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Dengue Risk Factors for Households in Endemic Areas in Palopo City, South Sulawesi, Indonesia: A Case-Control Study

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Abstract

Background: The risk factors and conditions that increase dengue fever cases and outbreaks in endemic areas needs to be identified to determine the specific prevention and control efforts required. This study aimed to determine the particular needs of dengue intervention in Palopo City.

Materials and Methods: Housewives in Palopo City's East Wara Sub-District were interviewed for the case-control study's data. There were 168 homes in the sample overall, 84 of which had dengue cases and 84 did not. Patients with dengue fever, as determined by hospital laboratory tests employing the NS1 antigen RDT and IgM-IgG antibodies from the Palopo City Health Office and public health center (PHC) reports in 2021, were considered cases in this research. The neighbors of cases who had never been diagnosed with dengue fever were the closest controls.

Result: Respondent achievement level (RAL) was poor for seven out of seventeen attitude statement points and low for four out of eleven practice statements. Most of the potential containers for dengue were discovered beyond the residence. In Palopo City, household larval density (CI>20%) was associated with a higher incidence of dengue illness (OR 2.173, 95%CI 1.097-4.304). The knowledge, attitude, practice, waste management, buildings and abandoned locations, and mobility were not demonstrated to be dengue fever risk factors in this study.

Conclusions: An intervention to promote community awareness of dengue fever prevention and vector control is to enhance specific knowledge about dengue fever through better counseling.

Keywords: Larva, Knowledge, Attitudes, Disease Outbreaks

Introduction

Dengue fever prevention and control efforts require different approaches due to different risk factors and specific conditions in a region [1]. Research suggests that health promotion, prevention, and control of dengue should start with knowing the social-ecological conditions of the local community [2]. The social-ecological level is categorized into five groups: intrapersonal (individual attitudes, actions, knowledge, and skills), interpersonal (family, friends, colleagues), institutional, policy, and environmental factors [3]. Knowledge, attitudes, and practice (KAP) have been extensively studied in relation to dengue incidence and have yielded varying results [4,5]. Some studies suggest that socio-ecological factors such as community movement, household demographics, availability of drinking water sources, garbage bins, and Aedes aegypti are drivers of dengue fever cases as well as outbreaks [6,7].

Indonesia ranked the fifth regarding largest number of cases of dengue hemorrhagic fever (DHF) in 2022 after Brazil, Vietnam, the Philippines, and India [8]. Annual cases of DHF in Indonesia continue to fluctuate. In 2019, dengue's incidence rate (IR) was 51.5 per 100,000 population. In 2021, it dropped to 27 per

100,000 people. In 2022, the 36th week increased to 31.4 per 100,000 population with a Case Fatality Rate (CFR) of 0.84%. A total of 92.2% of districts/municipalities in Indonesia are affected by dengue fever [9].

Over the last two years (2021-2022), dengue cases in Palopo City have increased with deaths. An outbreak was reported in 2021, with IR 154 per 100,000 people and CFR 1.06%, while in 2022, it was IR 132 per 100,000 population and CFR 0.40% [10]. Six out of nine sub-districts in Palopo City are dengue-endemic areas [10].

A study reports that implementing more rapid and rigorous interventions will significantly impact the prevention of outbreaks and shorten the duration of dengue epidemics[11]. In order to find appropriate solutions and interventions, it is essential to know the risk factors and drivers of dengue fever in an area, especially in areas with dengue fever cases throughout the year [12,13].

This study aimed to find and capture risk factors for dengue fever incidence as a description of the potential risk of dengue fever at the household level in Palopo City as information for proper intervention materials for dengue control across the community.

Materials and Methods

This case-control study was conducted in April-August 2023 in East Wara Sub-district, Palopo City. East Wara sub-district is an endemic area with the highest dengue fever cases yearly. In 2021, there was a dengue outbreak in Palopo City, where the highest number of cases and deaths cases occurred in the East Wara Sub-district.

The sample size was calculated using sample calculation formula based on the Lemeshow's test [14]:

Formula 1.

$$n = \frac{\{Z_{1-\frac{\alpha}{2}}\sqrt{2P_2(1-P_2)} + Z_{1-\beta}\sqrt{P_1(1-P_1+P_2(1-P_2))}\}^2}{(P_1-P_2)^2}$$

P1 and P2 are the proportion of cases in each variable exposure, confidence level 95%, and power of test 80%. The total sample for this study was 168 households, 84 cases and 84 controls, after considering the possibility of sample dropout.

