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CASE-CONTROL STUDY OF A CHIKUNGUNYA OUTBREAK IN GUNUNGKIDUL DISTRICT, INDONESIA (MAY–AUGUST 2024)

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Abstract: Gunungkidul District Early System was notified by the Paliyan Public Health Center about a rise in cases of sudden fever and arthralgia in the week of the 22nd. A team of the District Health Office and Paliyan Public Health Center's staff and FETP UGM residents conducted an epidemiological investigation.We used 1:1 unmatched case-control study design. Cases were defined as individuals with fever and arthralgia, with/without positive chikungunya lab results, who lived in Pampang Village, Paliyan Sub-district. The controls were healthy residents in the same neighborhood with cases. The total sample was 184 (92 cases and 92 controls). In-depth interviews and observation with structured questionnaires were used for data collection demographics, risk factors, and environmental data. Blood samples were tested using Rapid Diagnostic Test at a health laboratory. The analysis involved chi-square and multiple binomial regression methods.The majority of the cases were female (57.6%), with an age group of 19-59 (58.7%), and residents living in the neighborhood of RT 10/RW 03 (35.9%). All cases had fever and arthralgia. More than half had headaches (59.8%), rash (40.2%), and nausea (22.8%). Eleven samples were tested positive for Chikungunya. The House Index (HI) for larvae is 28.97%. The presence of mosquito larvae around the house (aOR=2.12; 95% CI=1.36 – 2.87) and the habit of collecting rainwater (aOR=1.68; 95% CI=1.02 – 2.45) were associated with higher illness risk in this outbreak. A chikungunya outbreak occurred in Gunungkidul District from 15 May 2024 to 5 August 2024, was linked to mosquito larvae presence and the community's rainwater collection habit. Education and promotion of health behaviors and implementation of the comprehensive 3M Plus Mosquito Nest Eradication Program (PSN) must be improved

Keyword: behavioral factors, chikungunya, mosquito breeding, outbreak, PSN 3M Plus, vector-borne disease

Introduction

Chikungunya is a mosquito-borne viral disease caused by the Chikungunya virus (CHIKV), primarily transmitted through the bites of Aedes aegypti and Aedes albopictus mosquitoes (Azman et al., 2024; Chen et al., 2021). The disease is characterized by sudden onset of fever, accompanied by severe and often debilitating arthralgia (Chen et al., 2021). Although fatalities from chikungunya are rare, the disease can significantly impact public health, particularly among vulnerable populations such as children, the elderly, and individuals with comorbid conditions (Badawi et al., 2018; Dutra et al., 2024). Prolonged arthralgia can persist for several weeks or even months severely disrupting daily activities and reducing productivity (Costa et al., 2023).

In Indonesia, chikungunya has been a recurring public health issue, frequently leading to outbreaks in various regions. A chikungunya outbreak is defined as a substantial increase in the number of cases

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within a short period or the emergence of more than one case in an area previously free of chikungunya (Direktorat Surveilans & Karantina Kesehatan Kemenkes RI, 2023). Outbreaks require rapid and coordinated responses from health authorities to identify and control sources of transmission and prevent further spread (Kim et al., 2020).

Although various studies have been conducted on chikungunya outbreaks in Indonesia, many have been limited to descriptive observations or secondary data analysis, which do not provide in-depth insights into the specific risk factors contributing to the spread of the disease (Sitepu et al., 2020; Sitepu & Depari, 2019). Furthermore, previous research has often overlooked systematic exploration of environmental and behavioral factors, such as mosquito larvae presence and the practice of collecting rainwater, which are critical contributors to the transmission of chikungunya (Tucunan et al., 2018). While studies have been conducted in Indonesia, few have specifically investigated these factors in rural areas with limited resources, such as Gunungkidul District (Sitepu et al., 2020; Sitepu & Depari, 2019). This gap highlights the need for more comprehensive research to better understand the factors driving Chikungunya transmission and to inform future prevention and control efforts.

In the 22nd week of 2024, the Gunungkidul District Early Warning and Allert Response System reported a significant increase in the number of fever cases accompanied by arthralgia in the Paliyan Health Center service area. This sudden rise raised concerns about a potential chikungunya outbreak, particularly due to the rapid and simultaneous spread of symptoms. In response, an epidemiological investigation was immediately conducted by the Paliyan Puskesmas Rapid Response Team, in collaboration with the Gunungkidul District Health Office and students of the Field Epidemiology Training Program (FETP) of Universitas Gadjah Mada.

