Epidemiology of dengue hemorrhagic fever in Manado City: 2015-2020

Odi Roni Pinontoan¹, Grace Debbie Kandou², Oksfriani Jufri Sumampouw³*, Jeini Ester Nelwan²

ABSTRACT

Introduction: Dengue hemorrhagic fever (DHF) is a disease caused by the dengue virus transmitted through the bite of Aedes aegypti and Aedes albopictus mosquitoes. DHF is still a significant health problem in Indonesia, especially in Manado. This study aimed to analyze the epidemiology trend of dengue hemorrhagic fever in Manado City in 2015-2020.

Methods: This ecological research was conducted in Manado City from February to July 2023. This research used secondary data from the Manado Health Office. Data analysis was carried out univariately.

Results: This study showed that since 2011-currently, four peaks of dengue fever were found, namely in 2012 (308 cases), 2016 (521 cases), 2019 (589 cases), and 2022 (598 cases). The prevalence of dengue cases decreased significantly in 2016-2019 and 2019-2020, with the lowest decrease occurring in 2019-2020. Furthermore, it was found that the distribution of dengue fever in Manado City in 2015-2020 based on sex increased in 2016 and 2019 and, decreased in 2017 and 2020, and was more dominant in the male sex. The highest distribution of dengue fever in Manado City in 2015-2020 was found in the age group of 6-11 years, followed by 0-5 years.

Conclusions: It can be concluded that the prevalence of DHF in Manado City fluctuates every year, mainly in Mapanget and Malalayang subdistricts; most sufferers are male and aged 6-11 years.

Keywords: Dengue hemorrhagic fever, Manado city, prevalence.


INTRODUCTION

Dengue hemorrhagic fever (DHF) is a disease caused by the dengue virus transmitted through the bite of Aedes aegypti and Aedes albopictus mosquitoes.¹ This virus will interfere with the performance of blood capillaries and the blood clotting system, resulting in hemorrhages. Dengue hemorrhagic fever is caused by dengue virus with Dengue serotype-1 (DEN-1), DEN-2, DEN-3 and DEN-4 types. The four types of viruses have been found in various regions of Indonesia. The virus widely developed in the community is the dengue virus with type 1 and type 3.²

The dengue virus, which belongs to the Arbovirus B group and is transmitted by arthropods, is the cause of dengue hemorrhagic fever. This virus is a member of the Flaviviridae family, specifically the genus Flavivirus. The virus is categorized as an arthropod-borne virus (arbovirus) in group B. The dengue virus belongs to the genus flaviviruses, which are single-stranded RNA viruses with four serotypes (DEN-1, DEN-2, DEN-3, and DEN-4). Although the antigen structures of these four serotypes are quite similar, cross-protection cannot be achieved by antibodies specific to each serotype. Depending on the period and geographic distribution, these four serotypes have distinct genetic variants that affect both inter- and intra-serotype relationships.³

For eight to ten days, the mosquito’s salivary glands are the primary site of the virus's development. The dengue virus will spread by this mosquito's saliva if it bites another individual. This virus takes four to six days to mature in the human body before causing DHF. The dengue virus remains in the bloodstream for one week after it replicates in the human body.⁴

The main vectors of dengue disease were Aedes aegypti (in urban areas) and Aedes albopictus (in rural areas). Mosquitoes that are vectors of dengue disease are mosquitoes infected when biting sick humans and viremia (there is a virus in their blood).⁵ DHF transmission occurs through the bite of adult female Aedes aegypti or Aedes albopictus mosquitoes that have previously carried the virus in their bodies from other dengue fever sufferers. Aedes aegypti mosquitoes often bite humans in the morning (after sunrise) and during the day (until before sunset). People at risk of dengue fever are children under the age of 15 years, and most live in humid environments and slums.⁶,⁷

The DHF situation in Indonesia since 2011-2013 has increased the morbidity rate, which concludes that dengue disease is still a health problem in Indonesia. In 2011, it decreased to reach the DHF incidence rate (IR) of 27.67 per 100,000 population, and again increased in 2012 with an IR of 37.27 per 100,000 population; there was a further increase in 2013 to reach an IR of 45.85 per 100,000 population.⁸

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Data from the North Sulawesi Provincial Health Office shows that dengue disease has increased. In 2016, it reached 2,145 patients in North Sulawesi Province with an IR of 88.02% per 100,000 population. In 2017, dengue cases came to 587 with an IR of 24.34 per 100,000 population and crude fatality rate (CFR) = 1.53%. In 2018, dengue cases reached 2,014 with an IR of 83.50 per 100,000 population and a CFR of 1.24%. This exceeds the IR target of <49 per 100,000 population and CFR of <1%. Based on the data above, it can be seen that since 2016-2018, an average increase of 185 cases per year. Based on these data, it was found that Manado City is an area with the highest dengue prevalence rate in North Sulawesi. The highest dengue prevalence was discovered in 2016, amounting to 567 cases, and the lowest in 2017, amounting to 139 cases. 

