Data in the form of perceived susceptibility, perceived severity, perceived benefits, perceived barriers and behavior to prevent contact vectors were collected through interviews using a prepared questionnaire. The data is then scored and categorized into good if the total score is > median and bad if the total score is < median. Previously the compiled questionnaire questions were tested for validity using the Pearson Correlation Test and data reliability using the Cronbach alpha method in the SPSS program.

Data regarding the type and number of containers and the presence of larvae to calculate the Entomo-

logical Index (CI, BI and HI) were taken using observation sheets for water storage places inside and outside the house.

Research Procedure: The research procedure consisted of several research stages, namely pretest, intervention and posttest. Each stage is described as follows:

Pretest: Collecting data before the intervention by conducting interviews using a questionnaire and observing the house using an observation sheet to see the number and type of containers and the presence of larvae in the containers.

Intervention: Environmental health interventions carried out apply the theory of the Health Belief Model (HBM) in it. So, this research does not only intervene from behavior but also respondents' perceptions of DHF prevention measures, which it is hoped that with good perceptions will result in better preventive behavior as well. Environmental health interventions based on Indonesian Republic Ministry of Health (2015) are health, safety and control measures to create healthy environmental quality in terms of physical, chemical, biological and social aspects, which can be in the form of information communication and education as well as community mobilization /empowerment, improvement and development facilities, development of appropriate technology and environmental engineering.[8] Environmental health interventions are carried out for 1 month with 3 stages of a series of activities, namely:

First Week: Health Counseling using the lecture method with power point media to deliver counseling material by presenters and media leaflets containing counseling material distributed to each counseling participant. The source of the counseling material and leaflets was taken from the official website of the Indonesian Ministry of Health (https://promkes.kemkes.go.id/leaflet-waspada-dbd). Counseling was held for 15 minutes and then followed by a question-and-answer session. The purpose of this activity is to stimulate perceived susceptibility, severity, benefits and barriers.

Second Week: DHF campaign in the form of mutual cooperation activities among residents who are research respondents to clean their homes and surroundings, especially places and trash that can hold water, planting citronella plants which are plants that mosquitoes don't like, distributing leaflets, installing promotional boards and banners to prevent DHF by 3M Plus in strategic locations so that it can be easily seen by residents. This activity is part of the cues to action in HBM theory.

Week III and IV: The DHF Healthy Home Competition is an assessment of activity during environmental health interventions (DHF Campaign), the results of home observations using research observation sheets containing points on DHF prevention as well as the perception values taken from the research questionnaire. The purpose of this activity is to appreciate and motivate or attract residents to be active in DHF campaign activities and prevention of DHF or in HBM theory is part of self-efficacy. The awarding of prizes to the winners of the DHF healthy home competition was carried out at the sub-district office and handed over by the Benteng village head and researchers, as well as closing the intervention and research activities.

Posttest: After the intervention, the respondents were interviewed again using a questionnaire to see changes in perceptions and behavior. then house observations were carried out using the observation sheet to look again at the number and type of containers and the presence of larvae in the containers. So that the results can be compared before the intervention and after the intervention.

Data analysis: The influence of environmental health interventions on perceived susceptibility, perceived severity, perceived benefits, perceived barriers and contact vector prevention behavior was analyzed using the Mc Nemar test. The results of research observations in the form of the type and number of containers and the presence of larvae are used to calculate the Entomological Index in the form of Container Index (CI), Breteau Index (BI) and House Index (HI) with the following formula:[9]

$$CI = \frac{\text{Number of containers positive larvae}}{\text{Number of containers checked}}\ x\ 100$$

$$BI = \frac{\text{Number of containers positive larvae}}{\text{Number of houses checked}}\ x\ 100$$

$$HI = \frac{\text{Number of houses positive larvae}}{\text{Number of houses checked}}\ x\ 100$$

