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The influence of environment, host and vector on the spread of dengue fever

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ABSTRACT

This research investigates the impact of host factors on the spread of Dengue Hemorrhagic Fever (DHF) in Indonesia through a survey study focused on the human population affected by the disease. By operationalizing key variables derived from theoretical frameworks, the study assessed observable factors that influence DHF transmission. The findings underscore the importance of host-related factors in understanding the dynamics of DHF, providing valuable insights for the development of effective public health strategies. The study aims to reduce the burden of DHF on communities, protect vulnerable populations, and decrease the incidence of severe health complications. Emphasizing the significance of health habits and environmental influences, the research advocates for targeted interventions to enhance community resilience against DHF. Ultimately, the study highlights the need for ongoing public awareness and education initiatives to combat this persistent health challenge and prevent future outbreaks in Indonesia.

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INTRODUCTION

As a significant infectious disease, Dengue Hemorrhagic Fever (DHF), commonly known as Demam Berdarah Dengue (DBD) in Indonesian, demands attention due to its association with severe health complications that can lead to hospitalization and, in some cases, mortality. Characterized by high fever, hemorrhagic manifestations, and plasma leakage, DHF can escalate rapidly if not diagnosed and treated promptly (Dhivya, 2015). The disease is primarily transmitted by mosquitoes, particularly those of the Aedes genus, such as Aedes aegypti and Aedes albopictus. These vectors thrive in urban environments, where they breed in stagnant water, making understanding their transmission pathways essential for effective intervention and prevention strategies (Organization, 2017). By identifying the specific conditions that facilitate mosquito breeding and the factors influencing human exposure to bites, public health initiatives can be designed to mitigate the risk of DHF outbreaks and protect vulnerable populations.

Indonesia faces a growing health crisis due to DHF, with the disease being endemic in many parts of the country (Organization, 2002). The tropical climate, characterized by high humidity and warm temperatures, creates ideal conditions for the breeding of Aedes mosquitoes. These environmental factors contribute to the ongoing transmission of the disease, making DHF a persistent challenge for public health authorities (Novaranti et al., 2021).

Despite the dengue virus being present in Indonesia for over 43 years, efforts to combat DHF have not yielded fully effective outcomes (E Setiati et al., 2006). The government has implemented various initiatives to prevent the spread of the disease, including public health campaigns, mosquito control programs, and community engagement efforts. However, these strategies have not been universally successful, underscoring the need for a more comprehensive understanding of the factors that contribute to DHF outbreaks.

One of the most significant challenges in controlling DHF is the lack of public awareness regarding the importance of maintaining a clean and healthy environment (Susianti, 2017). Poor waste management, stagnant water, and unclean living conditions provide ideal breeding grounds for Aedes mosquitoes. Without sufficient knowledge about dengue prevention and control measures, communities remain vulnerable to the disease (Spiegel et al., 2005).

Increasing public awareness is crucial for reducing DHF transmission. Educational campaigns aimed at informing the population about the risks associated with dengue and promoting practices such as regular cleaning of potential mosquito breeding sites can significantly impact the incidence of the disease (Kusuma et al., 2019). Empowering communities with knowledge about dengue symptoms, prevention methods, and the importance of seeking medical attention can also play a vital role in reducing severe health complications and fatalities, especially among vulnerable populations like children.

To better understand the dynamics of DHF transmission, the study focused on the health habits of the local population in North Sumatra Province (Vohra, 2020). This area served as an important case study for examining how various health-related behaviors (host factors) influenced the spread of DHF (Atika et al., 2023). For example, the research explored how the level of public knowledge regarding dengue prevention affected transmission rates. By examining these host factors, the study identified characteristics that contributed to the emergence of DHF outbreaks. It highlighted the influence of host factors on the transmission of DHF in North Sumatra Province and analyzed how interactions between these various factors manifested in the region.

Through a detailed examination of host factors, the study unveiled key characteristics that fueled the emergence of DHF outbreaks (Rao et al., 2018). It illuminated the profound impact of these host factors on the transmission dynamics of DHF in North Sumatra Province, revealing the intricate interactions among various elements that shaped the disease's spread in the region.