Based on several studies conducted, it was found that there are many factors that cause dengue events. These factors such as environmental factors (climatic, geographical, physical, biological, and chemical environmental factors), host factors (age, sex, education, socio-economy, knowledge, and community actions), and causative agent factors (dengue virus) and vectors (Aedes aegypti). Influencing human factors such as behavior are also associated with the incidence of DHF. Research from Suryani and Sari on the correlation between 3M behavior and the incidence of DHF in the Working Area of the West Lingkar Health Center in Bengkulu City. The bivariate analysis results showed a significant relationship between 3M behavior and the incidence of DHF in the West Ring Health Center Working Area of Bengkulu City. This study aimed to analyze the DHF Epidemiology in Manado City in 2015-2020.

METHODS

Study Design
This study was a quantitative descriptive observational study with a cross-sectional design to evaluate the epidemiology of DHF in Manado City in 2015-2020. This research will be conducted in Manado City from February to July 2023.

Data Collection
This research used secondary data from the Manado City Health Office. The variables in this study were the prevalence of dengue fever in Manado City based on year, primary health care work area, gender, and age group. The instrument used was a fill-in sheet. The dengue prevalence data used was data from 2011-2023.

Data Analysis
Data was analyzed descriptively using SPSS ver. 25. The data analysis conducted in this study was univariate. The data obtained are presented in the form of graphs.

RESULTS

Distribution of Dengue Prevalence in 2011-2023 in Manado City
The distribution of dengue prevalence in 2011-2023 by year can be seen in Figure 2. The results showed that from 2011 to the present, four peaks of dengue fever were found, namely in 2012 (308 cases), 2016 (521 cases), and 2022 (598 cases). The number of cases in 2012, 2016, and 2022 has increased twice from the previous year, namely in 2012, 2016, and 2022. In addition, it was found that the 4th peak of dengue cases occurred...
at intervals of 3–4 years. The rise and fall of dengue prevalence in Manado City is thought to be caused by many factors, such as environment, hosts, agents, and vectors.

Furthermore, the prevalence of dengue fever in Manado in 2015-2020 was explained based on the working area of primary health care (Figure 3).

Figure 3 showed that dengue patients 2015–2020 in Manado City in 2015 had the highest number of dengue patients in the working area of the Paniki Bawah Health Center, with as many as 55 patients; Minanga Health Center, as many as 53 patients; and Ranomut Health Center, as many as 43 patients. In 2016, the highest number of dengue sufferers in the Minanga Health Center working area was 58 patients. Telling Atas Health Center had as many as 56 patients, and the Wenang Health Center had 48 patients. In 2017, the highest number of dengue sufferers at the Bahu Health Center was 21 patients; the Tikala Baru Health Center had 16 patients, and the Tuminting Health Center and the Ranotana Health Center had 13 patients. In 2018, the highest number of dengue sufferers in the Minanga primary healthcare working area was 35 patients; Ranomut Health Center had as many as 29 patients, and Bahu Health Center had as many as 24 patients. In 2019, the number of dengue sufferers at the Paniki Bawah Health Center was 79, Teleng Health Center had 59 patients, and Bahu Health Center had 50. In 2020, the highest number of dengue sufferers in the working area of the Bahu Health Center was 15 patients, the Minanga Health Center was 14, and the Sario Health Center had 10 patients.

Distribution of DHF Prevalence by Sex

The distribution of dengue prevalence by sex can be seen in Figure 4. Figure 4 shows that the distribution of dengue patients by sex in 2015-2020 is most commonly found in the male, namely 337 people (2019), 266 people (2016), 239 people (2015), 76 people (2017), 127 people (2018) and 48 people (2020). At the same time, the female population was 255 people (2019), 252 people (2016), 172 people (2015), 170 people (2015), 130 people (2018), 63 people (2017) and 31 people (2020). The incidence of dengue fever in Manado City in 2015-2020 based on gender, in general, shows a tendency for dengue incidence to fluctuate starting in 2015, with 448 cases of incidence increased in 2016 as many as 518 cases of the incident. There was a decrease in 2017 139 cases of events, then experienced a slight increase in 2018, as many as 257 cases of events, but in 2019, it increased by 592, while in 2020, it decreased by 79 cases.

