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Research Article

Epidemiological Characteristics and Temporal Trends of Dengue Fever at the Mlati 2 PHC, Sleman, Indonesia, 2021–2024

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ABSTRACT

Background: Dengue is a mosquito-borne viral disease transmitted mainly by *Aedes aegypti* and *Aedes albopictus*. A rapid increase in cases may indicate a potential outbreak and requires timely surveillance. This study aimed to describe dengue cases by person, place, and time in the Mlati 2 Public Health Center area from 2021 to 2024 and identify potential outbreak patterns.

Method: This quantitative descriptive study used secondary data from epidemiological investigation records at Mlati 2 PHC. "Dengue cases" included all cases classified as DF, DHF, DSS, and DD. A total of 82 cases recorded from 2021 to 2024 were included. Data were analyzed descriptively and presented by person, place, time, laboratory diagnosis, and House Larvae-Free Index.

Results: Most cases occurred among adults aged 19–59 years, with more females than males. Sumberadi Village recorded the highest number of cases, followed by Tlogoadi and Tirtoadi. DHF was the most frequent classification, while cases in 2024 showed more varied diagnoses, including DF, DHF, DD, and DSS. The three-year minimum–maximum pattern showed that cases in February, March, April, May, and August 2024 exceeded the historical maximum from 2021 to 2023, indicating potential outbreak signals. The House Larvae-Free Index remained below the national standard of 95% during the study period.

Conclusion: Dengue cases occurred annually in the Mlati 2 Public Health Center area, with a marked increase in 2024. Cases were mainly found among productive-age adults and concentrated in Sumberadi Village. The potential outbreak signals and low House Larvae-Free Index highlight the need to strengthen surveillance, timely reporting, epidemiological investigation, and community-based vector control.

Keywords: *Aedes aegypti*; Dengue hemorrhagic fever; Epidemiology; Outbreak surveillance

INTRODUCTION

The rapid spread of communicable diseases among populations continues to be a primary public health issue. Dengue Hemorrhagic Fever (DHF) is a critical vector-borne illness caused by dengue virus infection within the Flaviviridae family and the Flavivirus genus. This disease is spread to humans via the bites of *Aedes aegypti* and Aedes albopictus mosquitoes, species that typically exhibit peak activity during the early morning and late afternoon hours.[1] While Dengue Hemorrhagic Fever (DHF) was once primarily a childhood illness, the epidemiological landscape has changed in recent decades as adult cases have become increasingly common.[2]

Dengue Hemorrhagic Fever (DHF) is a condition characterized clinically by high fever, severe headache, joint and muscle pain, nausea, and rashes; without prompt intervention, it can lead to hemorrhaging and shock. Predominantly found in tropical and subtropical climates such as Indonesia, dengue is on an upward trajectory globally. Recent data show the Americas reported 4.5 million cases and 2,300 fatalities, with Thailand, Malaysia, and Bangladesh also recording hundreds of thousands of infections. In Indonesia specifically, reports through the 17th week of 2024 indicate a total of 88,593 DHF cases and 621 deaths.[2]

At the provincial level, Sleman Regency ranked second in the number of DHF cases in Yogyakarta Special Region, with 458 reported cases.[3] The high transmission rate is linked to the breeding behavior of Aedes mosquitoes, which thrive in clean standing water such as bathtubs, flower pots, and unused containers. The short life cycle of mosquitoes, which lasts only 7–10 days from egg to adult, accelerates the spread of the virus.[4]

DHF also has the potential to cause outbreaks (Extraordinary Events called KLB in Bahasa) when there is a rapid and significant increase in cases, typically twice the normal incidence. According to the Indonesian Ministry of Health Regulation No. 1501 of 2010, an outbreak is defined as a statistically significant increase in morbidity or mortality in a specific area and period.[5] High population density and close proximity between houses further amplify the risk of transmission.[6]

Based on the 2023 Sleman Health Profile, Mlati Subdistrict recorded the highest number of DHF cases, distributed between Mlati 1 and Mlati 2 Health Centers. In Mlati 2, the number of cases increased sharply from 5 in 2023 to 46 in 2024, with peaks in March and May. Field investigations identified mosquito larvae in various water-holding containers, including water pots, dispenser trays, and bathtubs, within the community.[7]

Despite control measures such as Larval Source Management (called 3M in Bahasa), larviciding, health education, and fogging, the Larval-Free Index in Mlati 2 remained below 95%, indicating suboptimal vector control. Although Wolbachia-based dengue control has been introduced in Sleman Regency, its implementation has not covered all areas within the Mlati 2 Public Health Center working area. Contributing factors included high population density and the presence of water-filled containers made of recycled materials, which may serve as breeding sites for mosquitoes. Previous studies have described dengue epidemiology and vector control in broader settings; however, local evidence describing the distribution of dengue cases by person, place, and time, combined with outbreak signal analysis in the Mlati 2 Public Health Center area, remains limited. Therefore, this study aimed to describe the distribution of dengue cases by person, place, and time in the Mlati 2 Public Health Center area from 2021 to 2024, identify potential outbreak patterns, and provide evidence-based input for strengthening local dengue prevention and control programs.[8]

