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A COMPARISON OF RISK FACTORS OF DENGUE HEMORRHAGIC FEVER OUTBREAKS BETWEEN URBAN AND RURAL AREAS DURING THE COVID-19 PANDEMIC

Perbandingan Faktor Risiko Wabah Demam Berdarah Dengue di Daerah Perkotaan dan Pedesaan pada Masa Pandemi COVID-19

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ABSTRACT

The incidence of Dengue Hemorrhagic Fever (DHF) in Buleleng District during COVID-19 pandemic was very high. Mortality cases in 2021 will double from 2020. We conducted a case-control study in two sub-districts Buleleng District. A total of 143 samples were obtained by total sampling divided into cases and controls traced from February 1-28, 2021. Cases were individuals diagnosed by the hospital. Controls were individuals selected from the case environment and did not experience symptoms of DHF. We collected data door-to-door and data from a cohort of DHF sufferers. We processed and analyzed data using the IBM SPSS version 22 application. Inferential analysis used Chi-Square or Fisher-Exact statistical tests. We found 76 cases of DHF and 2 of them died. AR in urban areas was higher than rural areas with 4 per 10,000 and a CFR of 0.62%. A total of 45 cases were male. A total of 46 cases were in the young age group. The presence of larvae (OR: 2.01 95%CI: 1.3-3.03), open containers (OR: 2.2 95%CI: 1.2-4.2), open rubbish bins (OR: 3.1 95%CI: 1.7-5.4) in urban areas and the presence of larvae (OR: 2.5 95% CI: 1.1-5.3), open containers (OR: 2.5 95% CI: 0.8-8.1) in rural areas were significantly associated with DHF outbreaks during the COVID-19 pandemic. The presence of larvae, open containers, and open rubbish bins are associated with DHF outbreaks during the COVID-19 pandemic. It is necessary to intensify surveillance approaches and community empowerment in eradicating mosquito nests to limit the area of transmission.

Keywords: *dengue hemorrhagic fever, outbreaks, risk factors, urban and rural areas, COVID-19 pandemic*

ABSTRAK

Kejadian Demam Berdarah Dengue (DBD) di Kabupaten Buleleng pada masa pandemi COVID-19 sangat tinggi. Kasus kematian tahun 2021 meningkat dua kali lipat dari tahun 2020. Kami melakukan penelitian kasus kontrol pada dua kecamatan Kabupaten Buleleng. Sebanyak 143 sampel diperoleh dengan total sampling dibagi menjadi kasus dan kontrol yang ditelusuri mulai tanggal 1-28 Februari 2021. Kasus adalah individu yang didiagnosis oleh rumah sakit. Kontrol adalah individu yang dipilih dari lingkungan kasus dan tidak mengalami gejala DBD. Kami mengumpulkan data secara door to door dan dari data kohort penderita DBD. Kami mengolah dan menganalisis data menggunakan aplikasi IBM SPSS versi 22. Analsisis inferensial menggunakan uji statistik Chi-Square ataupun Fisher-Exact. Kami menemukan 76 kasus DBD dan 2 diantaranya meninggal dunia. AR di daerah perkotaan lebih tinggi dibandingkan pedesaan dengan 4 per 10.000 dan CFR 0,62%. Sebanyak 45 kasus adalah laki-laki. Sebanyak 46 kasus berada pada kelompok usia muda. Keberadaan jentik (OR: 2.01 95%CI: 1.3-3.03),kontainer terbuka (OR: 2.2 95%CI: 1.2-4.2),tempat sampah terbuka (OR: 3.1 95%CI: 1.7 -5.4) di daerah perkotaan dan keberadaan jentik (OR: 2,5 95% CI: 1.1-5.3), kontainer terbuka (OR: 2,5 95% CI: 0.8-8.1) di daerah perdesaan secara signifikan berhubungan dengan wabah DBD pada masa pandemi COVID-19. Keberadaan jentik, kontainer terbuka dan tempat sampah terbuka berhubungan dengan wabah DBD pada masa pandemi COVID-19. Pendekatan surveilans aktif dan pemberdayaan masyarakat dalam pemberantasan sarang nyamuk perlu dilakukan untuk membatasi daerah penularan.