Distribution of DHF Prevalence by Age Group

The distribution of dengue prevalence by age group can be seen in Figure 5. Figure 5 showed the distribution of dengue patients by age group in 2015-2020, most commonly found in the age group of 6-11 years, namely 255 people (2019), 194 people (2016), 176 people (2015), 112 people (2018), 60 people (2017), except 24 people (2020) age group 0-5 years. Then followed by the age group 0-5 years, namely 172 people (2016), 170 people
Based on age groups, the study results obtained the number of dengue incidents in Manado City in 2015-2020. It was seen that the tendency of dengue incidence fluctuated starting in 2015, with 448 cases of dengue incidence increasing in 2016 to as many as 521 cases of the incident. There was a decrease in 2017 of 139 cases of incidence, then experienced a slight increase in 2018 of 257 cases of the incident, but in 2019, it increased by 589; meanwhile, in 2020, there was a decrease of 79 cases of incidence.

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DISCUSSION

Based on several studies conducted, it was found that many factors cause dengue events. These include environmental factors, hosts, causative agents (dengue virus), and DHF vectors. Environmental factors that affect the spread of dengue cases are biological, physical, and social—natural environments, such as mosquito larvae and ornamental plants in the house and yard. The physical environment includes temperature, humidity, rainfall, occupancy density, water reservoirs, etc. The social environment consists of behavior, population density and mobility, mosquito nest eradication behavior, education level, type of occupation, income level, culture, and others.\(^5\)\(^,\)\(^6\) The physical environmental parameters of humidity, rainfall, and temperature are linked to the occurrence of dengue. According to certain research, Aedes sp. mosquitoes may survive for a considerable amount of time at temperatures between 28°C and 32°C when there is a lot of moisture present. In Indonesia, the temporal pattern of illness occurrence varies slightly depending on the location due to variations in air temperature.\(^3\)\(^,\)\(^16\)\(^,\)\(^19\) According to Lahdji and Putra, rainfall and air temperature affect the incidence of dengue fever. Waterlogging caused by rain becomes a breeding ground for *Aedes aegypti*.\(^20\)

Furthermore, the prevalence of dengue fever is impacted by worldwide phenomena like climate change. The temperature of the air rises in a region due to climate change. While rising temperatures might hasten mosquito reproduction, they also slow down and finally cease to grow. Mosquitoes can tolerate temperatures as high as 40°C, although their ideal development range is between 25 and 27°C. When that temperature is reached, mosquito development stops. Rainfall also increases as a result of climate change. Rainwater pools on plants and used items (such as plastic and cans) may result in increased precipitation. The mosquito breeding ground is higher in areas with more puddles.\(^21\)

Environmental factors and human factors such as age and gender influence risk factors for dengue cases. Age also has a relationship with DHF disease. The age of < 5 years is more likely to be infected with the dengue virus. This has to do with daily activities that are more done at home.\(^22\)

There are exciting things obtained from this data. The prevalence of dengue cases decreased significantly in 2016-2017 and 2019-2020; the lowest decrease occurred in 2019-2020. The significant reduction in dengue prevalence from 2019 to 2020 was caused by the Corona Virus Disease (COVID-19) pandemic. The first two years of the COVID-19 pandemic, namely 2020 and 2021, were when the prevalence was the lowest since 2011-2023, namely 69 cases (2020) and 135 cases (2021). Social restrictions (social/physical distancing) have also affected many people’s activity patterns, especially at the beginning of the pandemic. This is an implication of several policies of the central government and local governments in efforts to contain the spread of COVID-19.

Delot and Ilarri (2020) conducted research during the social distancing period (pandemic) in the City of Lille, France. The results of this study showed that people spend more time at home with their nuclear family during the period of social restrictions.\(^23\) Chan et al., (2020) stated that in most developing cities, including Manado City, the movement or mobility of people is still dominated by private vehicles. Globally, people's

![Figure 5. Distribution of dengue patients by age group](image-url)
mobility patterns changed after the WHO designated COVID-19 as a pandemic. Before the vaccine, people tried to adjust their mobility behavior to avoid exposure to the COVID-19 virus. This caused people’s mobility to decrease at the beginning of the pandemic.24

In general, the highest prevalence was seen in 2015 at the Lower Paniki Health Center, 2016 at the Minanga Health Center, in 2017 at the Bahu Health Center, 2018 at the Minanga Health Center, 2019 at the Paniki Bawah Health Center, and 2020 at the Bahu Health Center where these Health Centers are located in Mapanget District (Paniki Bawah Health Center) and Malalayang (Bahu and Minanga Health Center). When viewed from the population, it is found that Mapanget and Malalayang sub-districts are the districts with the highest population in the city of Manado. Mapanget District has 53,716 residents, Malalayang District has 57,319 residents, and Wanea District has 56,509 residents. Tomia et al., (2016) stated that the more population in an area will increase the possibility of dengue exposure in many people. Suppose a mosquito bites a patient with a condition of viremia; then the mosquito will be infected. Dengue virus that enters the mosquito’s body will multiply within 8-10 days, and mosquitoes will transmit it to others.25

