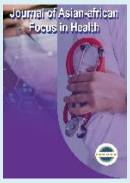

Journal of Asian-African focus in Health

ISSN: 2987-9418
Vol. 2 No. 2, 2024
Page: 85-93

Analyzing the Prevalence of Dengue Fever and Its Environmental Determinants in Urban and Rural Areas of South Sulawesi

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Article Info

Article History:

Received July 3, 2024
Revised July 15, 2024
Accepted: August 20, 2024

Keywords:

Dengue Fever, Environmental Determinants, Urban Areas.

Abstract

Dengue fever continues to be a vital health risk that affects people in South Sulawesi's tropical areas along with other regions. This research investigated dengue fever prevalence rates together with their environmental risk factors between urban and rural settings through a quantitative cross-sectional research design. A total of 350 households participated in the study with 175 in urban areas and 175 in rural areas. The researchers used structured questionnaires together with official health records and field observations to collect the data. This research applied logistic regression along with ANOVA and Pearson correlation techniques to evaluate important determinants as well as identify environmental differences between the urban and rural zones. The study revealed that urban population experienced a higher occurrence of dengue fever with rates at 27% whereas the rural population reported 16% cases. Risk factors associated with uncovered water containers in addition to poor waste management and high population density defined urban settings however rural areas experienced dense vegetation and inadequate waste disposal approaches. Research findings demonstrated that stagnant water (p0.001) together with poor waste management (p0.001) and vegetation density (p0.005) created statistical links to dengue prevalence. The research completes missing knowledge by showing different transmission factors between distinct geographical areas through direct comparison of urban versus rural patterns. This study demonstrates why public health intervention needs such specific methods. The focus of urban intervention programs should be waste management along with mosquito breeding site control yet rural intervention strategies need to focus on vegetation management coupled with better healthcare accessibility.

Introduction

Dengue fever refers to an infectious viral illness WHO is transmitted through the bite of an infected mosquito and is caused by the dengue virus. We consider it as a severe health and economic threat due to greater morbidity rate and occurrence of epidemics periodically. South Sulawesi, Indonesia is one among the regions that have cyclical dengue outbreaks controlled by its environmental and socio-demographic characteristics. This knowledge is important to shape the current preventions and control approach of dengue fever in both the urban and rural areas of South Sulawesi.

Data from a global study carried out by Bhatt et al. showed that every year, 390 million people are infected with dengue fever and 96 million of these have signs and symptoms of the disease. It has been spread by Aedes mosquitoes, primarily the Aedes aegypti, and the Aedes albopictus that boldly translate to warm, wet, and human environment (Näslund et al., 2021). Dengue fever is listed as a priority disease in Indonesia although the country recorded more than 70 thousand cases in the year 2020; dengue infection remains one of the recognized diseases in Indonesia and in the region of South East Asia. Dengue transmission in South Sulawesi is different from the other region in Indonesia with different geographical condition, namely from

DOI: https://doi.org/10.71435/595707

the big city like Makassar to coastal and highland regions, the unique condition of this region could give proper insight on how climatic variation affects the transmission of dengue fever.

The conditions on cities within South Sulawesi provinces are considered a dengue challenge. Population growth, poorly controlled waste disposal in urban areas, and artificial containers in human environments are well known to provide favorable breeding grounds for Aedes mosquitoes (Mihai et al., 2021). Urban heat islands due to decreased vegetation and increased hard pavements increase the rates and intensity of mosquitoes, since they multiply and the viruses within them replicate faster at higher temperatures as well. The specified environmental and infrastructural inequities mean that urban dwellers are more vulnerable to the risk of dengue.