METHOD

Study Design

This study used a quantitative descriptive design to describe the distribution of dengue hemorrhagic fever (DHF) cases by person, place, and time in the Mlati 2 Public Health Center area of Sleman District, Yogyakarta Special Region. The data analyzed covered DHF cases recorded from 2021 to 2024. The study was conducted from October to December 2024.

Population, Sample, Sampling Technique

The study population comprised all patients recorded in the epidemiological investigation data of the Mlati 2 Public Health Center from 2021 to 2024 who were diagnosed with dengue-related conditions based on clinical and/or laboratory examination. In this study, the term "dengue cases" refers to all recorded cases classified as Dengue Fever (DF), Dengue Hemorrhagic Fever (DHF), Dengue Shock Syndrome (DSS), and Dengue Diagnosis/Diagnosis Dengue (DD), according to the classification used in the surveillance records. A total of 82 dengue cases were included in the study sample using a total sampling technique, in which all eligible cases in the population were included in the analysis.

Variable

This study primarily investigated the distribution of DHF cases across three main dimensions: person, place, and time. Within the "person" category, the research evaluated age, sex, and diagnosis. The "place" dimension focused on geographic distribution at the village, hamlet, and neighborhood levels. For the "time" variable, the analysis tracked the onset of illness, dates of hospital admission, KDRS reporting timelines, and when epidemiological investigations occurred. Additionally, the study incorporated a three-year minimum–maximum case trend analysis and examined the larval-free index surrounding the residences of patients.

Instrument and Data Analysis

This study utilized secondary data from the Mlati 2 Health Center's epidemiological records, covering DHF cases from 2021 to 2024. These records provided comprehensive data, including patient demographics, residential locations, clinical histories, diagnoses, and larval-free indices. Data were analyzed using descriptive univariate methods, with findings presented in tables and graphs categorized by person, place, and time.

Ethical Clearance

This study obtained ethical approval from the Ethics Committee Board of Ahmad Dahlan University (012410329).

RESULTS

Description of DHF Cases Based on Person

An overview of dengue fever cases is presented in Tables 1 and 2, which detail individual demographic characteristics—specifically age and gender—alongside laboratory diagnostic findings.

Table 1. Case Based on Laboratory Examination Results

Case	2021		2022		2023		2024	
	n	%	n	%	n	%	n	%
DHF	19	100	12	100	5	100	17	36,96
DF	0	0	0	0	0	0	16	34,78
DD	0	0	0	0	0	0	12	26,09
DSS	0	0	0	0	0	0	1	2,17
Total	**19**	**100**	**12**	**100**	**5**	**100**	**46**	**100**

As presented in Table 1, laboratory test results from 2021 to 2024 indicate that the majority of cases were identified as DHF, totaling 53 cases. The yearly breakdown consists of 19 cases in 2021, 12 in 2022, and 5 in 2023. However, a notable surge occurred in 2024, with 17 additional DHF/DHF cases, including a single instance of DSS.

Table 2 presents the distribution of dengue cases by age group and sex. In this study, dengue cases included all patients classified as Dengue Fever (DF), Dengue Hemorrhagic Fever (DHF), Dengue Shock Syndrome (DSS), or Dengue Diagnosis/Diagnosis Dengue (DD) based on epidemiological investigation records. DHF cases by age among individuals aged 19-59 years in the work area of Public Health Center Mlati 2, Sleman, were 8 (42%), 6 (50%), 3 (60%), and 20 (43%). Regarding sex, DHF affected 11 males in 2021, 7 males in 2022, 3 males in 2023, and 31 females in 2024. Human characteristics such as age and gender might contribute to the prevalence of DHF.

Table 2. Distribution of Dengue Cases by Age Group and Sex

Age group (years)	2021				2022				2023				2024			
	Sex		Total	%	Sex		Total	%	Sex		Total	%	Sex		Total	%
	M	F			M	F			M	F			M	F		
<5	1	0	1	5	0	0	0	0	0	1	1	20	0	2	2	4
5-9	0	3	3	16	1	0	1	8	0	0	0	0	1	7	9	17
10-18	4	2	6	36	3	1	4	33	1	0	1	20	5	11	16	35
19-59	5	3	8	42	3	3	6	50	2	1	3	60	9	11	20	43
>60	1	0	1	5	0	1	1	8	0	0	0	0	0	0	0	0
Total	**11**	**8**	**19**	**100**	**7**	**5**	**12**	**100**	**3**	**2**	**5**	**100**	**15**	**31**	**46**	**100**