SEM proved particularly effective in this context as it integrated various analytical methodologies, including factor analysis, multiple regression analysis, and path analysis (Sarstedt et al., 2020). This comprehensive framework facilitated a deeper understanding of how underlying variables, such as community awareness and historical context, impacted the dynamics of DHF transmission. The research was classified as a survey study, focusing on the conditions of the human population affected by DHF (Pakaya et al., 2023). Measurements were taken to assess tangible aspects, which helped represent the abstract underlying variables. By operationalizing these variables through observable factors derived from theoretical frameworks, the study aimed to establish meaningful connections between identified variables.

The findings from this research are critical for developing more effective strategies to combat DHF in Indonesia (Soedarmo, 1994). By shedding light on the role of host-related factors in the transmission of the disease, the study provided valuable insights that could inform public health initiatives (Fajar, 2022)(Hasan & Azis, 2018). The ultimate goal was to reduce the burden of DHF on communities, protect vulnerable populations, and decrease the incidence of severe health complications (Organization, 2011).

Understanding the dynamics of Dengue Hemorrhagic Fever in Indonesia is essential for improving public health efforts and preventing future outbreaks (Khairulbahri, 2022). By focusing on the health habits of local populations and the environmental factors contributing to disease transmission, targeted interventions can enhance community resilience against DHF. Continued efforts to raise awareness and educate the public about dengue prevention remain vital in the fight against this persistent health challenge.

RESEARCH METHOD

This study adopts a quantitative approach that combines cross-sectional studies and retrospective record reviews to investigate dengue fever (DHF) among the human population (Liu et al., 2020). As an epidemiological study, it is inherently multidimensional, aiming to explain practical phenomena through various dimensions and intricate causal relationships. To effectively analyze this complexity, the research employs Structural Equation Modeling (SEM) and multinomial Poisson regression. SEM serves as a comprehensive analytical tool, integrating factor analysis, multiple regression analysis, path analysis, and both exploratory and confirmatory factor analyses alongside multinomial Poisson regression (Kala, 2009)(Chandra, 2007)(Timmreck, 2004).

The focus of the research is on measuring tangible factors related to the population affected by DBD to gain insights into abstract concepts, particularly latent variables that can be observed through measurable (observable) variables (Wassenaar, 2003). Conducted between January and June 2021, the study's timeframe allows for the observation of the effects of the rainy season, typically occurring at the end of the year, on the incidence of DHF. This duration was essential for accurately identifying epidemic factors, considering the extensive area covered by the research. Set in North Sumatra, Indonesia, a region with a high endemic rate of DHF, the study highlights fluctuations in incidence rates over the years, with the province reporting significant case numbers and demonstrating a widespread presence of the disease across all districts.

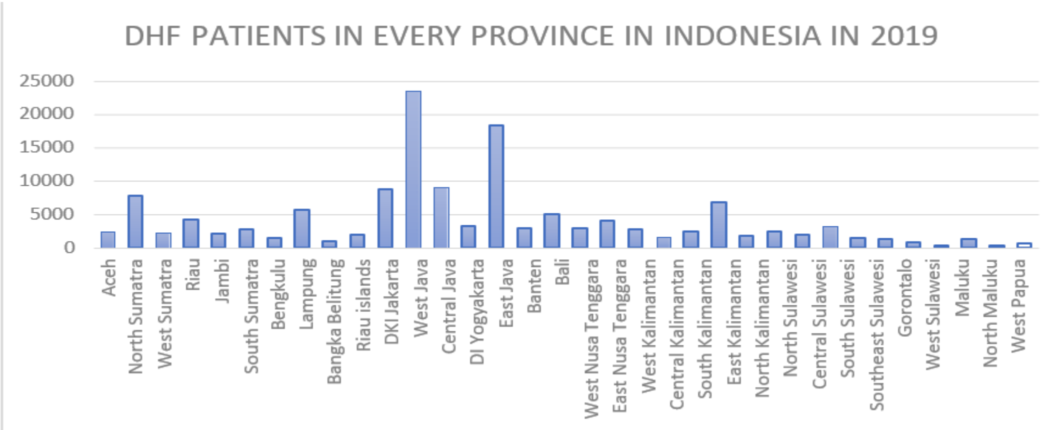

Figure 1. Diagram of the number of dengue fever cases by province in Indonesia for the year 2019