Kata kunci: demam berdarah dengue, wabah, faktor risiko, daerah perkotaan dan pedesaan, pandemi COVID-19

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INTRODUCTION

COVID-19 is a disease caused by SARS-CoV-2 and has the potential to become a double burden in disease control on the tropics areas (Harapan *et al.*, 2020). Dengue Hemorrhagic Fever (DHF) is one of the emerging diseases caused by Dengue Virus (DENV) which is transmitted through the bite of the Aedes aegypti mosquito vector and has become endemic in the tropics areas (WHO, 2021). During the last three decades, the incidence of DHF tends to increase and often causes outbreaks. The incidence of DHF is more often found in urban areas than in rural areas (Kemenkes RI, 2017).

The first dengue outbreak occurred in 1653 in the Frech West Indies (Caribbean Islands). Dengue outbreaks in Australia were first reported in 1897 and in Italy and Taiwan in 1931. Dengue outbreaks in Southeast Asia were first reported in the Philippines in 1953-1954. At that time, this disease attack was accompanied by a high death rate to hit Southeast Asia including Indonesia. Over the next two decades, the incidence of dengue has increased and the spread of cases in Indonesia (Kemenkes RI, 2017).

The DHF Incidence Rate (IR) in Indonesia before the COVID-19 pandemic was quite high. IR DHF in 2019 was reported at 51.48 per 100,000 population. This data shows an increase compared to the previous two years with IR of 26.1 and 24.75 per 100,000 population respectively. North Kalimantan, East Kalimantan, and Bali were the top three provinces with the highest IR in 2019 at 239, 180.6 and 114.8 per 100,000 population. The National Case Fatality Rate (CFR) showed a decline from 0.71% in 2018 to 0.67% in 2019 (Kemenkes RI, 2020).

Buleleng District is an area in northern Bali with the highest incidence of DHF in Indonesia on 2020 (Kemenkes RI, 2021). DHF cases reported during the COVID-19 pandemic were very high and far exceeded the national IR indicator of 49 per 100,000 population. The number of DHF cases in 2020 was recorded at 3,402 cases with an IR of 512 per 100,000 population and the number of death cases was 7 cases with a CFR of 0.21% (Dinas Kesehatan Kabupaten Buleleng, 2021).

The high number of DHF cases that occurred during the COVID-19 pandemic is thought to be due to outbreaks in several areas. The number of DHF cases in February 2021 showed a decrease compared to the same month in 2020 but seen from the number of deaths in February 2021, it doubled compared to the same month in 2020. The number of DHF cases in Buleleng District on February 2021 were 160 cases with two deaths, while on February 2020, there were up to 463 cases with one death (Dinas Kesehatan Kabupaten Buleleng, 2021).

Buleleng Sub-district and Seririt Sub-district are the two areas with the highest DHF cases in Buleleng District on 2020 with the number of cases reaching respectively 876 and 380 cases. Buleleng Sub-district is an urban area with 62 cases of DHF on February 2021, one of them was a death. Seririt Sub-district is a rural area with the second highest number of cases on February 2021 which was reported as many as 14 cases, one of them was a death (Dinas Kesehatan Kabupaten Buleleng, 2021).

This problem can occur due to multiple factors. Environmental conditions are thought to be one of the causes and part of the epidemiological triangle which is one theory of the cause of the disease. The presence of larvae, condition of containers, conditions of rubbish bins, conditions of waste disposal, and the distance housing area are components of environmental factors (Gama and Betty, 2010).

High urbanization, population density, and human mobility make urban areas more vulnerable to DHF outbreaks (Kemenkes RI, 2017). High urbanization causes population density, housing conditions are increasingly dense, and environmental conditions are polluted increasingly (Wahyuningsih, 2014). Human mobility will also facilitate the spread of DENV infection (Gama and Betty, 2010).

The increase number of cases DHF during the COVID-19 pandemic is a serious health problem and a solution needs be found to overcome is so that does not cause a double burden of disease control (Ulrich, Pillat and Tárnok, 2020).