The 19-59 age group is mainly active at home, as evidenced by the program holder's remark during epidemiological research, which noted that all activities are carried out at home, with no trips out of town or visitors. Mosquitoes that cause dengue fever breed in clean water reservoirs at home, so if someone lives in a house with a clean water reservoir and larvae are found, dengue transmission may occur indoors, given that the vector breeds in clean water.[9] According to previous research, people aged 15 to 64 are a productive age group who engage in activities outside the house in the morning and evening. *Aedes aegypti* mosquitoes are active between 09.00-10.00 and 16.00-17.00, which is working time for adults.[10] Children under 15 have inadequate immunity, making DHF more common.[4]

Figure 1 shows that DHF was the predominant diagnosis during 2021–2023, while in 2024 the cases became more varied, including DF, DD, DHF, and DSS.

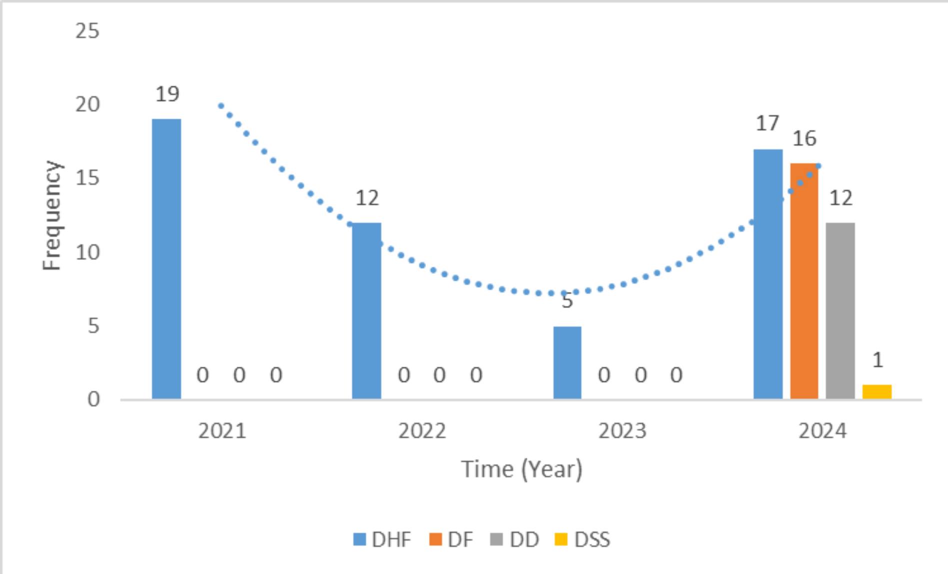

Figure 1. Distribution of Dengue Cases Based on Laboratory Diagnosis

Based on the epidemiological investigation records, dengue cases in the Mlati 2 Public Health Center area presented with various clinical manifestations, including fever, bleeding signs, liver enlargement, evidence of plasma leakage, signs of shock, cough, runny nose, vomiting, and headache. Among these symptoms, fever was reported in all recorded cases.

Overview of Dengue Fever Cases by Place

Table 3 shows that the Sumberadi sub-district has the most cases, 40 (53%), followed by the Tlogoadi sub-district with 28 (36%) and the Tirtoadi sub-district with 14 (11%), for a total of 82 cases by place from 2021 to 2024. *Aedes aegypti* mosquitoes transmit the dengue virus, which has spread rapidly throughout Indonesia's residential and public spaces, except at elevations above 100 meters.[2] Given the proximity of the Sumberadi and Tlogoadi sub-districts, the number of cases of the illness is likely to grow. Housing settings near sub-districts, along with the discovery of several containers filled with water that have never been cleaned, are more likely to attract mosquitoes and facilitate their breeding.[11]

Table 3. Distribution of Dengue Cases by Location in the Working Area of Mlati 2 Public Health Center, Sleman

	2021		2022		2023		2024		Total	
Village	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Sumberadi	4	21	10	83	2	40	24	52	40	53
Tlogoadi	8	29	1	8	2	40	17	37	28	36
Tirtoadi	7	50	1	8	1	20	5	11	14	11
Total	**19**	**100**	**12**	**100**	**5**	**100**	**46**	**100**	**78**	**100**

Overview of Dengue Cases by Time

Figure 2 shows an overview of cases over time, including the exposure period, curve type, and case index, as well as the minimum and maximum graphical patterns used to detect Dengue Fever.