This investigation was conducted to address the urgent need for understanding the factors contributing to the spread of chikungunya in Gunungkidul District. The primary aim of the study is to identify key risk factors, particularly environmental and behavioral factors such as mosquito breeding sites and public health practices, that contribute to the transmission of chikungunya. Additionally, the study seeks to determine the most vulnerable populations and formulate targeted recommendations for controlling and preventing future outbreaks.

By analyzing these factors, the study aims to provide valuable insights that can strengthen public health systems in Indonesia. The findings will help enhance surveillance, improve rapid response capabilities, and foster community engagement in disease prevention efforts. This study also emphasizes the importance of a coordinated One Health approach to address vector-borne diseases like chikungunya, integrating human, animal, and environmental health strategies. Ultimately, the goal is to improve prevention and control strategies, reduce the impact of future outbreaks, and strengthen the resilience of local health systems.

Materials and Methods

The epidemiologic investigation began with active case finding and continued with a 1:1 unmatched case control study. Cases were individuals living in Kalurahan Pampang, Kapanewon Paliyan who experienced symptoms of sudden fever accompanied by arthralgia, with/without positive laboratory

results for chikungunya in the period May 15, 2024 to August 5, 2024. Controls were healthy individuals living in Kalurahan Pampang, Kapanewon Paliyan during the period May 15, 2024 to August 5, 2024.

Primary data were obtained through interviews with residents of Kalurahan Pampang, Kapanewon Paliyan using a standardized questionnaire. Secondary data were obtained from SKDR reports, medical records from hospitals/community health centers, and laboratory results. Environmental investigation was conducted by interview and direct observation. Blood samples were taken as many as 15 samples, according to the Chikungunya outbreak management guidelines of the Ministry of Health of the Republic of Indonesia. Blood samples were analyzed at the DIY Provincial Health and Calibration Laboratory.

Descriptive analysis was conducted to describe cases based on people, places, and time. Bivariate analysis was performed to identify risk factors associated with chikungunya cases using chi-square (p-value <0.05). Furthermore, multivariate analysis was conducted from the significant results of the chi-square test, to identify risk factors that interact with each other and have a simultaneous influence on chikungunya cases using the logistic regression test (p-value <0.05) to identify factors that interact and have a simultaneous effect on chikungunya cases.

While the unmatched design was appropriate for this outbreak investigation, it is important to acknowledge its limitations. The lack of matching beyond the initial selection process could lead to residual confounding, as certain variables were not controlled for and could influence the comparison between cases and controls. Additionally, this design might result in imbalances in key demographic or environmental variables between cases and controls, which could affect the internal validity of the findings and limit their generalizability to other populations.

Results

The epidemiological investigation identified a total of 92 residents in Kalurahan Pampang, Kapanewon Paliyan, Gunungkidul District, Indonesia, who exhibited symptoms of sudden-onset fever and arthralgia. The first cases were detected in week 22 of 2024, with two initial cases reported. Over the subsequent weeks, the number of cases increased significantly, reaching its peak in week 25, during which 24 additional cases were recorded. After this peak, the number of cases began to gradually decline, with the last case being reported in week 28.

Table 1: Demographic Characteristics of Chikungunya Cases

Characteristics	Cases	
	Total, N=92	Percentages (%)
Gender		
Male	39	42.2

Female	53	57.6
Age Group		
≤ 9 years	3	3.3
10 – 18 years	12	13.0
19 – 59 years	54	58.7
≥ 60 years	23	25.0
Level of Education		
No formal education	12	13.0
Elementary school	20	21.7
Junior high school	24	26.1
Senior high school	32	34.8
Bachelor's/master's degree	4	4.4
Occupation		
Farmer	28	30.4
Entrepreneur	3	3.3
Privat sector	7	7.6
Civil servant	2	2.2
Laborer	12	13.0
Housewife	20	21.7
Student	15	16.3
Unemployed	5	5.4
Residential Areas		
RT 10/RW 03	33	35.9
RT 11/RW 03	11	12.0
RT 12/RW 03	27	29.3
RT 18/RW 05	16	17.4
RT 19/RW 05	5	5.4

As shown in Table 1, women are the most affected demographic, accounting for 57.6% of the total reported cases. Furthermore, individuals aged between 19 and 59 years exhibit the highest prevalence rate at 58.7%. Regarding educational qualifications, the highest proportion of cases is found among

individuals with a high school education or its equivalent, representing 34.8%. The occupation most affected is farming, with 30.4% of the cases, while the residential area RT 10/RW 03 shows the highest concentration of cases, at 35.9%.