Previous studies have found many risk factors for the occurrence of DHF related to behavior as the cause. Based on some of the results of these findings, it is recommended to conduct research environmental factors related to the incidence of DHF. The investigation of environmental risk factors for the incidence of DHF during the COVID-19 pandemic has never been found. Our study aims to explore environmental risk factors associated with the

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incidence of DHF in urban and rural areas during the COVID-19 pandemic and to develop recommendations for control efforts.

METHOD

We conducted a case-control study in two sub-districts in Buleleng District, namely Buleleng Sub-district and Seririt Sub-district. We chose this sub-district because it had a high number of DHF cases during the COVID-19 pandemic. Buleleng Sub-district represents urban areas and Seririt Sub-district represents rural areas. We explored environmental factors including the presence of larvae, container conditions, rubbish bins conditions, waste disposal conditions, and the distance housing area as independent variables and the incidence of DHF as the dependent variable.

We conducted the study from February 1-28, 2021. Our study sample was all residents who met the restrictions as cases and controls. Cases were individuals diagnosed with DHF and residing in the Sub-districts of Buleleng and Seririt and controls were individuals selected from the neighborhood where cases have been successfully met and the location of their homes was beside and or opposite the cases house with a minimum distance of 10 meters and did not experience clinical symptoms. We performed control selection without matching. Total sample of our study was 143 samples. The sample in urban areas consisted of 62 case samples, 61 control samples, samples in rural areas consisted of 14 case samples and 6 control samples. Our sampling technique used total sampling. The samples used were all individuals who had been found and all DHF patients during February 2021 and then a search was conducted.

We collected data including primary data obtained door to door at the research site and secondary data obtained from data on the cohort of DHF sufferers and the websites of related agencies. We performed computer-aided data processing and analysis using the IBM Statistical Package for the Social Sciences (SPSS) version 22 application in two stages of analysis, descriptive, and inferential. Descriptive analysis used a frequency distribution whose analysis results were in the form of frequency (n) and percentage (%) to report the prevalence of cases by place and person. Attack Rate (AR) was used to calculate the level of disease in an outbreak and Case Fatality Rate (CFR) was used to calculate the death rate of a disease in an outbreak. Inferential analysis used Chi-Square or Fisher-Exact statistical tests that compared two sample proportions with alpha values <0.05 or Confident Interval (CI) of 95% to prove the hypothesis. The strength of the resulting relationship was the Odds Ratio (OR).

RESULT

Table 1. Distribution of DHF Patients by Place and Person during the COVID-19 Pandemic

Variable	Total Population	Number of Cases	AR	Number of Deaths	CFR (%)
Area					
Urban	154.070	62	4 per 10.000	1	0,62
Rural	97.675	14	1 per 10.000	1	0,14
Gender					
Male	126.373	45	3 per 10.000	2	4,44
Female	125.372	31	2 per 10.000	0	0
Age group					
Young	58.184	26	4 per 10.000	1	3,84
Productive	137.803	46	3 per 10.000	1	2,17
Elderly	19.809	4	2 per 10.000	0	0

Source: (Disdukcapil Kabupaten Buleleng, 2019)
Information:
AR: Attack Rate
CFR: Case Fatality Rate

We found that AR DHF in urban areas was higher than in rural areas which was 4 per 10,000 populations, thus people living in urban areas had a higher risk of developing DHF compared to residents in rural areas. The CFR of DHF in urban areas was also higher at

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0.62%. We also found more cases of DHF in the male population, namely 45 cases with AR of 3 per 10,000 populations, thus the male population has a higher risk of developing DHF compared to female. All cases of death were found in the male population as many as 2 people with a CFR of 4.44%. DHF cases were also found to be more in the productive age group, as many as 46 cases. The highest AR was found at a young age of 4 per 10,000 populations thus the young age group had the highest risk of developing DHF compared to other age groups. We also found cases of death occurred in the young and productive age group with 1 case respectively with CFR 3.84 and 2.17%.