The larval index was then compared with the Density Figure (DF) on a scale of 1-9 to see the level of larval density in the 100 houses examined (Table 1). An area is declared not to have a high risk of DHF transmission if the Density Figure is < 1, the HI value is < 10%, and the BI value is < 50%, and is declared to have a high risk of transmission if the Density Figure is > 1, the HI value is > 10%, and BI value of 50. The higher the Density Figure, the more significant the risk of transmission.[10]

Table 1: Density Figure

Density Figure (DF)	House Index (HI)	Container Index (CI)	Breteu Index (BI)
1	1 – 3	1 – 2	1 – 4
2	4 – 7	3 – 5	5 – 9
3	8 – 17	6 – 9	10 – 19
4	18 – 28	10 – 14	20 – 34
5	29 – 37	15 – 20	35 – 49
6	38 – 49	21 – 27	50 – 74
7	50 – 59	28 – 31	75 – 99
8	60 – 76	32 – 40	100 – 199
9	>77	>41	>200

Source: WHO (2002)
Note: DF=1 (Low Density), DF=2-5 (Medium Density); DF=6-9 (High Density)

Ethical clearance: Ethical clearance certificate was obtained from Institutional ethical clearance committee of Public Health Faculty, Hasanuddin University Makassar, Indonesia (ref No. 14363/UN4.14.1/TP.01.02/2022). Written consent to participate was obtained from the respondents before data collection.

RESULTS

Respondents Characteristic: The research results that were conducted at RT 03 RW 06 Benteng Village Palopo city, Indonesia obtained data regarding the characteristics of the respondents in the form of the most interviewed respondents in the age group 47-56 years as much as 39.4%. While the sex of most respondents was male as much as 54.7%, with the most status in the family being husbands (53.5%). D3/D4/S1 graduates are the most educated respondents studied, namely 42.3%. And in general, the status of the house owned is the house itself, which is 90.1%.

Health Belief Model (HBM) Components

This research on the influence of environmental health interventions based on the Health Belief Model (HBM) compiles a series of health intervention activities in three stages, namely health education, DHF campaign and DHF healthy home competition. The following are the results of research on HBM components before and after environmental health interventions based on HBM:

The respondents' perceived susceptibility to contracting DHF in table 3 we can see that before the intervention there were 76.1% who had a good perception, increasing to 90.1% after the intervention. based on statistical analysis it was found that the p value was smaller than the α value (0.021 <0.05) which had a meaning that there was an effect of Environmental Health Intervention on the perceived susceptibility to contracting DHF. For the perceived severity of DHF infection before the intervention, 66.2% had a good perception and increased to 91.5% after the intervention. The statistical test value shows that the p value is smaller than the α value (0.000 <0.05) which means that there is an effect of Environmental Health Intervention on the perceived severity of DHF infection. For the perceived benefits of preventing DHF, table 3 shows that before the intervention there were 76.1% who had a good perception, increasing to 95.8% after the intervention was carried out. The statistical test results found that the p value = 0.001 <0.05 or the p value is smaller than the α value. which means that there is an influence of Environmental Health Intervention on the perceived benefits of preventing DHF.

Table 3 also shows that before the intervention was carried out there were 69% who had good perceptions of perceived barriers and increased to 88.7% after the intervention was carried out. Statistical test

Table 2: Distribution of Research Respondents Characteristics RT 03 RW 06 Benteng Village, Indonesia (n=71)

Variable	Participants (%)
Age (years)	
17-26	4 (5,6)
27-36	6 (8,5)
37-46	20 (28,2)
47-56	28 (39,4)
57-66	12 (16,9)
67-76	1 (1,4)
Gender	
Male	39 (54.9)
Female	32 (45.1)
Status in family	
Husband	38 (53.5)
Wife	30 (42.3)
Child	3 (4.2)
Last education	
Finished elementary school	3 (4.2)
Finished junior high school	7 (9.9)
Finish high school	22 (31)
End of D3/D4/S1	30 (42.3)
End of S2	8 (11.3)
End of S3	1 (1.4)
Home Status	
Own house	64 (90.1)
Contract/Rent/Cost	7 (9.9)