Table 2: Distribution of Chikungunya Cases Based on Symptoms

Symptoms	Cases	
	Total, N=92	Percentages (%)
Fever	92	100.0
Arthralgia	92	100.0
Headache	55	59.8
Rash	37	40.2
Nausea	21	22.8
Vomiting	19	20.7
Swelling	8	8.7

The investigation revealed that all 92 cases of the chikungunya outbreak presented with fever and arthralgia, as shown in Table 2. In addition to these primary symptoms, a considerable portion of individuals also experienced secondary symptoms such as headache (59.8%), rash (40.2%), and nausea (22.8%). Other symptoms, including vomiting and swelling, were less frequently reported, with 20.7% and 8.7%, respectively.

Based on the epidemiological curve in Figure 1, it is known that the Chikungunya outbreak period occurred from May 15, 2024, to August 5, 2024. The first symptomatic case was reported on May 27, 2024, while the last case was detected on July 12, 2024. Epidemiological investigations were conducted on June 10, 2024, June 27, 2024, and July 7, 2024. During this period, three peaks of cases were recorded on June 8, 2024 – Juni 10, 2024; June 17, 2024 – Juni 25, 2024; June 29, 2024 – July 1, 2024. These peaks correspond to significant increases in case numbers, and their temporal distribution aligns with the periods of epidemiological investigations and fogging interventions. The pattern of transmission indicates that it is propagated, likely transmitted from person to person through mosquito vectors.

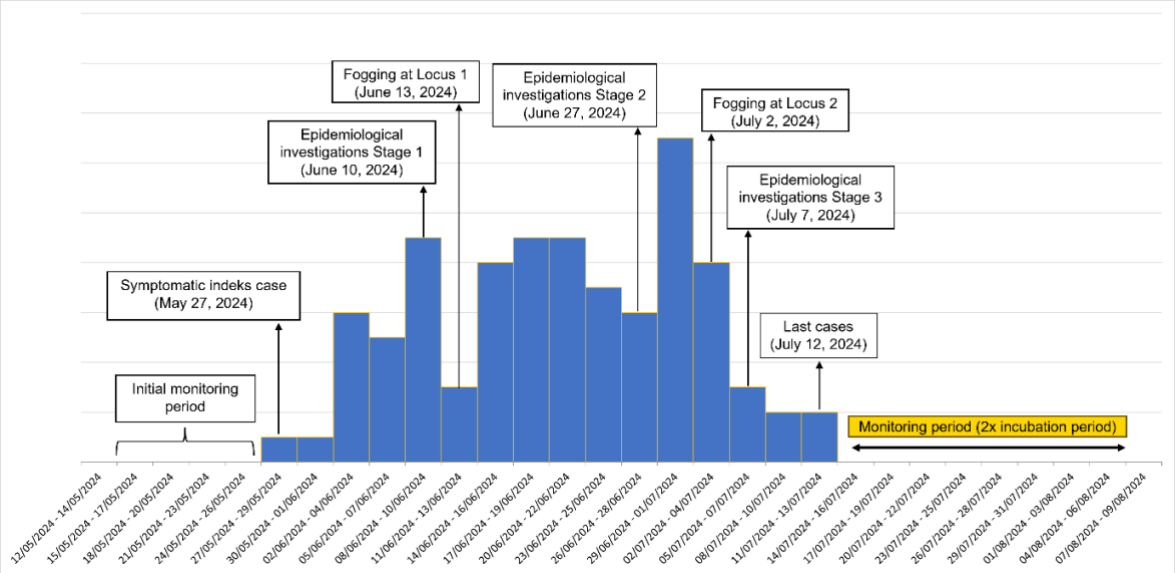

Figure 1: Epidemiological Curve of the Chikungunya Outbreak in Gunungkidul District, Indonesia, May-August 2024

Table 3: Bivariate and Multivariate Analysis of Risk Factors in the Chikungunya Outbreak in Gunungkidul District, May-August 2024