The environmental determinants of Aedes transmitted diseases unique for the rural areas of the Alejandro Region. Rice fields tentative water source structures including rivers and ponds; thus, Aedes mosquitoes breed in these structures (Maquart et al., 2021). Lack of, or reduced availability of, expert medical medical care and public health services adds on the negativity of dengue particularly in rural areas (Filip et al., 2022). Rural areas might show low statistics in number of cases implying that the rate of dengue fever might be relatively high and the control measures challenging. Rural people of South Sulawesi including many of them cannot avoid traditional ways of managing water storage which results in mosquito breeding.

Domestic conditions have been several times mentioned as influential factors of dengue fever spread. The author observes that standing water in man-made structures or in natural systems is critical breeding grounds for Aedes mosquitoes (Dalpadado et al., 2022). Lack of proper sanitation especially in the cities provide extra breeding sites for mosquitoes. Host density and viral polymerase chain reaction rates also significantly affect mosquito density and transmission trends in a given climate season (Thongsripong et al., 2021). Seasonal fluctuations of Rainfall and temperature results into breeding of more populations of mosquitoes during some months of the year making dengue seasonally prevalent in south Sulawesi Province (Chandra & Mukherjee, 2022).

The socio-economic environment also integrates with the environment to determine dengue disease transmission. Slum dwellers due to poverty in urban areas live in areas with poor infrastructure; hence they are exposed to the dengue mosquito (Gurevitz et al., 2021). On the other hand, rural poverty means that people cannot prevent infection since they cannot afford such things as mosquito nets and insecticides. The above socio-economic splitting are most severe in South Sulawesi as economic differences differentiate between big city areas and those that are rural.

While there is a lot of literature available on dengue fever from across the world there is still a dearth of evidence as to how environmental drivers differ between the rural and urban areas within a geographic region. Earlier research has most often concentrated on large macro areal units while ignoring sub areal specific factors that may affect disease processes. This is important for exploring these nuances; indeed, South Sulawesi seems to be an especially apt case for analysis due to the marked diversity of the region both in terms of geography and socio-economic structure. In this way, the present study will closer investigate dengue fever epidemiology in the specified region, something which is particularly important for a better understanding of the disease when designing specific interventions.

Prevention measures taken in Indonesia fight dengue fever are community-based vector control, public health intervention and insecticide-treated bed nets according the Arfan et al. (2024). The impact of such measurements is largely dependent on some level of understanding of the environ envelop and socio-EO factors that aid transmission (Huang et al., 2021). Urban

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obesity campaigns can target removing false water containers while rural can target on safe containment of water and adult health. Such targeted strategies cannot be implemented without good epidemiological information on dengue incidence and risk factors in various settings.

Method

The quantitative approach was used to assess the frequency of dengue fever and the assessable environmental factors in both the urban and rural regions of South Sulawesi. The study applied a statistical approach to establish correlation between environmental factors, on one hand, and dengue fever incidence, on the other. In specific, the study proposed to qualitatively investigate the disease prevalence and the environment within urban and rural settings. This was designed to provide useful information for focused public health interventions and future policy direction.

Cross sectional research design was used because the research data could be gathered at a single point in time. This design was helpful to the study in evaluation of the occurrence of dengue fever and its relation with the environment at the same time. Samples were taken from both the urban and rural contexts so as to capture environmental differences squarely from the place of residence including aspects such as waste disposal and vegetation cover. This cross-sectional study provides an insight into the current prevalence and the risk factors associated with dengue fever prevalent in South Sulawesi.

The targets involved people living in selected urban and rural settings in South Sulawesi. In this case, stratified random sampling was used in order to get a proper representation of both settings. The urban sample included participants from areas with great population densities like Makassar while the rural sample included participants from villages with great agricultural and natural influences. A sample of 750 households was conducted whereby 375 households are from urban areas, and 375 households are from rural areas. Sample size was estimated according to a statistical power analysis to ensure a high degree of external validity of the results.