The source population for this research consists of all dengue fever (DBD) patients recorded in North Sumatra province in 2019, totaling 7,731 individuals. This study focuses specifically on participants from two key areas within the province: Medan city and Batubara regency, both of which experienced significant DBD outbreaks during that year. Among the affected population, 1,682 individuals were identified as participants, with 192 cases reported in Batubara and a notably higher number of 1,490 cases in Medan city. This selection of participants allows for a comprehensive analysis of the DBD incidence within these regions, providing valuable insights into the epidemiological patterns and factors influencing the spread of the disease in a densely populated area of North Sumatra.

Simulation Frame

This research was carried out in two districts/cities of North Sumatra province, specifically in Medan city and Batubara regency. For the exploratory factor analysis (EFA), a sample of 136 individuals was randomly selected from a larger research sample of 748 participants. In contrast, the confirmatory factor analysis (CFA) and structural equation modeling (SEM) utilized the full sample of 748 individuals. The detailed breakdown of the samples for this study is as follows:

Table 1. Sample study

No.	District/City	Number of Patients	Sample Size
1	Batubara Regency	192	192
2	Medan	1,490	556
	Total	1,560	748

Simulation Sampling

The sampling method in this study is as follows: First, purposive cluster sampling was used to determine the study locations, resulting in Medan City and Batubara Regency. Second, total sampling was employed in Batubara Regency, with a sample size of 70 participants. Third, proportional random sampling was used to select participants in Medan City, yielding a sample size of 678 individuals. The sampling process involved calculating the proportion of dengue fever cases for each subdistrict in Medan using the following formula:

$$Proportion\ of\ each\ subdistrict = \frac{Number\ of\ Cases\ in\ Subdistrict}{Total\ Number\ of\ Cases\ in\ Medan\ City}$$

To calculate the number of samples for each subdistrict, the researcher used the formula: Number of Samples for Each Subdistrict = Proportion of Each Subdistrict × 556.

Simulation of Data Analysis

The analysis of starting with descriptive statistics followed by inferential statistics. Inferential statistical analysis commenced with path analysis, leading to the development of a factor analysis model and ultimately a structural equation model (SEM) that adjusted for latent variables. Descriptive statistics provided an overview of each measurable variable, allowing for concise descriptions of the data to understand respondent characteristics. Inferential statistics focused on hypothesis testing, which included both analysis of measurement models and structural models to establish causal relationships. The SEM approach encompassed all necessary analyses and required assumptions such as adequate sample size, normality, linearity, and the absence of outliers or multicollinearity. After meeting these prerequisites, the study explored the effects and contributions of various factors on latent variables, utilizing parameters such as Lambda, Beta, and Gamma to assess direct and indirect influences. The findings were analyzed using AMOS software, with key outputs including parameter estimates, total effects, and the largest eigenvalue of the covariance matrix, all aimed at elucidating the relationships between environmental, vector, and host factors in the spread of dengue fever.

RESULTS AND DISCUSSIONS

The Contribution of Host Factors to Dengue Hemorrhagic Fever Spread

In examining the spread of Dengue Hemorrhagic Fever (DHF), this study identifies four primary latent variables: Environment, Host, Vector, and DHF itself. Each variable comprises specific factors that collectively influence the dynamics of DHF transmission. The Host variable in this study encompasses several key factors that influence the spread of Dengue Hemorrhagic Fever (DHF). These factors include knowledge, which reflects the understanding of DHF symptoms and transmission methods; attitude, which pertains to how individuals perceive the disease and its risks; and behavior, which relates to the actions taken to prevent infection. Additionally, perception and motivation play crucial roles in

determining how individuals respond to DHF risks. Education level, age, and profession further contribute to the host's susceptibility and response to DHF. Moreover, personal and family histories of DHF are significant, as they can shape individuals' experiences and awareness of the disease. By examining these host factors, the study aims to highlight their impact on the overall dynamics of DHF transmission and control.

