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The effect of host and environmental factors on the incidence of dengue hemorrhagic fever (DHF)

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Abstract

This study aims to examine the factors contributing to the prevalence of DHF in Kwandang Subdistrict, with a particular focus on age, education, knowledge, residential density, and air temperature. The data were acquired via interviews, questionnaires, and observation. Subsequently, the collected data were subjected to statistical analysis in multiple stages. The results of the research indicate that the p-value for each factor is greater than the value of $\alpha = 0.05$. The p-value for the age factor is 0.779, for education 0.672, for knowledge 0.257, for residential density 0.244, and for air temperature 0.166. It can thus be concluded that the five factors analyzed in this study, namely age, education, knowledge, residential density, and air temperature, do not have a significant relationship with the incidence of DHF in Kwandang Subdistrict in 2022.

Keywords: Dengue Hemorrhagic Fever; DHF; Factors of DHF Incidence

1. Introduction

The health sector is a fundamental component of any nation-state, and it is the responsibility of governments at all levels to ensure its continued growth and advancement. This is as true in Indonesia as it is in any other country. The objective of health development in Indonesia is to enhance awareness, motivation, and capability to maintain optimal health for all citizens, thereby achieving the highest attainable standard of public health (Permenkes Number 15 of 2022).

In order to achieve this objective, the Indonesian government is engaged in a range of activities, encompassing both physical and non-physical development initiatives. It is imperative that any physical development be undertaken in a manner that is environmentally sustainable, taking into account the utilization of natural resources and the potential risks associated with ecosystem change. Such alterations will have both beneficial and detrimental consequences. One of the adverse consequences of ecosystem alteration is environmental degradation. Such environmental damage will provide opportunities for the emergence of various diseases, including dengue hemorrhagic fever (DHF).

Dengue hemorrhagic fever is a viral infection caused by the dengue virus (DENV) that is transmitted to humans through the bite of an infected mosquito. Dengue is endemic to tropical and subtropical climates worldwide, with a particularly high prevalence in urban and semi-urban areas. While the majority of DENV infections are asymptomatic or result in only mild illness, the virus can occasionally manifest in more severe forms, including fatal outcomes.

Dengue hemorrhagic fever (DHF) persists as a significant public health concern in Indonesia. Since 2009, the World Health Organization (WHO) has documented that Indonesia has the highest incidence of dengue fever cases in Southeast Asia. According to data from the Indonesian Ministry of Health, the incidence rate (IR) of DHF in Indonesia reached 65.70 per 100,000 population in 2010, equating to approximately 15,600 cases. Gorontalo Province is one of the provinces with a high incidence of dengue hemorrhagic fever (DHF), with cases reported annually. In 2019, the DHF IR

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in Gorontalo Province increased more drastically than the previous year, reaching 109.4 per 100,000 population. In 2020, it decreased to 86.9 per 100,000 population, although it remained above the national maximum limit (IR < 49/100,000 population). This decline in morbidity was accompanied by a reduction in the case fatality rate (CFR), which decreased from 1.6% in 2019 to 0.9% in 2020. This figure has reached the national target of CFR < 1%, with a total of nine DHF deaths. The decline in IR and CFR demonstrates the government's commitment to preventing DHF incidence in Gorontalo Province (Gorontalo Provincial Health Office, 2021).

Based on physical observations conducted in one of the health center areas that reported dengue cases in the homes of residents who were sick with dengue, several deficiencies were identified. Many used clothes were found hanging behind the door, indicating a lack of proper storage. Mosquito screens were not installed on the house ventilation, allowing mosquitoes to enter the residence. Uncovered water reservoirs, coasters on dispensers, and used glasses of mineral water scattered outside the house that were still filled with water were also found to have mosquito larvae, suggesting the presence of standing water.

In addition to the aforementioned habits, residents also engage in the practice of utilizing unsealed water storage containers, including drums, buckets, barrels, and other similar receptacles, which can serve as a potential breeding ground for DHF mosquitoes. This practice is the result of the challenge of accessing clean water, leading individuals to store water in these locations for extended periods to meet their daily needs. Despite the implementation of various prevention strategies, the level of commitment among residents remains relatively low. This is evidenced by the continued practice of not burying items that hold water, the infrequent draining of bathtubs, and the lack of routine gutter cleaning. This can exacerbate environmental conditions, which may subsequently serve as a breeding ground for DHF mosquitoes.

In light of the aforementioned description, the researcher conducted an assessment entitled "The Effect of Host and Environmental Factors on the Incidence of Dengue Hemorrhagic Fever (DHF) in Kwandang District." The objective of this study was to analyze the factors that influence the incidence of DHF in Kwandang Subdistrict, with a particular focus on the factors of age, education, knowledge, residential density, and air temperature.