Variables	Cases (n=92)	Controls (n=92)	OR	CI 95%	aOR	CI 95%
Presence of larvae						
Yes	64	21	7.73*	3.81-15.80	2.12*	1.36-2.87
No	28	71				
Using mosquito repellent						
Yes	44	33	1.64	0.87-3.10	-	-
No	48	59				
Emptying and cleaning water containers						
Yes	34	24	1.66	0.85-3.28	-	-
No	58	68				
Using mosquito nets						
Yes	23	17	1.47	0.69-3.19	-	-

No	69	75				
Hanging clothes indoors						
Yes	51	29	2.7*	1.42-5.17	0.92	0.03-1.34
No	41	63				
Travel history						
Yes	26	32	0.74	0.38-1.44	-	-
No	66	60				
Securely covering water containers						
Yes	56	60	0.83	0.44-1.58	-	-
No	36	32				
Keeping fish in water containers						
Yes	68	71	0.84	0.40-1.73	-	-
No	24	21				
Collecting rainwater						
Yes	71	42	4.02*	2.04-8.03	1.68*	1.02-2.45
No	21	50				

The results in Table 3 indicate that significant risk factors associated with the chikungunya outbreak include the presence of mosquito larvae and the practice of collecting rainwater. The odds ratio (OR) analysis reveals that individuals living in households with mosquito larvae are 2.12 times more likely to contract chikungunya than those without larvae. Moreover, the practice of collecting rainwater increases the likelihood of infection by 1.68 times. In contrast, factors such as using mosquito repellents, hanging clothes indoors, and travel history showed mixed or non-significant associations with the outbreak. Notably, hanging clothes indoors had a significant OR of 2.7 (1.42-5.17), but when adjusted for other variables in the multivariate analysis, the association was not statistically significant.

Discussion

This study aimed to identify the risk factors contributing to the transmission of chikungunya in Gunungkidul District, Indonesia. A comprehensive analysis was conducted covering clinical symptoms, demographic characteristics, behavioral patterns, and environmental conditions associated with the disease. The clinical manifestations observed among respondents were consistent with those reported in previous outbreaks. Fever and arthralgia were the most frequently reported symptoms, typically

appearing in the early stages of infection (Hakim & Aman, 2022). Additional symptoms such as headaches, rashes, and gastrointestinal complaints including nausea were also documented, aligned with prior findings that although fever and joint pain are dominant, a considerable portion of patients may exhibit broader symptomatology (Hakim & Aman, 2022; Rani et al., 2023).

These clinical patterns were found to be associated with certain demographic factors. Women experienced a higher rate of symptomatic infections, likely due to their increased exposure to mosquito bites while performing caregiving roles and domestic activities. This finding supports existing literature highlighting the vulnerability of women to vector-borne diseases transmitted by domestic mosquitoes (Mungall-Baldwin, 2022). Furthermore, individuals aged 19 to 59 years were most affected, which may be attributed to their active engagement in social and economic activities that increase the likelihood of exposure to mosquito vectors in both indoor and outdoor environments (Sitepu et al., 2020; Sitepu & Depari, 2019).

Socioeconomic and occupational characteristics were also found to play a critical role in influencing chikungunya risk. Individuals with lower educational attainment demonstrated limited awareness of effective disease prevention strategies, such as mosquito control and the use of personal protective measures (Whiteman et al., 2018). This lack of knowledge may hinder the adoption of behaviors that reduce the risk of infection (Whiteman et al., 2018). In addition, farmers and agricultural workers were particularly vulnerable due to the nature of their work, which involves frequent exposure to outdoor environments where mosquito populations are prevalent and access to preventive tools may be limited (Msellemu et al., 2024).These challenges underscore the necessity for tailored public health initiatives aimed at enhancing awareness and disease prevention among these vulnerable populations.

The pattern of disease occurrence during the outbreak exhibited multiple peaks, indicating a propagated transmission cycle. This pattern suggests that clusters of cases emerged over time due to continued interactions between infected individuals and mosquito vectors (Mohammed et al., 2024). Such dynamics are consistent with earlier studies emphasizing the role of Aedes aegypti and Aedes albopictus in sustaining transmission within densely populated or poorly managed environments (Mohammed et al., 2024). Environmental conditions, increased mosquito activity, and community-level interactions likely contributed to the observed spread (Prasad et al., 2024).