Host, which is one of the factors analyzed from an economic perspective, demonstrates that income levels have a significant influence on the spread and control of Dengue Hemorrhagic Fever (DHF). The statistical distribution analysis of income data can be illustrated through the following frequency distribution table.

Table 2. Income distribution frequency

		Frequency	Percent
Valid	Low	262	35.0
	Medium	262	35.0
	High	224	29.9
	Total	748	100.0

It is known that respondents with low income account for 262 individuals or 35%, those with medium income also account for 262 individuals or 35%, while those with high income make up 224 individuals or 29.9%. From this data, it can be concluded that the majority of respondents fall into the medium and low income categories.

Table 3. Distribution of frequency of number of dependents

		Frequency	Percent
Valid	Low	230	30.7
	Medium	425	56.8
	High	93	12.4
	Total	748	100.0

The number of respondents with a low number of dependents is 230 people, or 30.7%. Respondents with a medium number of dependents total 425 people, or 56.8%, while those with a high number of dependents amount to 93 people, or 12.4%. From this data, it is evident that the majority of respondents have a medium number of dependents, typically ranging from 4 to 6 people per family.

Host Factor

In analyzing the host factors that contribute to the spread of Dengue Hemorrhagic Fever (DHF), knowledge emerges as a critical component. Understanding the symptoms of DHF is essential not only for individual awareness but also for community health outcomes. When individuals are informed about the signs and symptoms of DHF, they are better equipped to recognize the illness early, seek medical help promptly, and take necessary precautions to prevent further transmission.

The study explores respondents' knowledge levels regarding DHF symptoms, which directly correlates with their ability to respond effectively to potential infections. Knowledge influences behaviors related to health-seeking practices, such as visiting healthcare facilities and adhering to preventive measures, including eliminating mosquito breeding sites and using protective measures like insect repellent.

To illustrate the distribution of knowledge among respondents, Table 4 provides a detailed breakdown of their understanding of DHF symptoms.

Tabel 4. Distribution of knowledge about DHF symptoms

		Frequency	Percent
Valid	Low	206	27.5
	Medium	326	43.6
	High	216	28.9
	Total	748	100.0

It is evident that the number of respondents with low knowledge about DHF symptoms is 206, accounting for 27.5%. Those with medium knowledge comprise 326 respondents, or 43.6%, while 216 respondents, or 28.9%, have high knowledge. This data indicates that the majority of respondents possess a moderate level of understanding regarding DHF symptoms. Such knowledge is vital, as it directly influences their ability to recognize symptoms early and seek appropriate medical attention, ultimately impacting the dynamics of DHF transmission within the community.

Vector

The data analysis for mosquito population density shows a distribution with most samples falling into the medium to high categories. Specifically, 10% of the samples have a low mosquito population density, while a significant 44.8% are categorized as medium, and 45.2% fall into the high density range.

Table 5. Frequency distribution of DHF cases

		Frequency	Percent
Valid	Low	75	10.0
	Medium	335	44.8
	High	338	45.2
	Total	748	100.0

When looking at larva density, the majority of samples, about 70.2%, have a high larva density, whereas 29.8% are classified as having a medium density. This indicates a predominance of high larva density in the studied samples.

Tabel 6. Frequency distribution of DHF

		Frequency	Percent
Valid	Medium	223	29.8
	High	252	70.2
	Total	748	100.0

For dengue hemorrhagic fever (DHF) cases, more than half of the samples (51.7%) are in the low severity category, 34.1% are medium, and 14.2% are high. This distribution suggests that most cases are less severe, with fewer cases being highly severe. Regarding the serotypes of the DHF virus, Den 2 is the most common, accounting for 55.1% of the cases. Den 3 is next with 29.9%, followed by Den 1 with 9.6%, and Den 4, which is the least common, with 5.3%. This distribution provides insight into the prevalence of different virus strains.