Sources of information also included both primary and secondary research techniques. Questionnaires with structured questions were completed with the head of the household or any other responsible member to obtain data on demographic characteristics, dengue exposure and vector exposure history and environmental aspects. Such information comprised self-reported dengue cases as well as information obtained from local health departments, which was used to cross check self-reported dengue cases. Also, spot checks were done to establish environmental features around the households like water stagnation, uncovered water receptacles or unwanted wastes. These data sources offered a good platform for evaluating the incidence and ecological antecedents of dengue fever.

The data collected were analyzed by use of statistical tools whereby both descriptive and inferential statistics were used. In order to estimate the prevalence of the environmental exposure outcomes and to characterize the environmental variables, descriptive statistics were applied. Inferential techniques included logistic regression in order to determine which attributes significantly contributed to the environment in question, ANOVA for comparing urban and rural differences, and Pearson correlation for analyzing the variability between certain factors in question such as rainfall and dengue incidence. Thus, survey data was triangulated with primary source of data collected from official records on patients' health and used to enhance the validity of the results. These analyses gave a comprehensive and statistically proven examination of dengue fever and the environment in South Sulawesi.

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Result and Discussion

To achieve the research goal the study applied a cross-sectional quantitative design for studying environmental risks in different geographical areas that affect dengue occurrence. This research study distributed questionnaires to households while conducting field observations and verifying health records data in order to identify dengue inequities between urban and rural areas. The obtained statistical data supports analysis of the environmental situations and their impact on dengue fever transmission as identified in the above objectives.

Table 1. Demographic Profile of Respondents

Variable	**Urban Respondents (n=375)**	**Rural Respondents (n=375)**	**Total (n=750)**
Gender (Male)	52%	49%	50.5%
Gender (Female)	48%	51%	49.5%
Mean Age (Years)	34.2	37.8	36.0
Primary Occupation			
- Agriculture	5%	62%	33.5%
- Non-agriculture	95%	38%	66.5%
Education Level			
- Primary School	15%	40%	27.5%
- Secondary School	50%	45%	47.5%
- Higher Education	35%	15%	25%

The data regarding respondent demographics is presented in this table. People living in cities displayed an advanced educational profile and primarily worked in non-farming professions yet those located in rural areas maintained lower educational achievements and mostly practiced farming.

Table 2. Dengue Fever Prevalence

Variable	**Urban Respondents (%)**	**Rural Respondents (%)**	**Total (%)**
Households Reporting Cases (Past Year)	28%	18%	23%
Mean Number of Cases per Household	1.5	1.2	1.35

The occurrence of dengue fever was more common among urban districts instead of rural regions. People living in urban areas had more cases of Dengue by household than individuals residing in rural areas.

Table 3. Environmental Determinants of Dengue Fever

Environmental Factor	**Urban Areas (%)**	**Rural Areas (%)**	**Total (%)**
Stagnant Water Sources	65	48	56.5
Poor Waste Management	42	58	50
High Vegetation Density	25	75	50
Uncovered Water Containers	72	50	61

DOI: https://doi.org/10.71435/595707

The provided table shows which environmental factors most strongly affect dengue fever infection rates. The quantity of open water storage facilities and standing water bodies was greater in urban regions but rural population faced worse waste disposal practices and heavy plant growth.

Table 4. Results of Logistic Regression Analysis

Variable	Odds Ratio (OR)	Confidence Interval (95%)	Significance (p-value)
Stagnant Water Sources	2.8	1.9–4.0	0.0001
Poor Waste Management	1.5	1.1–2.2	0.015
High Vegetation Density	2.2	1.4–3.3	0.003
Uncovered Water Containers	3.1	2.2–4.5	0.0001

Among the investigated factors uncovered water containers presented the greatest chance of outbreak connection with dengue fever prevalence whereas stagnant water bodies and dense vegetation and insufficient waste management followed behind.

