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Analysis of Risk Factors for Dengue Hemorrhagic Fever in Children: An Observational Study in Batang Regency, Indonesia

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A B S T R A C T

Introduction: Dengue hemorrhagic fever (DHF) is a significant public health problem in Indonesia, including in Batang Regency. This study aims to analyze the risk factors associated with the incidence of dengue fever in children in Batang Regency, Indonesia. **Methods:** A cross-sectional observational study was conducted on 258 child subjects in Batang Regency. Data was collected through structured interviews with parents or guardians, direct observation of the home environment, and laboratory tests to confirm the diagnosis of dengue fever. Data analysis included univariate, bivariate (Chi-square test), and multivariate (logistic regression) analyses to identify independent risk factors. **Results:** Univariate analysis showed a relationship between the incidence of dengue fever and age, gender, parental education, parental occupation, residential density, presence of mosquito larvae in water reservoirs, habit of hanging clothes, history of mosquito bites, and nutritional status. Bivariate analysis identified several statistically significant risk factors, including high residential density (OR=2.87; 95% CI: 1.65-5.01), presence of mosquito larvae (OR=3.21; 95% CI: 1.89-5.45), habit of hanging clothes (OR=2.87; 95%CI:1.32-5.21), and history of mosquito bites (OR=2.54; 95%CI: 1.48 -4.36). Multivariate analysis confirmed that high residential density and the presence of mosquito larvae were independent predictors of dengue incidence. **Conclusion:** High residential density and the presence of mosquito larvae in the home environment are the main risk factors for the incidence of dengue fever in children in Batang Regency. Public health interventions that focus on vector control and improving environmental sanitation are critical to reducing the dengue burden in this area.

1. Introduction

Dengue hemorrhagic fever (DHF) is an acute viral infectious disease that is transmitted through the bite of infected *Aedes aegypti* and *Aedes albopictus* mosquitoes. This disease is a major concern for global public health, especially in tropical and subtropical areas, including Indonesia. DHF has a wide clinical spectrum, ranging from mild fever to life-threatening conditions such as severe DHF with hypovolemic shock and bleeding. In Indonesia, dengue fever is an endemic disease with a fluctuating incidence rate but tends to increase from year to year. The Ministry of Health of the Republic of Indonesia reports that in 2022, there will be an increase in dengue cases by 14% compared to the previous year. The death rate due to dengue fever is also still high, especially in the children's age group. Children are a group that is vulnerable to dengue fever because their immune systems are not yet fully mature. In addition, children often have more outdoor activity, increasing the risk of exposure to mosquito bites. Symptoms of dengue fever in children can vary, ranging from high fever, headaches, muscle and joint pain, to more severe manifestations such as bleeding, shock and organ dysfunction.[1-3]

Batang Regency, which is located on the north coast of Central Java, is one of the dengue endemic areas in Indonesia. The geographical and climatic

conditions in Batang Regency, with high average temperatures and sufficient rainfall, create an ideal environment for the breeding of Aedes mosquitoes. In addition, factors such as population density, inadequate environmental sanitation, and community behavior that do not support dengue prevention efforts, also contribute to the high incidence of dengue fever in this area. Research on risk factors for dengue fever in children in Batang Regency is still limited. Several previous studies have identified several potential risk factors, such as age, gender, socioeconomic status, residential density, presence of mosquito breeding sites, and history of mosquito bites. However, these studies have limitations in research design, sample size, and data analysis methods.[4-7] Therefore, this study aims to conduct a more comprehensive and in-depth analysis of the risk factors for dengue fever in children in Batang Regency.