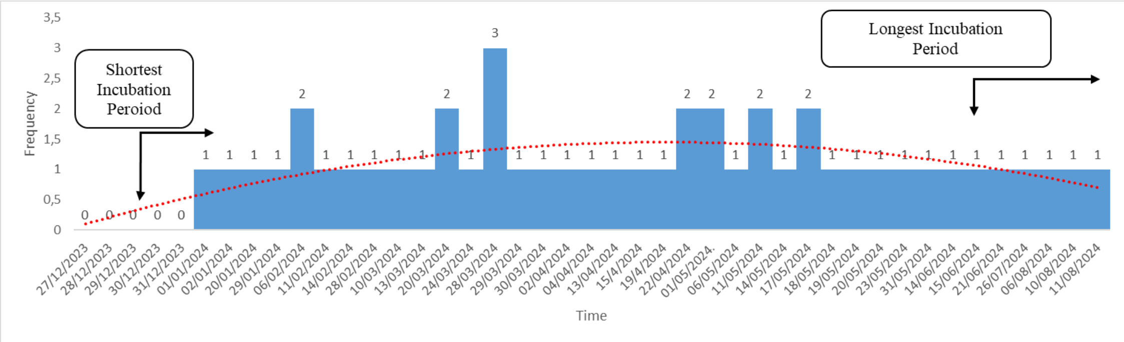

Figure 2. Epidemiology Curve of DHF Cases in 2024

The epidemiological curve shows that dengue cases in 2024 were reported continuously from January to August, with a fluctuating pattern. The number of cases began to increase in February, rose sharply in March, and peaked in May. A decline was observed in June and July, followed by another increase in August. The first recorded case in 2024 was a 12-year-old resident of Tlogoadi Village, with a house larvae-free index of 85%.

The monthly distribution of dengue cases, based on three years of surveillance data from 2021 to 2023 and the observed data in 2024, shows that dengue cases occurred every year in the Mlati 2 Public Health Center area, although the number of cases varied by month and year. The total number of cases decreased from 19 in 2021 to 12 in 2022 and 5 in 2023. However, in 2024, the number increased sharply to 46 cases. Therefore, a three-year minimum–maximum pattern chart was developed to compare the observed monthly cases in 2024 with the historical minimum and maximum values from 2021 to 2023. This analysis was used to identify abnormal increases in cases and potential outbreak signals when observed cases exceeded the historical maximum.

Figure 3 presents the three-year minimum–maximum pattern of dengue cases from 2021 to 2023 compared with the observed cases in 2024. This method was used to identify abnormal increases in dengue cases by comparing the monthly number of cases in the observed year with the historical minimum and maximum values from the previous three years.

Based on Figure 3, the number of dengue cases in January 2024 remained within the historical range, with four cases, compared with the previous maximum of five. However, the observed cases exceeded the historical maximum in February, March, April, May, and August 2024. In February 2024, five cases were recorded, exceeding the previous record of two. The increase continued in March, with 10 cases, which was five times higher than the previous maximum of two cases. In April, seven cases were recorded, exceeding the historical maximum of four cases. The highest increase occurred in May 2024, with 13 cases, whereas the previous three-year maximum for May was only one case. In August 2024, five cases were observed, while no cases had been recorded in August during the previous three years.

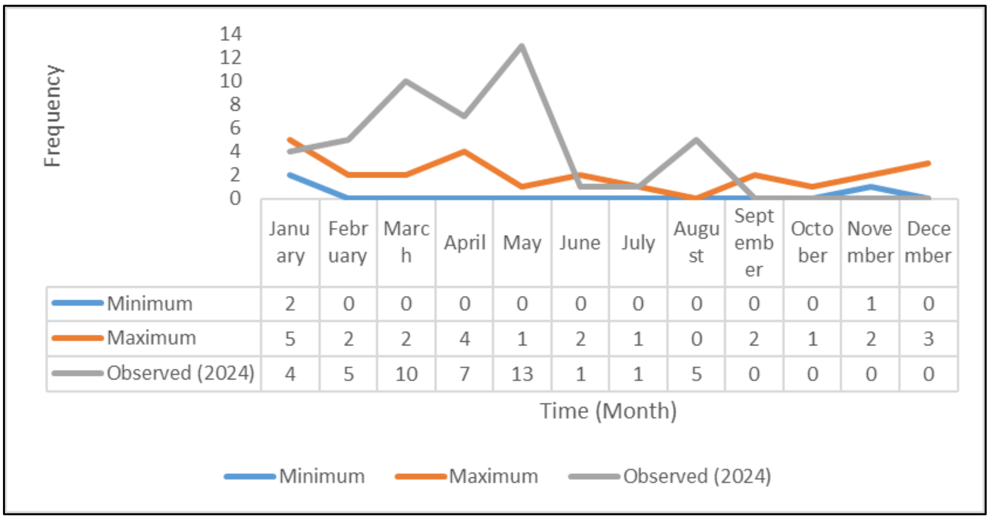

Figure 3. 3-Year Minimum Maximum Pattern Chart (2021-2023) and 2024 (observed)