Table 3: Analysis of the Influence of Environmental Health Interventions Based on HBM on Perceived Susceptibility, Perceived Severity, Perceived Benefits and Perceived Barrier of Respondents RT 03 RW 06 Benteng Village, Indonesia

Variable	Pretest (%)	Post Test (%)	p value
Perceived Susceptibility			
Good	54 (76.1)	64 (90.1)	0.021
Bad	17 (23.9)	7 (9.9)	
Perceived severity			
Good	47 (66.2)	65 (91.5)	<0.001
Bad	24 (33.8)	6 (8.5)	
Perceived benefits			
Good	54 (76.1)	68 (95.8)	0.001
Bad	17 (23.9)	3 (4.2)	
Perceived Barriers			
Good	49 (69)	63 (88.7)	<0.001
Bad	22 (31)	8 (11.3)	
Total	71 (100)	71 (100)	

Statistical testing used: Mc Nemar test, α: 0.05

Table 4: Analysis of the Effect of Environmental Health Interventions on Behavior to prevent Vector Contact RT 03 RW 06 Benteng Village, Indonesia

Behavior	Pretest (%)	Post Test (%)
Good	46 (64.8)	59 (83.1)
Bad	25 (35.2)	12 (16.9)
Total	71 (100)	71 (100)

Statistical testing used: Mc Nemar test, α: 0.05, p value 0.015

results in the table show that the p value is smaller than the value α (0.000 <0.05) which means that there is an influence of Environmental Health Intervention on perceived barriers to preventing DHF.

Vector Contact Prevention Behavior

Another variable that was examined in this study was the risk factor for DHF in the form of behavior to prevent vector contact. The following are the results of the analysis of behavior preventing vector contact before and after the intervention:

Based on table 4 we can see that before the intervention there were 64.8% of respondents who had good behavior in preventing vector contact and increased to 83.1% after the intervention. The statistical test results in the table show that the p value is smaller than the α value (0.015 <0.05) which means that there is an influence of Environmental Health Interventions on behavior in preventing vector contact.

Entomology Index

Other risk factors that were also examined in this study were the Entomological index in the form of HI, CI, and BI which could be calculated through observations of the presence of mosquito larvae in the containers owned by the respondents. Based on the results of the observations made, 507 containers were obtained before the intervention and 486 containers after the intervention with a variation of containers consisting of 13 types. The most common type of container found is the base for the flower pot, then the bathtub/bucket and the water reservoir behind the refrigerator. There was a decrease in the number of positive larvae containers after the intervention. Before the container intervention was carried out, the most commonly found larvae were tubs/buckets in the bathroom, namely 43.1%, then flower pot mats (24.14%), and water containers (barrels/buckets) (10.34%). Meanwhile, after the intervention, there was a decrease in the number of positive larvae containers found namely 35.71% in the bathtub/bucket container and flower pot base.

The observations result of containers and larval density showed that there was a decrease in CI values from the moderate to low category after the intervention was carried out. The same thing happened to the BI and HI values, which also decreased from the high category of larval density to medium category.

Table 5: Distribution of Container Types and the Presence of Larvae in RT 03 RW 06 Benteng Village, Indonesia