Data Analysis

This study investigates the impact of host factors on the spread of dengue hemorrhagic fever (DHF) using Structural Equation Modeling (SEM) analysis with IBM SPSS AMOS 26. The analysis process includes several stages, starting with the Measurement Model Test, which examines the relationship between indicators (host factors) and latent variables related to DHF. This integrated approach allows for the assessment of measurement error alongside hypothesis testing (Rajab & Epid, 2009).

Validity is Assessed through Confirmatory Factor Analysis (CFA), which tests the unidimensionality, validity, and reliability of constructs that cannot be directly measured. In the context of host factors, CFA aims to identify unidimensional indicators that significantly influence the spread of DHF and to determine which host-related characteristics are most dominant in forming the underlying constructs. The correlation of each variable—both exogenous (host-related factors) and endogenous (DHF outcomes)—is analyzed through the loading factor values of each indicator. Validity in the CFA model is measured by examining the standard factor loadings for observed host factors against latent variables for first-order models and the standard structural coefficients for higher-level models.

Reliability refers to the consistency of measurements of host factors, indicating that high reliability suggests these indicators consistently measure their latent constructs related to DHF. Reliability is assessed using composite reliability and variance extracted measures. A construct is considered reliable if its Construct Reliability (CR) is ≥0.70 and its Variance Extracted (VE) is ≥0.50 (Wijanto, 2008).

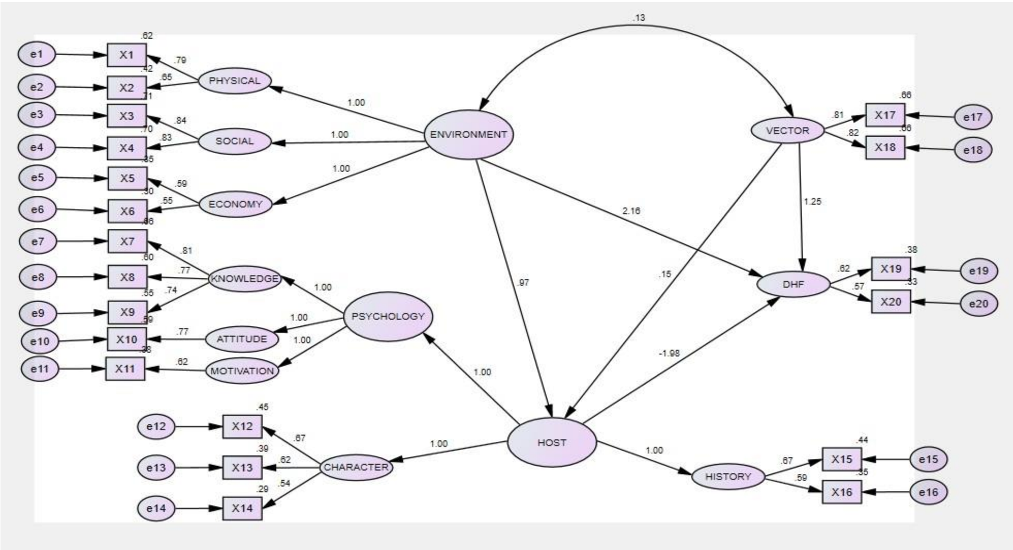

Figure 2. Measurement model of variablesusing IBM SPSS amos

The results of the measurement model estimation in Figure 2 were obtained using the Maximum Likelihood estimation method.