2. Methods

This research adopts an analytic observational research design with a case-control structure. The study sample consisted of patients diagnosed with dengue hemorrhagic fever (DHF) in the Kwandang District of North Gorontalo Regency between January and December 2022. The data were gathered through a combination of interviews, questionnaires, and observations. Subsequently, the data were subjected to statistical analysis across several stages, employing univariate and bivariate analytical techniques.

3. Results

3.1. Univariate Analysis

The results of the univariate analysis for each factor are presented in Table 1 for the reader's convenience. The majority of respondents were older than 19 years old (52%), had not completed high school (55.9%), were well-informed (97.1%), and resided in homes with low levels of congestion (65%). The lowest air temperature was recorded in June 2022, at 26.2°C, while the highest temperature was observed in October and December 2022, at 27.5°C.

Table 1 Results of Univariate Analysis of DHF Incidence Factors

Incidence of DHF		
Incidence of DHF	**Frequency**	**Percentage (%)**
Case	34	33.3
Control	68	66.7
Total	102	100.0
Age Factor		
Age of Respondents	Frequency	Percentage (%)

≤ 19 years old	49	48.0
> 19 years old	53	52.0
Total	102	100.0
Education Factor		
Education	Frequency	Percentage (%)
< High School	57	55.9
≥ High School	45	44.1
Total	102	100.0
Knowledge Factor		
Knowledge	Frequency	Percentage (%)
Not good	3	2.9
Good	99	97.1
Total	102	100.0
Residential Density Factor		
Residential Density	Frequency	Percentage (%)
Dense	37	36.3
Not dense	65	63.7
Total	102	100.0
Air Temperature Factor		
Month	Air Temperature (°C)	
January	26.8	
February	26.5	
March	27.1	
April	27.2	
May	26.6	
June	26.2	
July	26.7	
August	26.9	
September	27.0	
October	27.5	
November	27.1	
December	27.5	

3.2. Bivariate Analysis

3.2.1. Dengue hemorrhagic fever (DHF) incidence by age

Table 2 reveals that of the 34 case respondents, 17 were aged 19 years or less, while the remaining 17 were aged 19 years or above. Of the 68 control respondents, 32 were aged 19 years or less, while 36 were aged more than 19 years. The p-value of 0.779 exceeds the alpha value of 0.05, indicating that there is no statistically significant association between age and DHF incidence. The OR (95% CI) value of 1.125 (greater than 1) indicates that individuals aged ≤ 19 years have a 1.125 times greater risk of experiencing DHF compared to those aged more than 19 years. At the 95%

confidence level, the OR value is insufficient to explain the population, as the p-value is greater than 0.05. Therefore, it can be concluded that there is no effect of age on the incidence of DHF.

Table 2 Statistical Test Results of Age on DHF Incidence

Incidence of DHF					Total (N=102)		P-value	OR (95% CI)
Age	Case (n=34)		Control (n=68)					
	Σ	%	Σ	%	Σ	%		
≤ 19 years old	17	50.0	32	47.1	49	48.0	0.779	1.125 (0.494-2.564)
> 19 years old	17	50.0	36	52.9	53	52.0		

Source: Primary Data, 2024

3.2.2. Dengue hemorrhagic fever (DHF) incidence by education

The results of the education factor analysis on the incidence of DHF are presented in Table 3. As evidenced by the findings in Table 3, 20 of the 34 case respondents had received an education below the senior high school level, while 14 respondents had obtained a senior high school education or higher. Of the 68 control respondents, 37 had received less than a high school education, while 31 had obtained a high school diploma or higher. The p-value of 0.672 exceeded the alpha value of 0.05, indicating that there was no statistically significant association between education and DHF incidence. The OR (95% CI) value of 1.197 (greater than 1) indicates that individuals with less than a high school education exhibit a 1.197-fold increased risk of DHF compared to those with a high school education or above. At the 95% confidence level, the OR value is insufficient to explain the population, as the p-value is greater than 0.05. Therefore, it can be concluded that there is no effect of education on the incidence of DHF.