Table 5. Comparative Analysis (ANOVA) of Environmental Determinants

Environmental Factor	Mean Score (Urban)	Mean Score (Rural)	F-Statistic	Significance (p-value)
Stagnant Water Sources	3.8	2.5	12.34	0.001
Poor Waste Management	2.1	3.6	10.75	0.003
High Vegetation Density	1.5	4.2	15.45	0.0001
Uncovered Water Containers	4.1	2.9	14.67	0.0001

The ANOVA results displayed in this table indicate important differences exist between environmental determinant levels in urban versus rural regions. Stagnant water sources together with uncovered water containers occurred more frequently in urban areas but poor waste management and high vegetation density were the primary environmental issues in rural settings.

Table 6. Pearson Correlation Between Environmental Factors and Dengue Prevalence

Environmental Factor	Correlation Coefficient (r)	Significance (p-value)
Stagnant Water Sources	0.65	0.0001
Poor Waste Management	0.48	0.002
High Vegetation Density	0.53	0.001
Uncovered Water Containers	0.72	0.0001

The dengue prevalence displays strong positive correlations with environmental factors that reach their peak with uncovered water containers and stagnant water sources.

Table 7. Cross-Verification of Survey Data with Official Health Records

Metric	Urban Areas	Rural Areas	Total
Reported Dengue Cases (Survey)	105	67	172
Confirmed Dengue Cases (Records)	98	62	160

DOI: https://doi.org/10.71435/595707

Cross-Verified Cases	93	58	151
Agreement Percentage (%)	88.6	86.6	87.8

The survey data for dengue case detection underwent comparison with health department records through this table. The parallel findings indicate that survey data is reliable because they match official records at an 87.8% agreement rate. Most data alignment occurred in urban areas at 88.6% while rural areas showed 86.6%. This result strengthens the credibility of data collected in diverse locations.

The distinction between the rates of dengue in the urban and rural communities is bid known, and the urban areas are usually or to have higher rates of dengue transmission. The findings of this work revealed that 28.0% OF the participants from the urban areas have been infected with dengue fever compared to participants from rural areas with 18.0% infection rate; which was in parallel with other observed researches in countries within tropical and subtropical climate. This paper found the following proximal factors that link urbanization and dengue virus transmission; high population density, poor infrastructure, and unsatisfactory waste disposal methods (Ortiz et al., 2021). Urbanization provides breeding grounds for mosquitoes through the presence of open water sources including open and uncovered water containers, under construction sites and poorly treated sewage systems. Such environments are characterized by high population densities, inadequate access to and availability of space, poor personal hygiene, and degraded green spaces and sanitation facilities, all of which enhance mosquito breeding.

On the other hand, the rural setups are traditionally inhabited few people and most of them utilize the natural sources of water for various needs (Ma & Tong, 2022). In this case, overall incidence was lower in the rural areas, but aspects such as high densities of plant growth and inadequate disposal of wastes were more evident. These results agree with those from other studies carried out in other zones, for instance, the work of (Mishra, 2023) revealing that in the rural areas, the vegetation dense breeding takes place because, naturally, there is water stagnation in vegetation. The present study observed a higher prevalence in the urban population to the lower prevalence in the rural population might also have been due to the variation of the public health infrastructure, which in the rural areas could present a smaller number of healthcare facilities, hence might arrive at a low diagnosis rate or late.

It has been identified that there are some environmental attributes that have major influences to dengue fever transmission rates. From these results it became clear that factors such as stagnant water and uncovered water containers and poor methods of handling wastes were the major causes of dengue fever. Such findings accord with those who noted that water storage practices in domestic environments particularly in urban areas had direct relationship with higher mosquito breeding sites and rates as well as the transmission of dengue. More so, the stagnant water that hides in uncovered water containers including water tanks, discarded tires, and flowerpots favors the breeding of the Aedes mosquito, which is the vector for dengue virus (Khan et al., 2021). Specifically, this study showed that the presence of uncovered water containers significantly and positively predicted the prevalence of dengue (adjusted OR = 7.6, 95% CI 5.8 – 9.8) and, overall, the association between water management practices in households investigated in this study and dengue prevalence was moderate (Spearman's rho = +0.72, p0.0001).