Table 7. Results of construct validity test

Regression Weights: (Group number 1 - Default model)							
			Estimate	S.E.	C.R.	P	Label
DHF	<---	ENVIRONMENT	2.924	0.693	4.221	***	
SOCIAL	<---	ENVIRONMENT	1.221	0.076	16.048	***	
ECONOMY	<---	ENVIRONMENT	1				
PHYSICAL	<---	ENVIRONMENT	0.946	0.068	13.823	***	
DHF	<---	HOST	-2.799	0.721	-3.882	***	
PSYCHOLOGY	<---	HOST	0.917	0.058	15.699	***	
CHARACTER	<---	HOST	1.138	0.082	13.809	***	
HISTORY	<---	HOST	1				
HOST	<---	VECTOR	0.088	0.012	7.497	***	
DHF	<---	VECTOR	1				
MOTIVATION	<---	PSYCHOLOGY	1				
ATTITUDE	<---	PSYCHOLOGY	1.271	0.072	17.541	***	
KNOWLEDGE	<---	PSYCHOLOGY	1.691	0.099	17.076	***	

Regression Weights: (Group number 1 - Default model)							
			Estimate	S.E.	C.R.	P	Label
X1	<---	PHYSICAL	1.223	0.065	18.696	***	
X2	<---	PHYSICAL	1				
X3	<---	SOCIAL	1.013	0.035	28.638	***	
X4	<---	SOCIAL	1				
X5	<---	ECONOMY	0.963	0.074	13.011	***	
X6	<---	ECONOMY	1				
X7	<---	KNOWLEDGE	1.188	0.052	23.001	***	
X8	<---	KNOWLEDGE	1.082	0.05	21.737	***	
X9	<---	KNOWLEDGE	1				
X10	<---	ATTITUDE	1				
X11	<---	MOTIVATION	1				
X12	<---	CHARACTER	1.324	0.095	13.879	***	
X13	<---	CHARACTER	1.219	0.092	13.234	***	
X14	<---	CHARACTER	1				
X15	<---	HISTORY	1				
X16	<---	HISTORY	0.877	0.058	15.048	***	
X17	<---	VECTOR	1				
X18	<---	VECTOR	0.905	0.046	19.596	***	
X19	<---	DHF	1				
X20	<---	DHF	0.955	0.074	12.952	***	

The construct validity test is conducted to ensure that the dimensions of the constructs of the latent variables under study are valid. From Table 7 above, it is indicated that all dimensions within the exogenous variables, specifically indicators X1-X20, have a CR value greater than +2.58. Therefore, all indicators within the exogenous variables meet the validity assumption.

Based on the analysis, the latent variables, including Host, have met the requirements for validity and reliability testing.

Structural Model Fit Test and Model Assessment

Table 8. Results of normality assessment (normality test)

Assessment of normality (Group number 1			
Variable	min	max	skew
Knowledge	1	3	0.069
Attitude	1	2	-0.314
Motivation	1	2	0.513
Physical	1	2	-0.154
Social	1	2	0.171
Economy	1	3	0.291
X20	1	4	-0.062
X19	1	3	0.182
X18	1	3	-0.914
X17	1	3	-0.293
Character	1	3	0.295
History	1	3	0.135

Based on the calculations in Table 8, all indicator skewness values are below ± 2.58. The data from these indicators are normally distributed and suitable for use.

Table 9. Resuts of the good fit model

GOF Index	*Cut-Off Value*	Output	Description

GOF Index	*Cut-Off Value*	Output	Description
Probability	p > 0,05	0.476	Fit
RMSEA	RMSEA ≤ 0,08	0.001	Fit
RMR	RMR < 0,08	0.007	Fit
GFI	GFI ≥ 0,9	0.994	Fit
AGFI	AGFI ≥ 0,8	0.983	Fit
CMIN/DF	CMIN/DF ≤ 2	0.992	Fit
TLI	TLI ≥ 0,95	1.000	Fit
CFI	CFI ≥ 0.95	1.000	Fit
IFI	IFI ≥ 0.90	1.000	Fit

The interpretation of Table 9 reveals that the model exhibits a good fit based on several criteria. The Probability value of 0.476 indicates model fit since it exceeds the threshold of 0.05. Additionally, the RMSEA value of 0.001 suggests a good fit, as it is less than the acceptable limit of 0.08. The GFI value is 0.994, which signifies a strong model fit, given that it is well above the 0.9 benchmark. Furthermore, the CMIN/DF ratio is 0.992, indicating a good fit as it is below the 2.00 threshold.