The case households in this study were households with dengue fever cases. Cases in this study were patients with dengue fever diagnosed through hospital laboratory tests using the NS1 antigen RDT plus IgM-IgG antibodies in the 2021 Health Department and Public Health Center (PHC) reports. The number of cases in East Wara Sub-District was 109 which was obtained from the reports of 9 hospitals in Palopo city. Since the unit of study was the household, multiple cases in the same household were counted once. Sample cases were selected sequentially based on the order of the annual case list reported by the hospitals to the Palopo City Health Department. Households that had moved were replaced based on the order in the sample list until the sample size was reached.

The criteria for control households were the closest neighbors in 100-m radius of the case's house. Control households were neighbors whose household members have never been diagnosed with dengue by a health worker or in health facility. Control households were selected based on the distance of the nearest door. We did not match case characteristics in determining the criteria for control households.

Data were collected by interviewing housewives using a structured questionnaire. Housewives were selected as respondents considering their role as the main human resource in the household so that they can provide insightful information about home conditions related to the variables to be studied [15]. The questionnaire contained questions to assess the household, where some questions on knowledge of symptoms were taken from the dengue investigation guideline [16] and previous studies that developed questionnaires to assess attitudes as well as practices of dengue prevention [17]. Interviews were conducted by the research team by visiting the homes of case and control samples accompanied by the cadres and health center staff.

Knowledge questions were measured by scoring 1 for correct answers and 0 for incorrect ones. Respondents' knowledge was considered good if the value of the respondents' answers was ≥56 (median value of the total score) and less than the median value, which was categorized as poor.

Respondents' attitudes and practices were measured using a Likert Scale with five categories: strongly disagree, disagree, neutral, agree, and strongly agree. Statements were prepared by combining positive and negative statements. Positive attitude and practice categories are respondents who have attitudes and practices that support DHF prevention which have a score higher than the average cumulative respondent achievement level (RAL) score and negative respondents who score less than the average cumulative RAL score. Attitudes were positive if the answer score was ≥72.6% (cumulative RAL score) while scores less than the RAL were categorized as negative. Practices were positive if the answer score was ≥72.3% (cumulative RAL score) and scores lower than that were categorized as negative.

Waste management refers to the availability of regular waste collection facilities. The presence of abandoned buildings/areas was measured by interview and observation of the presence or absence of abandoned buildings or areas within 100 m of the respondent's house. Mobility was measured by asking if any household members or other relatives routinely

mobilized during the case period. The density of larvae was measured by observing water-filled containers inside and outside the house, which were recorded in the larval observation form [18]. The house was categorized as dense if the Container Index (CI) was ≥20% and not if the CI was <20%.

Validation and reliability tests were conducted on 30 respondents to determine the feasibility of the questionnaire measuring respondents' knowledge, attitudes, and practices. The validation test results of the knowledge, attitude, and practice variables revealed the value of r-count > r-table (0.361) so that the questions in the questionnaire were declared valid. The calculated r value of the knowledge variable was within 0.702-0.833. The r-count value of the attitude variable was between 0.757 and 0.926, and the r-count value of the practice variable ranged from 0.707 to 0.816. The reliability test showed Cronbach's Alpha values for knowledge, attitude, and practice were 0.805, 0.817, and 0.759, respectively.

Following data collection, we conducted the analysis stage, and in the final stage we used logistic regression analysis to obtain the risk factors for dengue fever incidence. Bivariate analysis uses the odds ratio test to observe the relationship between the independent variable and dependent variable where the relationship is seen by the odds ratio (OR) results. The selection was done through a bivariate analysis where variables with p value>0.25 were excluded from multivariate analysis [19]. Analysis was also conducted to test for possible confounding and interaction variables. The test was conducted on larval density, knowledge, attitude, practice, waste management, and the presence of abandoned buildings/areas. Multivariate analysis can be used to obtain the strength and significance of the relationship between the independent variable and the dependent variable with OR and Confidence Interval (CI) values.

Results

Table 1 reports an overview of respondents' knowledge about dengue fever. In Table 1, there were four question points that showed an association with the incidence of dengue fever ($p<0.05$). Knowledge that DHF is more susceptible to children under 15 years old, and that avoiding mosquito bites in the morning and evening can prevent DHF, was highest in the control group. Knowledge that littering leads to more mosquitoes, and regularly draining water reservoirs can prevent dengue fever, was highest in the case group. Most respondents received counseling about dengue fever more than 6 months ago.