These findings indicate that several months in 2024 showed case numbers above the expected historical pattern, particularly from February to May and again in August. The sharp increases in March and May suggest a potential outbreak signal in the Mlati 2 Public Health Center. In addition, the increase from February to March 2024, from 5 to 10 cases, represents a twofold rise over the previous month. A similar abnormal increase was observed from July to August 2024, with cases rising from 1 to 5. These patterns are consistent with outbreak alert criteria based on an increase in cases compared with previous periods. Overall, the minimum–maximum pattern shows that dengue cases in 2024 were substantially higher than the historical pattern from 2021 to 2023. Therefore, February, March, April, May, and August 2024 should be considered alert months requiring strengthened surveillance, timely epidemiological investigation, vector control, and community-based prevention activities.

Overview of Environmental Conditions in the Work Area of Mlati 2 Public Health Center, Sleman

The ABJ criterion is>95%; Figure 4 shows that the average larval-free rate calculation results are below the standard (<95%). According to the DHF programmer at the Mlati 2 Sleman Health Center, *Aedes aegypti* mosquito larvae were still detected in clean water reservoirs in 2024, which may have contributed to the decline from 94.18% in 2023 to 92.98% in 2024.

Figure 4 presents the House Larvae-Free Index in the Mlati 2 Public Health Center area from 2021 to 2024. The index remained below the national standard of 95% throughout the study period, ranging from 92.98% in 2024 to 94.62% in 2021. A slight decrease was observed from 94.18% in 2023 to 92.98% in 2024. This finding indicates that mosquito larvae were still found in some inspected houses, suggesting the persistence of potential Aedes breeding sites in the community.

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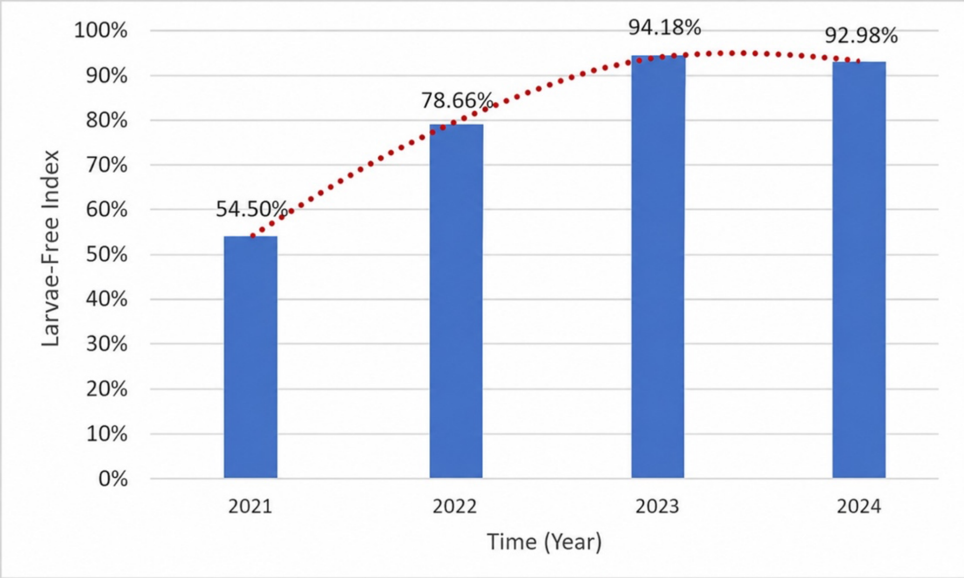

Figure 4. House Larvae-Free Index, 2021–2024

DISCUSSION

Age Distribution of Dengue Cases

The age range of 19–59 years represented the highest proportion of dengue cases in the Mlati 2 Public Health Center area. This age group is characterized by daily activities such as working, studying, and social interactions, many of which occur indoors. According to field interviews conducted during epidemiological investigations, most patients reported limited travel and no visitors prior to illness, suggesting that transmission may have occurred within the household.[7] The local population consists of both working individuals and homemakers, whose daily routines primarily take place indoors.[12–14] Meanwhile, those aged 50 years and older experience decreased immune function and physical activity, which may increase their susceptibility to dengue infection. Stable immune function plays a crucial role in preventing infection, whereas weakened immunity facilitates viral transmission and symptom onset.[15]

Mosquito vectors responsible for dengue fever breed primarily in clean water containers located indoors.[16] Therefore, individuals who spend most of their time at home, particularly in environments with water storage and the presence of larvae, are more likely to be infected. Individuals aged 15–64 years, considered the productive age group, often engage in daily activities in the morning (09:00–10:00) and late afternoon (16:00–17:00), which coincide with peak biting times for Aedes mosquitoes.[10] Similarly, 76 out of 86 dengue cases occurred among individuals aged >15 years, emphasizing that adults are particularly vulnerable due to their exposure both indoors, where *Aedes aegypti* is dominant, and outdoors, where Aedes albopictus thrives.[17]