Table 2. Risk Factors for DHF Outbreaks in Urban Areas during the COVID-19 Pandemic

Variable	Case n (%)	Control n (%)	OR	95%CI	p value
Presence of larvae					
Yes	43 (35,0)	22 (17,9)	2,01	1,3-3,03	0,000
No	19 (15,4)	39 (31,7)			
Container					
Open	54 (43,9)	38 (30,9)	2,2	1,2-4,2	0,002
Close	8 (6,5)	23 (18,7)			
Rubbish bins					
Open	52 (42,3)	25 (20,3)	3,1	1,7-5,4	0,000
Close	10 (8,1)	36 (29,3)			
Waste disposal					
Open	45 (36,3)	41 (20,3)	1,1	0,7-1,7	0,516
Close	17 (13,8)	20 (16,3)			
Distance housing area					
1-5 meters	51 (41,5)	55 (44,7)	0,7	0,4-1,1	0,204
6-10 meters	11 (8,9)	6 (4,9)			

Information:
OR: Odds Ratio
CI: Confident Interval

We found that the presence of larvae in urban areas was higher on the case group by 35.0% with OR = 2.01, thus the presence of larvae was 2 times higher risk of causing DHF outbreaks. The presence of larvae was significantly associated with DHF outbreaks (p=0.000). Open containers were also found to be higher on the case group which was 43.9% with OR=2.2, thus the condition of open containers was 2.2 times higher causing DHF outbreaks. Open containers were significantly associated with DHF outbreaks (p=0.002). Open rubbish bins were also higher on the case group which was 42.3% with OR = 3.1, thus the condition of open rubbish bins was 3.1 times higher risk of causing DHF outbreaks. We also found that the condition of open rubbish bins was significantly associated with DHF outbreaks (p=0.000). Open waste disposal was found to be higher on the case group which was 36.3% with OR=1.1. We found no relationship between open waste disposal conditions in urban areas and DHF outbreaks (p=0.516). We also found that the distance of housing area that were close together was between 1 and 5 meters higher on both the case and control groups which were 41.5% and 44.7% respectively, but there was no relationship between the distance of housing area that were close together and DHF outbreaks.

Tabel 3. Risk Factors for DHF Outbreaks in Rural Areas during the COVID-19 Pandemic

Variable	Case n (%)	Control n (%)	OR	95%CI	p value
Presence of larvae					
Yes	10 (50,0)	0 (0,0)	2,5	1,1-5,3	0,011
No	4 20,0)	6 (30,0)			
Container					

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Open	12 (60,0)	2 (10,0)	2,5	0,8-8,1	0,037
Close	2 (10,0)	4 (20,0)			
Rubbish bins					
Open	13 (65,0)	5 (25,0)	1,4	0,3-5,9	0,521
Close	1 (5,0)	1 (5,0)			
Waste disposal					
Open	12 (60,0)	4 (20,0)	1,5	0,5-4,1	0,549
Close	2 (10,0)	2 (10,0)			
Distance housing area					
1-5 meters	13 (65,0)	4 (20,0)	2,2	0,4-11,6	0,202
6-10 meters	1 (5,0)	6 (10,0)			

Information:
OR: Odds Ratio
CI: Confident Interval

We found that the presence of larvae in rural areas was higher on the case group by 50.0% with OR=2.5, thus the presence of larvae was 2.5 times higher risk of causing DHF outbreaks. The presence of larvae was significantly associated with DHF outbreaks (p=0.011). Higher open containers were found on the case group which was 60.0% with OR=2.5, thus the condition of open containers was 2.5 times higher causing DHF outbreaks. We also found that open containers were associated with DHF outbreaks (p=0.037). Open rubbish bins were also found to be higher on the case group, which was 65.0% with OR=1.1. The condition of open rubbish bins was only 1.1 times higher risk of causing DHF. We found that the condition of open rubbish bins in rural areas had no relationship between DHF outbreaks (p=0.521). Open waste disposal was found to be higher on the case group which was 60.0% with OR=1.5. Open waste disposal was only 1.5 times higher risk of causing DHF outbreaks and we found no relationship between open waste disposal conditions in rural areas and DHF outbreaks (p=0.549). We also found that the distance of housing area was between 1 and 5 meters higher on the case group up to 65.0% and OR = 2.2 but there was no relationship between the distance of housing area and the incidence of DHF

DISCUSSION

The distribution of DHF cases in Buleleng District during the COVID-19 pandemic based on place, it was found that people living in urban areas had a higher risk of getting DHF compared to residents in rural areas. Our findings are in line with the report (Kemenkes RI, 2017) which reported that the area of residence was one determinants of the incidence DHF.