Table 1. Respondents' General Knowledge of Dengue Hemorrhagic Fever

Question		Case (%)		Control (%)		P-value
Is dengue a contagious disease?	Yes	64	(76.2)	46	(54.8)	0.004
	No	14	(16.7)	18	(21.4)	
	Don't know	6	(7.1)	20	(23.8)	
Person-to-person contact transmits dengue fever	Yes	3	(3.6)	12	(14.2)	0.004
	No	66	(78.6)	47	(56.0)	
	Don't know	15	(17.8)	25	(29.8)	
Children under 15 years old are more susceptible to dengue fever	Yes	40	(47.6)	49	(58.3)	0.119
	No	20	(23.8)	10	(11.9)	
	Don't know	24	(28.6)	25	(29.8)	
Do dengue mosquitoes breed in stagnant water that tends to be clean?	Yes	50	(59.5)	68	(81.0)	0.001
	No	18	(21.4)	3	(3.6)	
	Don't know	16	(19.0)	13	(15.4)	
Carelessly disposed of garbage causes more mosquitoes	Yes	71	(84.5)	69	(82.1)	0.900
	No	3	(3.6)	3	(3.6)	
	Don't know	10	(11.9)	12	(14.3)	
Preventing mosquito bites in the morning and evening can prevent dengue fever.	Yes	61	(72.6)	66	(78.6)	0.667
	No	4	(4.8)	3	(3.6)	
	Don't know	19	(22.6)	15	(17.8)	
Regularly draining water reservoirs can prevent dengue.	Yes	73	(86.9)	66	(78.6)	0.871
	No	5	(6.0)	8	(9.5)	
	Don't know	6	(7.1)	10	(11.9)	
Is there a special medicine for dengue fever?	Yes	77	(91.7)	67	(79.8)	0.001
	No	0	(0.0)	12	(14.3)	
	Don't know	7	(8.3)	5	(6.0)	
Receive dengue information	<6 months	8	(9.5)	5	(6.0)	0.564
	>6 months	76	(90.5)	79	(94.0)	

*$P<0.05$ (statistically significant)

Table 2. The cumulative respondent's achievement level score of attitude category

	Attitude towards DHF (Symptoms, Causes, Control)	RAL		
		Case	**Control**	**Cumulative**
1	I worry if a family member has a high fever for over two days.	41.1	39.9	81.0
2	The red rash on the skin and fever made me think of dengue fever.	39.6	39.5	79.1
3	I am at risk of dengue fever.	33.7	34.3	68.0
4	Children under 15 years old are more susceptible to dengue fever.	35.1	34.8	69.9
5	The fever for 3 days made me worried. I felt that I could not wait until 5 days to get treatment.	39.9	41.0	80.9
6	Dengue fever is not related to mosquitoes.	37.0	37.7	74.7
7	The PHC is the first place that comes to mind when a family member is suspected of having dengue fever.	38.8	41.9	80.7
8	Mosquito bites during the day have never worried me.	37.5	35.8	73.3
9	Mosquito bites during the day will not cause my family members to get sick.	36.7	35.4	72.1
10	If one person knows about dengue fever at home then he or she can help prevent dengue fever at home.	37.4	39.2	76.6
11	I only throw garbage in the designated place.	38.8	38.8	77.6
12	I do not mind and am not bothered by people littering.	30.5	33.1	63.6
13	I do not store unused items that can store water.	34.8	36.7	71.5
14	The accumulated garbage does not worry me as long as it is not in my yard.	31.8	34.5	66.3
15	Conveying information about dengue fever to family members is important.	39.3	39.5	78.8
16	I should take the time to check the mosquito breeding grounds around my house.	39.6	41.0	80.6
17	I need the help of health workers to monitor potential mosquito breeding sites in my home.	20.1	19.0	39.1
	Average	36.0	36.6	72.6

DHF: Dengue Hemorrhagic Fever. RAL: Respondent Achievement Level. PHC: Public Health Center

Table 2 indicates that seven of the attitude statements have a value lower than the cumulative mean (72.6%), namely statement numbers 3,4,9,12,13,14, and 17. Table 3 shows that for the action category, there are four statements that have a lower RAL than the cumulative mean (72.3%), namely statement numbers 7,8,9, and 10. These results are also same when compared to the mean values of respondents in each case and control group.