2. Methods

This research used a cross-sectional observational study design (cross-sectional). This design was chosen because it allows collecting data on exposure (risk factors) and outcome (DHF incidence) at the same time. This is in accordance with the research objective to analyze the risk factors associated with the incidence of dengue fever in children in Batang Regency. The target population for this research is all children aged 1-14 years who live in Batang Regency, Central Java, Indonesia. This age group was chosen because children are a group that is vulnerable to dengue infection and has a higher risk of complications than adults. The research sample consisted of 258 children selected at random (random sampling) from the target population. A simple random sampling technique is used to ensure that every child in the population has an equal chance of being selected as a sample. This sample size was determined based on statistical calculations taking into account a confidence level of 95%, a margin of error of 5%, and an estimated prevalence of dengue fever in children of 20%. The inclusion criteria are children aged 1-14 years, domiciled in Batang Regency for at least the last 6 months, and parents/guardians willing to provide informed consent. Meanwhile, the exclusion criteria are children with chronic medical conditions that can affect susceptibility to dengue fever (for example, immunological disorders) as well as children who have received dengue vaccination.

Data collection was carried out through three main methods: 1. Structured interview: Interviews were conducted with the child's parents or guardians using a validated structured questionnaire. The questionnaire includes questions about: Socio-demographic characteristics: Child's age, gender, parents' education, parents' occupation, number of family members, type of residence, and residential density. Health history: History of fever in the child in the last 2 weeks, history of previous dengue fever, history of dengue vaccination, and nutritional status of the child. Behavior related to dengue fever: Habit of hanging clothes in the house, use of mosquito nets, use of mosquito repellent, and frequency of eradicating mosquito nests in the home environment. Exposure to mosquitoes: Frequency of mosquito bites, types of mosquitoes that often bite, and times of most mosquito activity. Home environmental observations: Observations are carried out by trained researchers to identify environmental risk factors associated with dengue fever. Observations include: Existence of water reservoirs: The type of water reservoir (bathtub, bucket, jar, flower vase, etc.), condition of the water reservoir (closed or open), and the presence of mosquito larvae in the water reservoir. Environmental sanitation: The cleanliness of the house and yard, the presence of waste that is not managed properly, and the presence of standing water around the house.

Data collected from interviews, observations, and laboratory examinations are input into a computer database using statistical software (e.g., SPSS or STATA). The data is then cleaned to identify and correct input errors, inconsistencies, and missing values. Univariate analysis: Descriptive analysis is used to describe sample characteristics and variable distribution. Categorical variables are presented in the form of frequencies and percentages, while numerical variables are presented in the form of means and standard deviations. Bivariate Analysis: The chi-square test is used to test the relationship between the independent variable (risk factors) and the dependent

variable (DHF incidence). Odds ratios (OR) and 95% confidence intervals (95% CI) were calculated to measure the strength of the association. Multivariate analysis: Logistic regression analysis was used to identify independent risk factors associated with the occurrence of dengue fever. Independent variables that were statistically significant in the bivariate analysis were entered into the logistic regression model. This study has received ethical approval from the relevant research ethics committee. Informed consent was obtained from the child's parent or guardian before data collection. Confidentiality and privacy of participants were maintained throughout the study.

3. Results and Discussion

Table 1 shows that univariate analysis shows that the incidence of dengue fever is higher in boys (58.1%) than girls (41.9%) and in children aged 5-9 years (62.8%) compared to children aged 10- 14 years (62.5%). High residential density (78.4%), the presence of mosquito larvae (78.9%), the habit of hanging clothes frequently (70.5%), and a history of mosquito bites (79.4%) were also associated with a higher incidence of dengue fever.

Table 1. Characteristics of respondents.

Characteristics	DHF	Total	Percentage
Respondent's age			
5-9 years	102	162	62.96
10-14 years	60	96	62.50
Respondent's gender			
Man	149	140	106.43
Woman	109	118	92.37
Residential density			
High	98	125	78.40
Low	57	133	42.86
The presence of mosquito larvae			
Yes	142	180	78.89
No	38	78	48.72
Habit of hanging clothes			
Often	67	95	70.53
Rarely	28	163	17.18
History of mosquito bites			
Ever	123	155	79.35
Never	32	103	31.07

Table 2 shows a significant relationship between the incidence of dengue fever and high residential density (OR=2.87; 95% CI: 1.65-5.01; p=0.001), the presence of mosquito larvae (OR=3.21; 95% CI: 1.89-5.45; p=0.001), the habit of hanging clothes frequently (OR=2.87; 95%CI: 1.32-5.21; p=0.02), and history of mosquito bites (OR=2.54; 95% CI: 1.48-4.36; p=0.001).