In this study, dengue cases were most frequently reported among individuals aged 19–59 years, suggesting that the productive-age population was the dominant affected group in the Mlati 2 Public Health Center area. This finding may be associated with daily mobility, work-related activities, household activities, and exposure to Aedes mosquito bites both indoors and outdoors. Adults may be exposed during the peak biting times of Aedes mosquitoes, particularly in the morning and late afternoon.[18] However, detailed occupational data were not available in this study; therefore, this finding should be interpreted descriptively rather than as evidence of a higher biological risk among adults. Although previous studies have reported that children under 15 years may be more susceptible due to immature immune responses and school-based exposure, the present study indicates that dengue prevention in this area should place greater emphasis on the productive-age group, while continuing preventive measures for children and older adults.[19]

Cases Distribution by Sex

The study conducted in the working area of Mlati 2 Public Health Center, Sleman, revealed that dengue fever cases from 2021 to 2023 were predominantly found among males, whereas in 2024, more cases occurred among females. This shift may be related to differences in daily activity patterns and exposure settings. Women who spend more time in domestic or indoor environments may have greater contact with *Aedes aegypti*, which commonly rests and bites inside houses. However, dengue cases can occur in both males and females, and differences in sex-specific case distribution should not be interpreted as the virus specifically targeting one sex. Instead, such variation may reflect differences in exposure, health-seeking behavior, immune response, and environmental or demographic conditions.[20,21] The variation in case distribution across years is likely influenced by differences in immunity levels and environmental conditions that affect individual susceptibility to infection.[22,23]

Similar results were reported by Ahmad et al. (2023) at the Tuyutan Public Health Center, where females (n=47) were more frequently infected than males (n=25).[24] Female children are more susceptible due to lower estrogen levels, which affect body fat distribution and leptin production. Reduced leptin levels can weaken immune responses, increasing the risk of infection.[25] In contrast, males may also be more vulnerable because they produce fewer cytokines, resulting in weaker immune reactions. Occupational exposure also contributes to risk differences; males engaged in indoor work such as office or shop jobs may face similar exposure levels to females.[26] Kulsum et al. (2023) and Ashary et al. (2024) also observed higher infection rates in males, attributing this to outdoor activities and lower immunoglobulin production.[27,28] Meanwhile, dengue virus can infect individuals regardless of sex, as both men and women share equal susceptibility to the disease.[29]

Cases Distribution Based on Laboratory Diagnosis

Laboratory diagnosis showed that DHF was the most frequently recorded classification during the study period, particularly from 2021 to 2023. This may be related to the surveillance and reporting system, in which patients with clearer clinical manifestations such as persistent fever, thrombocytopenia, bleeding signs, or suspected plasma leakage were more likely to be recorded and followed up. Dengue infection can present with a wide clinical spectrum, ranging from uncomplicated dengue to severe dengue; in the older classification, this spectrum includes DF, DHF, and DSS. DHF and DSS usually indicate more severe manifestations and therefore are more likely to be detected through health facility-based reporting.[7]

In 2024, the classification became more varied, including DF, DHF, DD, and one DSS case. This variation may be influenced by differences in the timing of examination and clinical presentation. NS1 antigen testing is useful during the first seven days of illness, allowing

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dengue infection to be detected before bleeding signs or shock develop. Thus, patients examined earlier may have been classified as DF or DD, whereas those presenting later with warning signs, thrombocytopenia, bleeding manifestations, or shock were more likely to be classified as DHF or DSS. [30, 31]

These findings suggest that the predominance of DHF in the records may reflect the type of cases captured by the epidemiological investigation system rather than the full spectrum of dengue infections in the community. Therefore, early diagnosis, timely reporting, and active surveillance are essential to detect both mild and severe dengue cases. The clinical manifestations observed in this study are consistent with the common dengue symptoms described by the Indonesian Ministry of Health, including sudden high fever, severe headache, muscle pain, fatigue, nausea, and vomiting.[32] DHF is commonly characterized by fever, bleeding tendency, hepatomegaly, and, in severe cases, circulatory failure.[17] Other clinical features may include muscle or joint pain, leukopenia, lymphadenopathy, rash, thrombocytopenia, and hemorrhagic manifestations.[33]

Case Reporting Overview Based on the Date of Onset, Hospital Admission, Receipt of Early Warning Letter, and Epidemiological Investigation Date