Container Types	Number of Containers		Number of positive larvae containers	
	Pretest (%)	Posttest (%)	Pretest (%)	Posttest (%)
Bath/Bucket	138 (27.22)	138 (28.4)	25 (43.1)	5 (35.71)
Dispenser reservoir	39 (7.69)	39 (8.02)	3 (5.17)	0 (0)
Refrigerator rear bin	41 (8.09)	41 (8.44)	2 (3.45)	1 (7.14)
Flower pot mat	199 (39.25)	198 (40.74)	14 (24.14)	5 (35.71)
Water storage (barrel/bucket)	39 (7.69)	41 (8.44)	6 (10.34)	1 (7.14)
Pet drinking place	5 (0.99)	5 (1.03)	1 (1.72)	0 (0)
Used cans	9 (1.78)	4 (0.82)	1 (1.72)	1 (7.14)
Used Bottles	13 (2.56)	5 (1.03)	1 (1.72)	0 (0)
Used glass	12 (2.37)	3 (0.62)	3 (5.17)	1 (7.14)
Used bucket	2 (0.39)	1 (0.21)	1 (1.72)	0 (0)
Used tires	3 (0.59)	4 (0.82)	1 (1.72)	0 (0)
Pool	4 (0.79)	4 (0.82)	0 (0)	0 (0)
Aquarium	3 (0.59)	3 (0.62)	0 (0)	0 (0)
TOTAL	507 (100)	486 (100)	58 (100)	14 (100)

Table 6: Entomology Index Measurement Results of RT 03 RW 06 Benteng Village Before and After Intervention

Intervention	Pre test	Post test
Container Index	11.44	2.88
Density Figure	4	1
Breteau Index	81.69	19.72
Density Figure	7	3
House Index	45.07	15.49
Density Figure	6	3

DISCUSSION

Health Belief Model (HBM) Components

Based on the description of the components Health Belief Model (HBM) above, we can conclude that environmental health interventions based on HBM have an influence on Perceived Susceptibility, Perceived Severity, Perceived Benefits and Perceived Barrier. In other words, there are differences in Perceived Susceptibility, Perceived Severity, Perceived benefits and Perceived Barrier before and after environmental health interventions based on HBM.

This research is in line with Wahyudi and Ningrum's research (2021) which showed that there was an increase in the average value of five HBM indicators, namely perceived susceptibility, perceived severity, perceived benefit, perceived barrier, cues to action in eradicating larvae in the residents of Ngrancah Hamlet, Senggreng Village after being carried out intervention.[11] Research by Hanklang et al (2018) in Thailand also found that DHF prevention intervention programs significantly increased knowledge, per-

ceived vulnerability, perceived severity, perceived benefits, perceived barriers and preventive actions. Where these findings support the assumption that the application of HBM in interventions in rural communities can promote preventive action and may be useful in the primary care of people with high risk of dengue hemorrhagic fever (DHF).[12]

Environmental health interventions in the context of preventing DHF affect healthy living behavior to improve public health status by using the theory of the Health Belief Model (HBM). This is in line with the research of Attamimy et al (2018) which explains that each individual has an assessment of trust in the level of vulnerability and severity that is felt by each so that they make prevention efforts.[6] The concept of the Health Belief Model can provide an assessment of healthy actions to prevent DHF at the individual level. Research by Syed et al (2021) also demonstrated the efficacy of HBM constructs for assessing the likelihood of communities taking the necessary precautions. The results show that perceptions of susceptibility, severity and benefit are significantly associated with engagement in community prevention practices in Saudi Arabia during the novel coronavirus disease pandemic. Therefore, they recommended the inclusion of an HBM component for the assessment of disease prevention programs.[13]

Vector Contact Prevention Behavior

The results showed that 64.8% of respondents had good behavior in preventing contact vectors and after HBM-based interventions it increased to 83.1%. Meanwhile, behavior in the bad category decreased by 35.2% to 16.9% after HBM-based environmental health interventions. The statistical test results in the table show that the Exact Sig. value = 0.015 <0.05 or the p value is smaller than the α value which has a meaning, namely that there is an effect of Environmental Health Interventions on behavior in preventing vector contact. It can also be concluded that there are differences in behavior in preventing contact vectors before and after environmental health interventions based on HBM.