The Tucker Lewis Index (TLI) shows a value of 1.0, which meets the recommended acceptance level of 0.95, affirming the model's fit. The Comparative Fit Index (CFI) also achieves a perfect score of 1.0, indicating an excellent fit that is not affected by sample size. Lastly, the Incremental Fit Index (IFI) of 0.997 further supports the model's good fit since it exceeds the minimum acceptable value of 0.9. Overall, with all nine criteria indicating a model fit, it can be concluded that the structural model in this study is a good fit.

The Influence of Latent Variables on the Vector

The analysis from Table 9 indicates several significant effects. First, there is a notable positive influence of the Environment (X) on the Vector, with a p-value of 0.044, suggesting that Environment increases the Vector by 9.8%, thus accepting hypothesis H1. Similarly, Environment positively affects the Host, with a p-value of 0.001 and an estimate of 74.7%,

leading to the acceptance of hypothesis H3. Additionally, the Environment has a positive influence on Dengue Hemorrhagic Fever (DHF), shown by a p-value of 0.023 and an increase of 38.5%, validating hypothesis H5.

The Host also significantly influences Psychology, as indicated by a p-value of 0.001 and an estimate of 1.075, which accepts hypothesis H2. However, the Host's influence on DHF is significant and negative, with a p-value of 0.033 indicating a reduction of 42.7%, accepting hypothesis H4. Furthermore, the Vector positively influences the Host with a p-value of 0.032, resulting in a 2.9% increase, thus validating hypothesis H4. Finally, the Vector has a significant positive effect on DHF, with a p-value of 0.001 and an increase of 88.9%, accepting hypothesis H7.

Moreover, the SEM method highlights its capability to identify indirect effects between exogenous and endogenous constructs not directly connected, illustrating the complexity of relationships in this research model.

The Influence of Hosts on the Spread of Dengue Fever in North Sumatra

Analysis indicates that hosts significantly impact the spread of dengue fever in North Sumatra, demonstrating that the condition of the host can have a tangible and strong effect on the disease's dissemination. In this context, a host refers to organisms, typically humans or animals, that serve as carriers of the disease. The study specifically focuses on human respondents, assessing their psychological conditions, including knowledge of dengue, attitudes towards prevention, and motivation for seeking information about the disease. It also considers respondent characteristics such as education, age, occupation, and personal or family history related to dengue.

The findings reveal that respondents possess a moderate understanding of dengue transmission, with 18.4% categorized as having low knowledge, 50.4% as moderate, and 28.9% as high. This knowledge varies among individuals, shaped by their learning experiences, which can influence their ability to evaluate and apply prevention strategies effectively. A lack of awareness regarding dengue significantly impacts health management within families, hindering their capacity to recognize and mitigate health threats.

Higher levels of knowledge correlate with better acceptance of preventive measures, such as the 3M Plus strategy (draining, covering, and burying), essential for controlling dengue cases. In contrast, individuals with low awareness are less likely to take preventative actions, potentially allowing the disease to spread more widely.

Educational background also plays a crucial role, with most respondents having completed secondary education. A higher educational level facilitates the absorption of health-related information, improving preventive decision-making. Educated individuals are more likely to engage in proactive measures, have better health status, and respond effectively to health issues. This suggests that increasing public knowledge can positively affect health outcomes.

Dengue fever can affect anyone, regardless of status, as evidenced by the study showing that most respondents previously infected with dengue had good knowledge about the disease. However, possessing knowledge does not guarantee immediate and appropriate actions; there can be a disconnect between understanding and behavior. A strong sense of awareness, combined with knowledge, is essential for effective prevention.

The behaviors observed among respondents included regular cleaning of bathrooms, not leaving clothes hanging indoors, using mosquito repellents, and taking precautions with water storage. Additionally, respondents were proactive in seeking medical care for family members showing dengue symptoms and reporting cases to community health workers.