Table 3 Statistical Test Results of Education on DHF Incidence

Incidence of DHF					Total (N=102)		P-value	OR (95% CI)
Education	Case (n=34)		Control (n=68)					
	Σ	%	Σ	%	Σ	%		
< High School	20	58.8	37	54.4	57	55.9	0.672	1.197 (0.520-2.754)
≥ High School	14	41.2	31	45.6	45	44.1		

Source: Primary Data, 2024

3.2.3. Dengue hemorrhagic fever (DHF) incidence by knowledge

Table 4 Statistical Test Results of Knowledge on DHF Incidence

Incidence of DHF					Total (N=102)		P-value	OR (95% CI)
Knowledge	Case (n=34)		Control (n=68)					
	Σ	%	Σ	%	Σ	%		
Not good	2	5.9	1	1.5	3	2.9	0.257	4.188 (0.366-47.905)
Good	32	94.1	67	98.5	99	97.1		

Source: Primary Data, 2024

The results of the knowledge factor analysis on dengue incidence are presented in Table 4. As evidenced in Table 4, the results indicated that 2 respondents exhibited inadequate knowledge, while the remaining 32 demonstrated a satisfactory level of understanding. Of the 68 control respondents, one exhibited poor knowledge, while 67 demonstrated good knowledge. The p-value of 0.257 exceeded the alpha value of 0.05, indicating that there was no statistically significant association between knowledge and DHF incidence. The OR (95% CI) value of 4.188 (greater than 1) indicates that individuals with limited knowledge are at a 4.188 times greater risk of experiencing a DHF episode compared to those with comprehensive knowledge. At the 95% confidence level, the OR value is insufficient for

explaining the population, as the p-value is greater than 0.05. Therefore, it can be concluded that there is no effect of knowledge on the incidence of DHF.

3.2.4. Dengue hemorrhagic fever (DHF) incidence by residential density

The results of the analysis of the residential density factor on DHF incidence are presented in Table 5. As evidenced in Table 5, the analysis revealed that 15 of the 34 case respondents resided in densely populated houses, while the remaining 19 occupied houses with lower population densities. Of the 68 control respondents, 22 resided in densely populated houses, while 46 occupied houses that were not densely populated. The p-value of 0.244 exceeds the alpha value of 0.05, indicating that there is no statistically significant association between housing density and DHF incidence. The OR (95% CI) value of 1.651 (greater than 1) indicates that individuals residing in densely populated houses exhibit a 1.125-fold increased risk of developing DHF in comparison to those residing in less densely populated houses. At the 95% confidence level, the OR value is insufficient to explain the population, as the p-value is greater than 0.05. Therefore, it can be concluded that there is no effect of residential density on the incidence of DHF.

Table 5 Statistical Test Results of Residential Density on DHF Incidence

Incidence of DHF					**Total (N=102)**		**P-value**	**OR (95% CI)**
Residential Density	**Case (n=34)**		**Control (n=68)**					
	Σ	**%**	**Σ**	**%**	**Σ**	**%**		
Dense	15	44.1	22	32.4	37	36.3	0.244	1.651 (0.708-3.848
Not dense	19	55.9	46	67.6	65	63.7		

Source: Primary Data, 2024

3.2.5. Dengue hemorrhagic fever (DHF) incidence by air temperature

The findings of the analysis examining the influence of air temperature on DHF incidence are presented in Table 6. As evidenced in Table 6, the correlation coefficient (r) was -0.427 with a significance value (p-value) of 0.166. The r value indicates a moderate relationship between air temperature and DHF incidence in Kwandang subdistrict, with an inverse correlation. The p-value exceeding the alpha level of 0.05 indicates the absence of a statistically significant correlation between air temperature and DHF incidence.

Table 6 Statistical Test Results of Air Temperature on DHF Incidence

Variable	**Incidence of DHF**		
	Quantity (n)	**Correlation Coefficient (r)**	**Significance (P-value)**
Air temperature	12	-0,427	0,166

Source: Primary Data, 2024

4. Discussion

4.1. The Effect of Age on the Incidence of Dengue Hemorrhagic Fever (DHF) in Kwandang District

Age is one of the factors that influence the sensitivity of an individual to infection by the dengue virus. All age groups have the potential to be infected by dengue viruses, even at a very early stage of development, (Kolondom et al., 2020). The statistical test yielded a p-value of 0.779 and an OR (95% CI) value of 1.125. This indicates that age does not exert a statistically significant influence on the prevalence of DHF in the Kwandang subdistrict. The two age groups observed exhibited an identical probability of developing DHF. Furthermore, the incidence of DHF is influenced by an individual's genetics, immunity, and nutritional intake. These findings align with those of Baitanu et al. (2022), who conducted research in Wulauan, Minahasa Regency, and concluded that age is not a significant predictor of DHF incidence.

4.2. The Effect of Education on the Incidence of Dengue Hemorrhagic Fever (DHF) in Kwandang District

Education is inextricably linked to an individual's corpus of knowledge. One of the fundamental objectives of education is to facilitate the acquisition and enhancement of knowledge, thereby fostering the development of a civilized society.

This, in turn, gives rise to a transformation in behavior. The educational outcomes associated with an object can be either positive or negative, contingent on one's attitude towards the object (Lestari, 2018).