Table 3. The cumulative respondent's achievement level score of practice category

	Practice (Prevention and Control)	RAL		
		Case	**Control**	**Cumulative**
1	I use mosquito repellent inside the house.	39.8	38.8	78.6
2	Always store water in my house in tightly sealed containers.	39.6	39.5	79.1
3	Abandoned buildings/areas in my neighborhood require me to take action to prevent them from becoming mosquito breeding grounds.	36.4	36.4	72.8
4	I filed a complaint with the authorities when I discovered the illegal dumping site.	38.0	38.7	76.7
5	I am worried if there are illegal dumping sites around my house.	39.4	39.4	78.8
6	Household members should feel alert when many mosquitoes are biting during the day.	41.7	40.2	81.9
7	Fogging is the last step in stopping dengue fever transmission.	35.5	35.7	71.2
8	Fogging is not the way to prevent dengue fever.	23.8	27.0	50.8
9	Dengue is a seasonal disease and I will be safe from dengue if the dengue season has passed.	29.9	32.9	62.8
10	I get bitten by mosquitoes daily but have never been sick with dengue. So, I am dengue safe.	31.1	31.8	62.9
11	Environmental hygiene is my responsibility. I make sure to check where mosquitoes can thrive.	39.6	39.5	79.1
	Average	35.9	36.4	72.3

(RAL: Respondent Achievement Level)

The results of bivariate analysis on independent variables obtained three variables that qualify to be continued in the multivariate test: practice, larval density, and the presence of abandoned buildings/areas. The larval density variable had a significant value with a p-value <0.05, so there was a significant association between larval density and dengue fever incidence in dengue-endemic areas in Palopo City. The OR value of 2.173(95% CI: 1.097-4.304) does not include the number 1, so the OR is said to be meaningful. The larval density variable was significantly associated with the incidence of dengue fever as a risk factor. Households with dense larvae had 2.173 times the odds of DHF cases compared to those without dense larvae (Table 4).

Table 4. Crude and adjusted OR in the logistic regression model

Variables		Case n=84	Control n=84	Crude OR (CI 95%)	P-value	Adjusted OR (CI 95%)	P-value
Knowledge	Less	35	37	0.907 (0.492-1.672)	0.755	-	-
	Good	49	47	1 (ref)		-	
Attitude	Negative	48	47	1.05 (0.570-1.932)	0.876		
	Positive	36	37	1(ref)			
Practice	Negative	40	29	1.724 (0.927-3.208)	**0.086**	1.524 (0.802-2.895)	0.198
	Positive	44	55	1 (ref)		1 (ref)	
Larva Density	Yes	37	20	2.519 (1.300-4.882)	**0.006***	2.173 (1.097-4.304)	0.026*
	No	47	64	1 (ref)		1 (ref)	
Waste Management	No	13	10	1.355 (0.558-3.287)	0.654	-	-
	Yes	71	74	1 (ref)		-	
Abandoned Building/Area	Yes	73	64	2.074 (0.924-4.656)	**0.077**	1.688 (0.732-3.895)	0.219
	No	11	20	1 (ref)		1 (ref)	
Mobility	Yes	10	16	0.574 (0.244-1.352)	0.286	-	-
	No	74	68	1 (ref)		-	

*P<0.05 (statistically significant); ref (reference category)

Discussion

The density of larvae is the only variable stated as a risk factor in this study and is also a risk factor proven by previous studies [20,21]. Most positive containers of larvae in endemic areas are found inside the house. This condition causes closer contact between vectors and humans, especially when environmental conditions support larvae' development into adult mosquitoes. Different studies have mentioned that variations in Ae. aegypti vectors capability also affect dengue transmission. A study mentioned the presence of female Ae. aegypti mosquitoes infected with dengue virus in the house contributed positively to the incidence of dengue, while the presence of adult mosquitoes in the house contributed negatively to the incidence of dengue [22].

Although many positive containers were found inside the house in the case group, the overall number of positive containers was higher outside. Research suggests that outdoor containers are also potential breeding site and should be monitored [23]. Dengue vectors are resilient and adaptable to changing environmental conditions [24,25].