The epidemiological investigation of the chikungunya outbreak in Gunungkidul District found two significant risk factors: the presence of mosquito larvae around homes and the habit of collecting rainwater. These findings underscore the importance of understanding the surrounding environment in the context of the transmission of mosquito-borne diseases, particularly by *Aedes aegypti* and *Aedes albopictus* (Moglia et al., 2016; Nilsson et al., 2018; Whiteman et al., 2019). These two species are known to breed in stagnant water commonly found around houses, such as flower pots, discarded cans, and uncovered water storage containers (Mohammed et al., 2024). The presence of mosquito larvae around homes reflects a high potential for the mosquito life cycle to continue, ultimately leading to the formation of adult mosquito populations capable of transmitting the chikungunya virus (Kumar et al., 2024). Therefore, environmental conditions that support mosquito breeding must be prioritized in risk mitigation efforts.

The community's habit of collecting rainwater without adequate coverings has been shown to significantly contribute to the increased risk of chikungunya transmission (Moglia et al., 2016). Uncovered water storage containers, such as buckets or tanks, create ideal conditions for *Aedes* mosquitoes to breed (Mohammed et al., 2024). Stagnant water left unattended for prolonged periods offers a substantial opportunity for mosquitoes to breed unchecked (Mohammed et al., 2024). Without proper preventive measures, this habit will continue to contribute to the rising mosquito populations around residential areas, significantly increasing the risk of chikungunya transmission.

Enhanced educational efforts and health behavior promotion focusing on vector control are necessary to address these issues (de Lima, 2018; Hemingway, 2019). The community must be provided with a comprehensive understanding regarding the importance of maintaining environmental cleanliness and proper rainwater management to minimize potential mosquito breeding sites (Hemingway, 2019). These educational programs need to be implemented intensively and sustainably, actively involving all layers of society. The main goal is to ensure that every individual understands the health risks associated with the presence of mosquito larvae and the importance of implementing effective preventive measures.

In addition to education, the implementation of mosquito breeding eradication programs through the 3M Plus approach (Draining, Covering, Burying, and Monitoring) should be expanded and enhanced to prevent the spread of chikungunya (Alhamda & Barlian, 2019). This program includes routine cleaning of water storage containers such as baths and buckets. Water storage must also be tightly covered. Discarded items that could serve as mosquito breeding sites, such as cans and old tires, should be buried or recycled (Mawaddah et al., 2023)

The "Plus" aspect in the 3M Plus approach encompasses various additional preventive actions, such as applying larvicides to water storage containers that are difficult to drain regularly, using mosquito repellents or mosquito-repelling plants around the house, and installing mosquito nets while sleeping (Irfandi et al., 2023; Mawaddah et al., 2023). Other additional measures include maintaining fish that eat mosquito larvae in ponds, planting mosquito-repelling plants, and regulating light and ventilation in homes to reduce humidity that attracts mosquitoes (Okoh et al., 2021; Van Hulle et al., 2022).. Additionally, the habit of hanging clothes indoors, which can serve as resting spots for mosquitoes, should be avoided (Dzul-Manzanilla et al., 2016). The overall implementation of the 3M Plus approach must be supported by intensive monitoring and rapid responses to reports of chikungunya cases to ensure that all preventive and control actions are effectively and accurately carried out.

Interestingly, certain variables such as travel history and mosquito net usage did not show statistically significant associations with infection risk. The insignificance of travel history could be attributed to the localized pattern of the outbreak, where transmission primarily occurred within the community, rather than being imported from other endemic areas (Loevinsohn et al., 2024; Tauro et al., 2019). Likewise, the limited protective effect of mosquito nets is likely due to inconsistent usage across households and the behavioral characteristics of Aedes mosquitoes, which tend to bite during the daytime, thereby reducing the effectiveness of nets typically used at night (Moscibrodzki et al., 2018).

Despite the valuable findings, this study has several limitations. Recall bias may have influenced the accuracy of symptom onset data, as participants may not have accurately remembered when symptoms first appeared. To address this limitation in future studies, researchers should consider using more objective data collection methods, such as medical records or symptom diaries. Another limitation is the lack of entomological surveillance to confirm the presence of chikungunya virus in local mosquito populations. Future studies should incorporate mosquito collection and testing to strengthen the epidemiological findings and provide more direct evidence of transmission sources.

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Declaration of Interest Statement

The authors declare that they have no conflict of interests.

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