Awareness and early intervention are vital to prevent the widespread outbreak of dengue. Government attention is necessary to manage the endemic nature of the disease across various regions, aiming to minimize occurrences. Community participation and governmental support are essential for the eradication and prevention of dengue, reinforcing that knowledge should be accompanied by a high level of awareness to optimize public health efforts.

The actions taken by individuals can greatly influence their environment, necessitating consistent and sustainable community efforts to combat the spread of Aedes aegypti mosquitoes and dengue fever. Overall, a community-driven approach to regular preventive measures can significantly reduce dengue transmission risks.

The Influence of Hosts on the Spread of Dengue Fever in North Sumatra

The study on the factors influencing the spread of dengue fever (DBD) in North Sumatra identifies three main components: environment, host, and vector. The findings reveal that these factors significantly affect the transmission of DBD. The model of interaction indicates that the host conditions in North Sumatra are moderate, with the community exhibiting average levels of education and knowledge regarding DBD transmission and prevention. This moderate understanding helps keep the spread of DBD relatively low. However, the environmental conditions, both inside and outside the homes, are not ideal, which poses challenges.

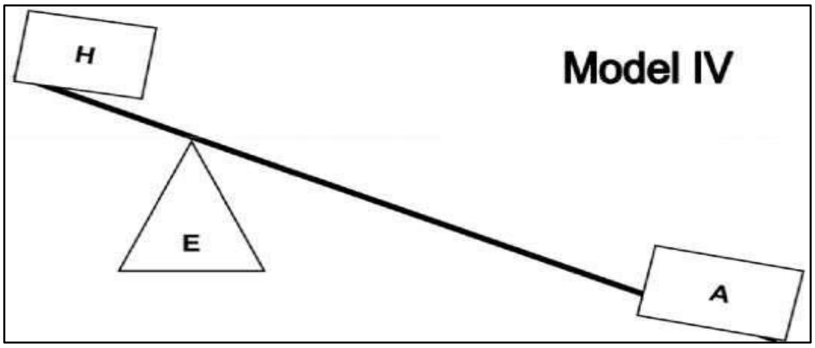

Figure 3. Model interaction diagram

CONCLUSION

Based on the research findings, several important conclusions emerge regarding the impact of host factors on the spread of dengue hemorrhagic fever (DHF) in North Sumatra Province. First and foremost, host factors significantly influence the transmission of DBD. The study reveals that the knowledge, attitudes, and actions of individuals play a crucial role in shaping the dynamics of dengue transmission. High levels of awareness about the disease can effectively mitigate its spread. When the community possesses a solid understanding of transmission methods and prevention strategies, the risk of dengue outbreaks diminishes significantly. Additionally, environmental conditions in the region have a noteworthy impact on DBD transmission. The findings indicate that the physical environment—both inside and outside homes—falls into a less favorable category. Poor environmental conditions can facilitate the spread of the disease, highlighting the necessity for better management of living spaces. The surrounding environment profoundly influences the incidence of DBD, underscoring the need for community-level interventions aimed at improvement. Furthermore, the role of vector factors cannot be overlooked. The study underscores that the proliferation of mosquitoes, the primary carriers of dengue, is a critical determinant of transmission levels. Effective vector management strategies are essential in controlling the incidence of DBD, as the health of the community is closely tied to the presence and breeding habits of these insects. In light of these findings, it is imperative for the community to take proactive measures in enhancing their environmental conditions. Efforts should focus on creating healthier living spaces through regular maintenance and improvement of homes, which can significantly reduce the risk of dengue transmission. Moreover, government initiatives are vital in providing support and guidance to communities facing challenges related to their environment. By promoting education on dengue prevention and effective environmental management, authorities can empower individuals to take control of their health and reduce the burden of this disease. In conclusion, addressing host factors, improving environmental conditions, and managing vector populations are critical steps in controlling the spread of dengue hemorrhagic fever in North Sumatra Province. By implementing community and governmental recommendations, we can work towards reducing the incidence of this disease and enhancing public health outcomes for the population.

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