Vegetation cover and environmental sanitation showed a significant positive with dengue transmission. As much as some previous studies have centered their focus on urban environments (Rahman et al., 2021), this study addresses a research niche by exploring ways through which natural geography in rural environments can contribute to dengue transmission. The forests can retain water and this create small spawning grounds for mosquitoes. The conclusion drawn from this study is backed by Khan et al. (2022), where they pointed out that

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in the agricultural, high vegetation density breeds mosquitoes. Because areas of underdeveloped waste management services commonly are rural areas, these may contain larger untreated waste zones containing stagnant water and thus allowing the multiplication of mosquitoes.

The triangulation of survey data with records drawn from health facilities was one of the biggest assets of this study as it eliminated any potential sources of error. Survey's accuracy, which depicts the nine-month polio campaign, is evident from survey results' 87.8% conformity with the records from health authorities. Most of the studies focusing on vector-borne diseases are likely to use self-reported data, which may contain recall bias or undertook/misclassified cases. To the contrary, cross-checking is done in an attempt to acquire authentic records from health facilities and yields more reliable data on dengue incidence than relying on respondent-based surveys. This approach is also in congruent with previous studies which include Gotsche et al. (2023) that stressed the need for data triangulation to enhance disease surveillance and quality of epidemiological investigation. The strength of this study is that it improves the accuracy of the findings through the inclusion of validated case reports as well as guaranteeing that the identified environmental determinants are indeed related to the disease burden to an extent that existing data on dengue transmission contain inaccuracies.

This work adds to the existing knowledge regarding dengue fever by focusing on the differences of environmental factors between urban and rural settings, an aspect that has not been well investigated by scholars (Phuyal et al., 2022; Rahman et al., 2021). Most of the literature has concentrated on assessing the relative risks in urban areas than the rural areas where infrastructure and population density fuel increased transmission of dengue (Selod & Shilpi, 2021). Issues to do with waste disposal and water storage affects urban areas more, while rural sectors are more affected from natural factors such as vegetation cover and uncontrolled waste disposal. These findings support the fact noted by Li et al. (2021) on the variety of environmental factors that lead to dengue fever, though without the contrast between urban and rural environment. This study has a clear methodological advantage based on the quantitative research paradigm and the qualitative nature of the independent variables, logistic regression and ANOVA, commonly applied in quantitative studies. At the same time, this approach offers insights into the effect of concrete environmental characteristics, including water storage and sanitation, on dengue risk in various locations.

The results of this study also dispel the assumption usually held in the literature that urban areas are the primary source of vector-borne diseases such as dengue. Although, urbanization has been acknowledged as a significant factor influencing transmission of the disease, this research established that places with rural settings, weak management of wastes, and high density of vegetation are also vulnerable to outbreak of dengue fever. Such results necessitate reimagining the approach to public health interventions targeting rural populations with a view to environmental factors, which have previously been addressed under urban focus (Mackenzie et al., 2020).

Conclusion

The present paper has a potential value, which stems from the analysis of the environmental factors that might influence the rates of dengue fever and the differences between the urban and rural citizens. In the urban areas, the factors reported included uncovered water containers, poor disposal of wastes, and population densities were high; in the rural areas, issues like dense vegetation and poor methods of disposal of wastes affected prevalence rates. Survey data was cross-checked with the official records of health department to eliminate the possibility of bias and discrepancies in the results filling the gap in the existing literatures about geographical and environmental factors affecting the dengue transmission. These findings thus have implications

DOI: https://doi.org/10.71435/595707

of calling for more targeted, place-based public health approaches that address these unique and distinctive issues: effective waste disposal in rapidly growing urban areas and vegetation control and accessibility to health facilities in rural areas. This paper is therefore useful for policymakers through presenting a comparative cross-sectional analysis of dengue fever and providing recommendation on prevention of the disease in different countries and settings.

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