According to Law No. 44 of 2009 on Hospitals, Chapter IX on Recording and Reporting, every hospital is required to record and report all activities in a hospital information management system, including reporting of infectious or outbreak-prone diseases in accordance with regulations.[34] The Early Warning Letter serves as an index case report for surveillance and field investigation activities, which must be issued within 24 hours after a diagnosis is established. The Early Warning Letter document contains information on infectious diseases, such as dengue fever, and is intended to strengthen surveillance and outbreak control by providing complete and timely case data.[35,36]

Analysis of data from the Mlati 2 Public Health Center in Sleman shows that the interval between symptom onset and hospital admission generally aligns with the dengue incubation period of 4–6 days, as stated in the Ministry of Health's 2020 outbreak guideline. In 2021 and 2023, most cases were admitted within this range, indicating early health-seeking behavior. However, in 2022 and 2024, several patients were hospitalized after more than six days of illness, up to 21 days in some cases, indicating late-stage disease progression characterized by gum bleeding, hepatomegaly, or shock.[7]

Epidemiological investigations were ideally conducted one day after the early warning letter was received, as mandated by surveillance protocols.[35]. These activities include confirming the case chronology, verifying patient data, inspecting mosquito breeding sites within and around the patient's residence (up to a 200-meter radius), and conducting community education on 3M Plus vector control (draining, covering, and recycling water containers, as well as additional preventive measures).[14] However, delays of up to three days were noted in some cases, which could allow mosquito larvae to mature into adults, increasing the risk of transmission.[7]

The average delay between hospital admission and receipt of the early warning letter ranged from 31 to 104 days during 2021–2024, despite the standard requirement that hospitals submit the report within 5 days of diagnosis. Prolonged delays impede timely epidemiological investigation and increase the risk of new dengue cases in the community. When the early warning letter is not received by primary health care within 7 days, preventive actions such as larval monitoring and health education cannot be implemented promptly.[7,37]

In Mlati 2, reporting procedures follow national regulations: once a hospital confirms a dengue case, an early warning letter is issued and sent to both the patient and the relevant primary health care center for follow-up. If the hospital does not report directly to the public health center, patients are responsible for submitting the document within 24 hours of diagnosis. The early warning letter serves as an official record detailing the patient's identity, disease chronology, diagnosis, laboratory results, and clinical manifestations, allowing the Mlati 2 Public Health Center to record, categorize, and follow up on each case.

Delays in reporting caused by patients or community health volunteers postponing submission, or by overlapping public health center field activities, can hinder rapid epidemiological responses and contribute to rising dengue incidence, as seen in Mlati 2, where cases increased from 5 in 2023 to 46 in 2024. Therefore, effective coordination between hospitals, primary health facilities, and the community is essential. Regular implementation of the 3M Plus program remains a key preventive measure to eliminate mosquito breeding sites and interrupt dengue transmission.[38]

Epidemiological curves are useful for describing the distribution of cases over time, identifying the first case, estimating the possible exposure period, and recognizing potential outbreak patterns. In this study, the dengue case pattern in 2024 showed a clear increase from February to May, suggesting intensified transmission during this period. The interpretation of this pattern should take into account the incubation period of dengue, which is generally 4–6 days, according to the Indonesian Ministry of Health's outbreak guidelines.[39] In addition, *Aedes aegypti* mosquitoes may become infective after feeding on the blood of a dengue-infected person, supporting the possibility of continued local transmission when vector control is delayed.[40]

The Sleman District Health Office, in collaboration with Mlati 2 Public Health Center, has implemented several dengue prevention and control programs, including PSN 3M, larvicide distribution, fogging, and health education. These programs are directly related to reducing mosquito breeding sites and improving the House Larvae-Free Index. However, the index remained below the national standard, indicating that community-based vector control still needs strengthening.

In addition to conventional vector control, Sleman Regency has introduced the "Si Wolly Nyaman" Wolbachia program as a complementary dengue control strategy. Wolbachia-infected *Aedes aegypti* mosquitoes can reduce dengue virus replication and transmission, and prior evidence indicates that Wolbachia deployment can significantly reduce dengue incidence.[41,42] However, Wolbachia should not be interpreted as a direct intervention to increase the House Larvae-Free Index, because ABJ reflects the presence or absence of larvae in inspected houses. Therefore, Wolbachia-based control should be implemented as a complementary strategy alongside the eradication of breeding sites, larval monitoring, and community participation to strengthen dengue prevention and control.[43–45]

Surveillance Analysis of Dengue Cases Using a Three-Year Minimum–Maximum Pattern

The three-year minimum–maximum pattern is useful for identifying abnormal increases in dengue cases by comparing observed monthly cases with historical surveillance patterns. In this study, the 2024 pattern showed several months when the number of dengue cases exceeded the historical maximum observed from 2021 to 2023, indicating a potential outbreak signal in the Mlati 2 Public Health Center area. This finding suggests that dengue transmission in 2024 was not only a continuation of annual endemic transmission but also reflected an unusual increase that required strengthened surveillance and a rapid public health response.[36,7]