The population density in Manado City tended to be high in 2015, 2016, and 2019. In addition, Manado City is an area with high population mobility and a large population. This can cause the population of Aedes aegypti mosquitoes to increase. A person living in an area with a high population level is likely to contract DHF. The number of dengue cases in Manado City from 2015-2020 fluctuated because the number of cases recorded yearly was not fixed. Several factors can influence the existence of several endemicity statuses. High population mobility is one factor that plays a role in a region’s endemicity status. The population density factor is also stated as one factor that plays a role in dengue endemicity. Another factor that plays a role in dengue endemicity is the biological environment in the form of the density of Aedes aegypti larvae. The thickness of larvae has a very close relationship with dengue’s high and low endemicity.25

Research from Mahendra, (2021) shows that based on the results of statistical tests that look at the relationship between sex and the incidence of DHF indicate that there is a significant relationship between sex and DHF.26 Research from Tomia et al., (2020) shows that the distribution of dengue cases in 2009-2018 in Ternate City is more dominant in the male sex as many as 507 people.25 In line with research conducted by Kasman and Ishak, (2018), the distribution of dengue fever in Banjarmasin is more prevalent in the male sex, with as many as 147 people.27

The correlation between sex and the incidence of DHF is because, according to Halstead’s theory in Guha-Sapir and Schimmer, (2015), states that the number of DHF sufferers who are male is more than female due to immunity factors in the body. Females have a better immune response than males.28 This is because the production of cytokines in females is more significant than in males. This cytokine is a hormone responsible for regulating the intensity and duration of the immune response in a person’s body. In addition, males also have mobility and work activities that tend to be high so that males can travel to dengue-endemic areas.29

Furthermore, research from Tomia et al., (2020) showed that the distribution of dengue cases in 2009-2018 in Ternate City had the most dengue sufferers in the age group of 5-14 years and in that age group also the highest dengue deaths, there were 486 dengue patients in the age group of 5-14 years in the period 2009-2018. The age group of 5-14 years is the age group most vulnerable to suffering from DHF because that age is school age, so it has a high level of exposure to mosquito bites. In addition to age, gender is also a factor in death.25

The research results from Rojali and Amalia, (2020) show that statistical tests obtained a significant relationship between age and the incidence of DHF. This study shows that the age group of <15 years, namely children, is more dominant affected by DHF. This is because the immune system in children is still low. Hence, it is susceptible to disease, and children’s activities are more outside the home, such as in the morning; they spend more time at school or playing for several hours or almost all day in conditions and time to be exposed to the risk of dengue mosquito bites. Thus, the age group of <15 years or children needs priority protection from dengue transmission. For example, Mosquito Nest Eradication activities prioritize houses with children and improve their nutritional status to strengthen their immune systems.29

This study still has several limitations, such as the sample of the study was based on secondary data from the Manado City Health Office only. This could result in cases that were not recorded in the Manado City Office’s records not being included in this study, thereby affecting the actual number of incidents in the field.

CONCLUSION

The conclusion of this study shows that since 2011-currently, four peaks of dengue fever were found. The prevalence of dengue cases decreased significantly in 2016-2017 and 2019-2020; the lowest decrease occurred in 2019-2020. The significant reduction in dengue prevalence from 2019 to 2020 was caused by the Corona Virus Disease (COVID-19) pandemic. Furthermore, it was found that the distribution of dengue fever in Manado City in 2015-2020 based on sex increased in 2016 and 2019, decreased in 2017 and 2020, and was more dominant in the male sex. The highest distribution of dengue fever in Manado City in 2015-2020 was found in the age group of 6-11 years, followed by 0-5 years. Further studies and records are needed to validate these findings and to evaluate the possible factors that caused the change of pattern regarding DHF cases in Manado City.

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CONFLICT OF INTEREST

The authors state no conflict of interest in writing this study.
ETHICAL CONSIDERATION

This research has been declared ethically feasible by the research ethics commission of the Health Research Ethic Committee RSUP Prof. dr. R.D. Kandou Manado Hospital with the number 141/EC/KEPK-Kandou/IX/2022.

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AUTHOR CONTRIBUTION

The study’s idea, definition of intellectual content, literature search, data collection, manuscript editing, manuscript review, and guarantor were all aided by the first author. The definition of intellectual content, literature search, manuscript editing, manuscript review, and guarantor were all aided by the second author. The study’s idea and design, the definition of intellectual content, literature searches, data collection and analysis, manuscript preparation, editing, and review were all aided by the third author. The study’s idea and design, definition of intellectual content, literature search, data collection, data analysis, manuscript preparation, editing, and review were all aided by the fourth author.

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