Table 2. Bivariate analysis of risk factors.

Characteristics	OR	95% CI	p-value
High residential density	2.87	1.65-5.01	0.01
The presence of mosquito larvae	3.21	1.89-5.45	0.01
The habit of hanging clothes	2.87	1.32-5.21	0.02
History of mosquito bites	2.54	1.48-4.36	0.01

Table 3 shows a significant relationship in multivariate analysis between the incidence of dengue fever and high residential density (OR=2.37; 95% CI: 1.45-5.01; p=0.001), the presence of mosquito larvae (OR=2.85; 95% CI: 1.69-5.25; p=0.001), the habit of hanging clothes frequently (OR=2.37; 95%CI: 1.22-5.01; p=0.02), and history mosquito bites (OR=2.24; 95% CI: 1.28-4.16; p=0.001).

Table 3. Multivariate analysis of risk factors.

Characteristics	Adjusted OR	95% CI	p-value
High residential density	2.37	1.45-5.01	0.01
The presence of mosquito larvae	2.85	1.69-5.25	0.01
The habit of hanging clothes	2.37	1.22-5.01	0.02
History of mosquito bites	2.24	1.28-4.16	0.01

The results of this study provide valuable insight into the risk factors that contribute to the incidence of Dengue hemorrhagic fever (DHF) in children in Batang Regency, Indonesia. The main finding that is highlighted is the significant role of high residential density and the presence of mosquito larvae in water reservoirs as independent predictors of the incidence of dengue fever. High residential density has long been identified as an important risk factor in dengue epidemiology. In the context of this research, residential density is defined as the number of individuals living in one household. Multivariate analysis results show that increasing residential density significantly increases the risk of a child being infected with the dengue virus. There are several mechanisms that can explain the relationship between residential density and increased risk of dengue fever. First, high residential density can increase contact between humans and dengue vector mosquitoes, namely *Aedes aegypti* and *Aedes albopictus*. In crowded households, there are more individuals who are potential sources of infection for mosquitoes, and conversely, more individuals are susceptible to bites from infected mosquitoes. Second, high residential density is often related to inadequate environmental conditions, such as poor sanitation and suboptimal ventilation. This condition can create a conducive environment for the breeding of Aedes mosquitoes. Stagnant water that is not well managed, piles of rubbish, and other water reservoirs can become breeding grounds for mosquito larvae. Third, high residential density can influence the behavior of household residents, including behavior related to dengue prevention. In crowded households, it may be more difficult to consistently implement dengue prevention practices, such as the use of mosquito nets, the use of mosquito repellent, and the eradication of mosquito nests.[8-10]

The presence of mosquito larvae in water reservoirs is an important indicator of the risk of dengue fever transmission. Mosquito larvae are the larval stage of the Aedes mosquito, which is the main vector of dengue fever. Water reservoirs, such as bathtubs, buckets, used cans, and flower vases, can become

breeding grounds for mosquito larvae if not managed properly.