The increase in dengue cases may be influenced by several interconnected factors, including the presence of mosquito larvae around patients' residences, a House Larvae-Free Index below the recommended standard, high population density, and suboptimal implementation of mosquito breeding site eradication. These factors may facilitate the persistence of *Aedes* breeding sites and increase the risk of local dengue transmission.[46–49] These conditions can facilitate the persistence of Aedes mosquito breeding sites and increase the possibility of local transmission. In addition, delayed case reporting and epidemiological investigation may reduce the effectiveness of early response measures, as vector control and community education cannot be implemented promptly after a case is detected.[50,7]

From a surveillance perspective, the minimum–maximum pattern can help public health officers identify alert periods and prioritize field interventions. When observed cases exceed the historical maximum, health centers should strengthen active case finding, accelerate epidemiological investigation, intensify larval monitoring, and improve community participation in 3M Plus activities. Previous studies emphasize that eradicating mosquito breeding sites is a simple, safe, and cost-effective vector control strategy, but its success depends heavily on active community participation.[51] In line with the Regulation of the Minister of Health Number 82 of 2014, community empowerment and health promotion are essential strategies in the prevention and control of communicable diseases.[52] Therefore, this finding highlights the importance of integrating routine surveillance data with timely vector control and community-based prevention to reduce the risk of future dengue outbreaks in the Mlati 2 Public Health Center area.

Description of Cases Based on the House Larvae-Free Index

Based on epidemiological investigation data from Mlati 2 Public Health Center, Sleman, the House Larvae-Free Index among dengue cases' residences remained below the national standard of 95%, indicating that Aedes breeding sites were still present in household environments. Houses with positive larvae findings commonly had cement or ceramic water containers and small water-holding objects, such as flower vases and pet water bowls, that were not cleaned regularly. A low larvae-free index reflects the persistence of potential mosquito breeding sites and may increase the risk of local dengue transmission, consistent with previous findings that lower larval indices are associated with higher dengue transmission risk.[53]

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These interventions are directly related to improving the House Larvae-Free Index by eliminating or reducing mosquito breeding sites.[54,55] In contrast, the Wolbachia program should be understood as a complementary dengue control strategy rather than a direct intervention aimed at increasing the larvae-free index. Wolbachia-infected *Aedes aegypti* mosquitoes reduce dengue transmission by limiting the dengue virus's ability to replicate and be transmitted by mosquitoes.[56] A cluster-randomized trial in Yogyakarta showed that the deployment of Wolbachia-infected *Aedes aegypti* significantly reduced virologically confirmed dengue incidence by 77.1% and dengue hospitalization by 86.2%.[57] The persistence of a House Larvae-Free Index below the national standard indicates that behavioral and community-based interventions remain necessary. Health promotion strategies, particularly those involving community empowerment, social support, and cross-sector collaboration, have been shown to strengthen dengue prevention efforts by encouraging active participation in eradicating mosquito breeding sites and in larval monitoring.[58]

Therefore, the persistence of a low House Larvae-Free Index in the Mlati 2 area indicates that community-based vector control, particularly 3M Plus and routine larval monitoring, still needs strengthening. The Wolbachia program may help reduce dengue transmission, but it does not replace the need to eliminate breeding sites. Since Sumberadi Village has not yet received the Wolbachia intervention, continued community engagement, environmental monitoring, and consistent eradication of mosquito breeding sites remain essential to achieving a House Larvae-Free Index ≥95% and reducing dengue transmission in the area.

CONCLUSION

This study described the distribution of dengue cases by person, place, and time in the Mlati 2 Public Health Center area from 2021 to 2024. A total of 82 dengue cases were reported during the study period. Based on person, most cases occurred among adults aged 19–59 years, and more cases were reported among females than males. By location, the highest number of cases was recorded in Sumberadi Village, particularly in Warak Kidul. Based on time, dengue cases occurred every year, with a marked increase in 2024 compared with the previous three years. The three-year minimum–maximum pattern indicated several months in 2024 with potential outbreak signals. In addition, the House Larvae-Free Index remained below the national standard of 95%, indicating persistent mosquito breeding sites in residential areas. These findings emphasize the need to strengthen dengue surveillance, improve timely case reporting and epidemiological investigation, and intensify community-based vector control activities in the Mlati 2 Public Health Center area.

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Declarations

Authors' contribution

The authors of this article have contributed to its writing. RW: contributed to data collection, data processing, data analysis, and discussion; LS: contributed to data processing, data analysis, and preparation of the discussion; RR & DN: preparation of the discussion; and AWO: contributed to the finalization of the draft of the article and translation of the article.

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Conflict of interest

There is no conflict of interest in this research.

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