The results of research conducted by Musta'inah. et al (2020) in the working area of the Tenggilis Health Center, Surabaya found that the more information and interventions individuals receive about PSN, the better the preventive behavior will be.[14] Another study conducted by Attamimy et al (2018) used a correlation test to obtain a value of r = 0.432, which means that there is a strong relationship between the perception of cues and the efforts to prevent DHF. Where the more often the respondent gets a cue to act, the better the preventive behavior is.[6]

Actions or preventive behavior can be influenced by several things that serve as cues for someone to take action, these cues can be either external or internal factors such as messages in the mass media, advice or invitations from friends or family and others.[14] In this study are described in HBM-based environmental health interventions which contain counseling activities, DHF campaigns and DHF healthy home competitions. If the cue to take action is higher, the motivation to take action in the form of prevention efforts will be even better. The more often a person gets a signal to act either through the media or advice from people around him, the better the prevention efforts that can be done. Someone will get good prevention efforts based on the information received .[14] So we can conclude that the existence of an environmental health intervention program which contains a series of activities in the form of counseling, DHF campaigns, as well as DHF healthy home competitions can be a motivation and cue for respondents or the public to carry out DHF prevention activities which can be in the form of vector contact prevention behavior.

Entomology Index

The entomological index is a measure of the density of Aedes aegypti larvae which can be measured by the House Index (HI), Container Index (CI) and Breteau Index (BI). The results of these measurements are then compared with the vector density figures from WHO.[15] The risk of dengue transmission will be categorized as low, moderate and severe based on the density figure (DF). Entomological indicators are very effectively used in monitoring areas prone to frequent cases of DHF so that new cases can be anticipated.[16]

The results of this study indicate that HBM-based environmental health interventions have an influence on the Entomological Index in the form of CI, BI and HI. CI = 11.44%, BI = 81.69%, and HI = 45.07% before the intervention decreased to CI = 2.88%, BI = 19.72% and HI = 15.49% after the intervention. This means that HBM-based environmental health interventions can reduce CI, BI and HI values. Reducing CI, BI and HI values means reducing the risk of DHF transmission in an area.

This research is in line with the research of Sitorus et al (2017) in Prabumulih City, South Sumatra which found that DHF vector control through health promotion in community groups accompanied by selective larvicidation contributed to a greater decrease in larval density as seen through HI, CI and BI values compared to other regions.[17] Another study by Zulaikhah and Yusuf (2018) also found that interventions in the form of counseling could affect the density of Aedes aegypti larvae, namely reducing CI, HI and BI but the results were still high because CI≥5% and HI≥10% in this area still had density and high vector spread and high risk of DHF transmission.[18]

This research is not in line with the research of Widhihutami (2018) in the Badungrejosari Village, Malang City, which found that the intervention in the form of a DHF responsive village program showed no significant difference in reducing mosquito larvae population density marked by a tendency to increase the House Index, Container Index, and Breteau Index.[19] Based on the analysis of the data, the results showed that the observation of vector density figures

before and after the DHF responsive village program showed that the program was not effective in reducing HI, BI and CI in Bandungrejosari Village. Another study by Leri et al (2021) found that community participation was classified as poor and the density of *Aedes aegypti* mosquito larvae with HI, CI and BI indicators was in the high category for the risk of DHF transmission.[20]

Conclusion

Based on the research results of the Analysis of the Effect of Environmental Health Interventions Based on the Health Belief Model (HBM) on the Risk Factors for Dengue Fever (DHF) in the Benteng Village of Palopo City, it can be concluded that There is an influence of environmental health interventions based on the Health Belief Model (HBM) on perceived susceptibility, perceived severity, perceived benefits, and perceived barrier at the study site, RT 03 RW 06 Benteng Village. There is an influence of environmental health interventions based on the Health Belief Model (HBM) on behavior in preventing vector contact in RT 03 RW 06 Benteng Village. The results of entomological index measurements, namely the Container Index (CI), Breteau Index (BI), and House Index (HI) decreased after environmental health interventions based on the Health Belief Model (HBM).

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