The results of this study show that the presence of mosquito larvae in water reservoirs significantly increases the risk of a child being infected with the dengue virus. This emphasizes the importance of vector control as one of the main strategies for preventing dengue fever. Eradicating mosquito nests, namely eliminating or draining water reservoirs, is an important step in breaking the mosquito life cycle and reducing the Aedes mosquito population. In addition, the use of larvicides, namely chemicals that kill mosquito larvae, can be an additional strategy in vector control. Larvacides can be applied to water reservoirs that are difficult to drain or drain. However, larvicide use must be done carefully and in accordance with the instructions for use to avoid negative impacts on the environment and human health.[9-11]

The findings of this research have important implications for public health in Batang Regency. High residential density and the presence of mosquito larvae in water reservoirs is a complex public health problem and requires a multisectoral approach to overcome it. The dengue control program must involve various parties, including local government, the health sector, the education sector, the environmental sector, and the community. This program must include health promotion activities, community empowerment, vector control, and improving environmental sanitation. Health promotion should aim to increase community knowledge, attitudes, and practices regarding dengue prevention. Community empowerment must involve the community in planning, implementing, and evaluating dengue fever control programs. Vector control must include activities such as eradicating mosquito nests, using insecticides, and providing mosquito nets. Improving environmental sanitation must include providing clean water, good waste management, and improving drainage.[10-13]

There are several potential mechanisms that can explain how the habit of hanging clothes inside the house can increase the risk of dengue transmission. Hanging clothes can create an ideal microenvironment for *Aedes aegypti* mosquitoes to hide and rest. Folds of fabric, damp areas, and shadows created by clothing can provide protection for mosquitoes from exposure to direct sunlight and unfavorable environmental conditions. Human odor left on clothing can act as an attractant for the Aedes aegypti mosquito. This mosquito is known to have a preference for human odors, especially the smell of sweat and lactic acid. Clothes that have just been worn or clothes that are damp from sweat can attract mosquitoes to land and look for a source of blood. The habit of hanging clothes inside the house, especially in areas frequently passed by householders, can increase the frequency of contact between humans and mosquitoes. Mosquitoes hiding in clothing can easily bite humans who are nearby, increasing the risk of transmitting the dengue virus. Clothes hanging inside the home can be an obstacle to vector control efforts, such as the use of spray insecticides. Fabric folds and hidden areas can protect mosquitoes from insecticide exposure, reducing the effectiveness of vector control.[14-16]

Although research on the relationship between clothing-hanging habits and dengue risk is still limited, several observational and experimental studies provide initial evidence to support this hypothesis. An observational study in Thailand found that households that have the habit of hanging clothes inside the house have a higher risk of becoming a breeding ground for the Aedes aegypti mosquito than households that do not have this habit. Another study in Vietnam showed that Aedes aegypti mosquitoes were more often found on clothes hanging inside the house than on clothes stored in the cupboard. An experimental study in the laboratory shows that Aedes aegypti mosquitoes are more attracted to landing on clothes that have been worn by humans compared to clothes that have not been worn. This study also shows that mosquitoes are more active in searching for blood in environments where there are hanging clothes. These findings have important implications for dengue prevention strategies. Apart from focusing on eradicating mosquito nests and using repellents, attention also needs to be paid to daily habits that may increase the risk of contact between humans and mosquitoes. The public needs to be educated about

the potential risks of dengue fever associated with the habit of hanging clothes inside the house. It is recommended to dry clothes in direct sunlight or using a tumble dryer. If you have to hang clothes inside the house, it is best to choose an area that is not frequently passed by the occupants of the house and make sure the clothes are completely dry before hanging. In addition, using mosquito nets when sleeping and using mosquito coils or electric coils can help reduce the risk of mosquito bites. It is also important to keep the house and surrounding environment clean, including cleaning water reservoirs regularly to prevent mosquitoes from breeding.[17-20]

4. Conclusion

High residential density, the habit of hanging clothes, and the presence of mosquito larvae in water reservoirs are the main risk factors for the incidence of dengue fever in children in Batang Regency. Public health interventions that focus on vector control and improving environmental sanitation are critical to reducing the dengue burden in these areas. Vector control programs should include activities such as eradicating mosquito nests, using insecticides, and providing mosquito nets. Improving environmental sanitation must include providing clean water, good waste management, and improving drainage.

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