The statistical test yielded a p-value of 0.672 and an OR (95% CI) of 1.197. This indicates that there is no notable impact of educational attainment on the prevalence of DHF in the Kwandang subdistrict. Information regarding the biology, causes, signs and symptoms, and prevention and treatment of DHF can be obtained from various sources, including mass media and healthcare professionals. It can be concluded that a high level of education is not a prerequisite for acquiring knowledge and information about DHF. Therefore, it can be concluded that education does not exert any influence on the incidence of DHF in the Kwandang subdistrict. This study is consistent with the findings of Umaya (2013), who conducted research in the catchment area of *Puskesmas* Talang Ubi Pendopo. Her research indicated that there was no statistically significant relationship between education and the incidence of DHF.

4.3. The Effect of Knowledge on the Incidence of Dengue Hemorrhagic Fever (DHF) in Kwandang District

A greater public awareness of dengue fever will lead to a greater awareness of the need to control the incidence of DHF. Conversely, a lack of knowledge among the general public will increase the probability of DHF occurrence. An individual's knowledge of an object can be either positive or negative, contingent upon their attitude toward the object in question (Lestari, 2018).

The statistical test yielded a p-value of 0.257 and an OR (95% CI) of 4.188. This indicates that knowledge does not exert a notable influence on the prevalence of DHF in the Kwandang subdistrict. The findings of this study are consistent with those of Baitanu et al. (2022), who investigated the relationship between knowledge and dengue incidence in Wulauan, Minahasa Regency, and reported no significant association.

Although this study did not identify a significant association between knowledge and the incidence of DHF, the findings indicate that the majority of the population in Kwandang Subdistrict demonstrated a comprehensive understanding of the etiology, infectious factors, manifestations, and prevention and treatment strategies associated with DHF.

4.4. The Effect of Residential Density on the Incidence of Dengue Hemorrhagic Fever (DHF) in Kwandang District

The term "residential density" is defined as the number of individuals residing in a given dwelling unit, expressed as a ratio of population to the total floor area of the unit. An increase in population density has been identified as a significant risk factor for dengue transmission (Prasetyo et al., 2023). Individuals engaged in a range of outdoor activities are at an elevated risk of contracting dengue.

The results of the statistical test indicated a p-value of 0.244 and an OR (95% CI) of 1.651. This indicates that there is no statistically significant correlation between housing density and the incidence of DHF in the Kwandang subdistrict. The results demonstrated that the proportion of individuals residing in densely populated dwellings was less than the proportion residing in dwellings with lower population density.

The findings of this study are consistent with those of Murwanto (2019), who conducted research in the Hajimena Health Center area in Natar Subdistrict and concluded that there was no statistically significant relationship between occupancy density and DHF incidence. Another study that yielded comparable outcomes was the investigation conducted by Widodo (2012) in Mataram City, West Nusa Tenggara Province. The findings indicated that there was no statistically significant correlation between occupancy density and DHF incidence.

4.5. The Effect of Air Temperature on the Incidence of Dengue Hemorrhagic Fever (DHF) in Kwandang District

The statistical test yielded a p-value of 0.166 and a correlation coefficient (r) of -0.427. This indicates that there is no notable impact of air temperature on the prevalence of DHF in Kwandang Subdistrict. Despite the fact that the mean monthly temperature in 2022 was conducive to the proliferation of dengue mosquitoes (within the range of 25°C-30°C), the temperature variable did not exhibit a statistically significant correlation with the incidence of DHF in Kwandang Subdistrict. The findings of this study are consistent with those of a previous investigation conducted by Indriyani and colleagues (2015) in the Jepara subdistrict, which also demonstrated that there was no statistically significant correlation between air temperature and DHF incidence.

The relationship between air temperature and DHF incidence is complex and not always straightforward. While air temperature can influence the activity of Aedes aegypti and Aedes albopictus mosquitoes (mosquitoes that transmit DHF), other factors, such as rainfall, air humidity, wind speed, and environmental conditions, also play a significant role.

Furthermore, host factors, such as water management habits and vector control efforts, also influence dengue transmission rates. Consequently, although air temperature plays a role, its direct relationship with DHF incidence may not always be linear, as was the case in this study.

5. Conclusion

The objective of this study is to examine the factors that contribute to the prevalence of DHF in Kwandang Subdistrict, with a particular focus on age, education, knowledge, residential density, and air temperature. The results indicated that the p-value for each factor was greater than $\alpha = 0.05$. The p-value for the age factor is 0.779, for education 0.672, for knowledge 0.257, for residential density 0.244, and for air temperature 0.166. It can thus be concluded that the five factors analyzed in this study, namely age, education, knowledge, residential density, and air temperature, do not have a significant relationship with the incidence of DHF in Kwandang Sub-district in 2022.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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