Several previous studies have suggested that KAP was a risk factor for dengue incidence [26], but this study did not prove the same. Respondents' knowledge was mainly good, and the highest was in the case group. The predominance of good knowledge could be because the questions in the questionnaire were mostly general knowledge about dengue fever that respondents may have heard before or even often. In the case group, they had heard the information during the officer's visit to the house or when family members were hospitalized. This result was in line with other studies where KAP was not associated with dengue fever incidence [19]. The study's results in Palopo City stated that knowledge did not contribute to the incidence of dengue, but 5.4% of the incidence in Palopo City could occur due to the interaction between education level and environmental conditions [27].

People in the study area generally knew that mosquitoes spread dengue fever and can cause death. However, respondents scored less regarding the follows: the virus being the cause of dengue fever, treatment of dengue fever, and potential breeding sites of Ae. aegypti. Although almost all respondents knew that mosquitoes spread dengue fever, not all respondents agreed that dengue fever is a contagious disease. This result aligns with research stating that health knowledge based on correct and objective information will help the community respond and adopt appropriate disease management efforts to minimize potential exposure to disease in the community [28,29].

Although the attitude variable was not proven to be a risk factor, RAL values were mostly low on negative statements. It may indicate a tendency to choose positive answers based on general knowledge but has not been realized in the form of supportive attitudes and actions. Research on behavior states that individual attitudes are very supportive of disease intervention. However, factors related to individual conditions have a significant influence on getting community agreement [30],31].

Respondents' practices had low RAL values on all negative statements. The community does not yet have a correct understanding of fogging. Fogging is seen as an effort to prevent dengue fever. When a case occurs in their area, people always expect fogging to be carried

out, and some even argue that fogging should be done before there is a dengue fever case. Research results related to dengue prevention and control in the Netherlands show that many people think fogging is the best method for dengue vector control [32].

Some people in the study area still believed that dengue fever is a seasonal disease. They depend on fogging without implementing mosquito nest eradication and tend to be indifferent to dengue control at certain times only. Research suggests that in addition to knowledge and perceptions, dengue prevention and control practices were influenced by dengue experiences. Most of the actions chosen concerning dengue prevention were based on knowledge due to experience [33]

In several studies in Indonesia, waste management and abandoned buildings/areas were among the risk factors for dengue fever [34,35]. Although this study proves different results, it was in line with a study in China where waste management, household garbage, and abandoned sites were not associated with dengue fever incidence [12]. Waste management is not a risk factor since most areas in Palopo City have routine waste collection facilities. Areas that do not have routine waste collection facilities can access waste containers that are available in several public places, especially around commercial centers. The presence of abandoned buildings/areas was not proven as a risk factor due to the similarity of conditions between the case and control groups. The control group in this study was the closest house to the cases, so that this characteristic could be similar in number.

Regular community mobility to disease source areas was a significant factor in the spread of vector-borne diseases [36]. Research in Mataram states that mobility to endemic areas was a risk factor for dengue fever incidence [37]. This study provided different results. Mobility was not a risk factor in endemic areas of Palopo City. Respondents who traveled to endemic areas were more in the control group. Population mobility in endemic areas was not a risk factor as there have been local transmissions without the entry of viruses or cases from outside the areas [38,39].

Although the questions in the questionnaire were taken from many previous studies, most of the questions to measure knowledge were common knowledge for the people of the study area. This condition caused the questionnaire not to be able to measure specific knowledge about dengue fever.

Conclusion

The density of larvae was the only risk factor for dengue incidence in endemic areas, as evidenced in this study. However, specific knowledge about the disease still scored low, and some misperceptions about fogging and dengue transmission remained. Dengue prevention and control programs in endemic areas should focus on improving specific knowledge that can encourage the community's active role in taking proper preventive measures, including monitoring the presence of outdoor containers.

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Conflict of interest

None declared.

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Ethical Considerations

We applied informed consent prior to data collection.

Code of Ethics

Ethical approval for this study was obtained from the Research Ethics Committee of the Faculty of Public Health, Hasanuddin University number 146/UN4.14.1/TP.01.02/2023.

Authors' Contributions

Yona Patanduk: Conceptualised the study, data collection, Statistical analysis, interpretation of results, drafted, revised and reviewed the manuscript. Nur Nasry Noor: Conceptualised the study and reviewed the results. Ansariadi: Conceptualised the study and reviewed the results.

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