Urban areas tend to have a higher potential to trigger the occurrence of DHF than rural areas. This is influenced by population density, population mobilization, and the increasing flow of urbanization. Increased urbanization causes rapid population density thus living conditions become increasingly dense and environmental conditions become less conducive, which will potentially lead to DHF outbreaks. Human mobility will also facilitate the spread of DENV infection by following the flow and traffic patterns of the population (Wahyuningsih, 2014), (Gama and Betty, 2010).

The COVID-19 pandemic has caused a decrease in human mobility but has actually resulted an increase in DHF cases. 70% of the population stayed at home during the COVID-19 pandemic due to social restrictions, causing an increase in the average total DENV infection by up to 10%. The prevalence of infected residents in their own homes rose from 54% under normal conditions to 66% during social distancing conditions, and the household secondary attack rate rose from 0.109 to 0.128 or an increase of 17% (Cavany *et al.*, 2021).

A study conducted (Yuliawati *et al.*, 2020) in Rowosari Village, Tembalang Sub-district, Semarang City actually found the opposite result that in rural areas the risk of DHF was higher. This can occur due to low level of public knowledge regarding environmental hygiene. These findings will have an impact on increasing the number of

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deaths. A study conducted (Moraes, Duarte and Duarte, 2013) in Brazil using data from the National Notifiable Diseases Surveillance System (SINAN) found that rural areas had a higher risk of death due to DHF with severe symptoms (OR = 2.84, 95% CI = 2.19-3.69).

The distribution of cases by person can be seen from gender and age group. We found the number of DHF cases was higher in the male population. Men tend to be more susceptible to DHF infection because they do more activities or work outside the home during the day, which is the time of exposure to the DENV vector. The seroprevelence of DENV infection in male is 81.89% and female is 78.19% (Saraswati and Mulyantari, 2017).

The high incidence of DHF in the male population is in line with the case of death. We found all cases of death occurred in the male population. Our findings are in line with studies conducted by (Lee *et al.*, 2018) at Kaohsiung Chang Gung Memorial Hospital (KSCGMH) and Kaohsiung Medical University Hospital (KMUH) Taiwan which found male individuals were at higher risk of dying from DHF upon arrival. and during hospital stay. This is because male antibodies are genetically and hormonally less optimal in producing immunoglobulins than female individuals (Sahly *et al.*, 2020).

We found that the age group with the highest number of DHF cases was the productive age. This finding is slightly different from the results of a study conducted (Pradipta, Laksanawati and Pramono, 2016) which found that the age group 5-18 years and under 5 years had a higher risk of experiencing severe DHF with each (aOR=4.140; p=0.007), (aOR=4.022; p=0.018). The age group of infants and children will be susceptible to severe dengue due to an unstable immune system and more permeable blood vessels (WHO, 2011).

We found that cases of death in this outbreak were in the young and productive age group. Our findings are different from the results of a study conducted by (Karunakaran *et al.*, 2014) which found that the elderly group had a higher risk of developing DHF complications and even death (aOR=9.3; 95% CI: 1.9-44.4). This is because with increasing age, there will be a decrease in the ability of the body organ performance and endurance (WHO, 2011).

The presence of larvae in urban and rural areas in Buleleng District is significantly related and has an equally high risk of causing DHF. Larvae in urban areas are found in used plastic bottles of drinks and in open drains in front of people houses, while larvae in rural areas are found in puddles, especially on used tires, plastic food packaging and used plastic bottles. Our findings are corroborated by the results of a study (Yuliawati *et al.*, 2020) in Rowosari Village, Tembalang Sub-district, Semarang City that larvae density in rural areas was very high based on the larva density index consisting of House Index (HI) = 44.1%, Container Index (CI) = 31.7%, Breteau Index (BI) = 74.9% and Ovitrap Index (OI) = 64.1% hence there is a high risk of DHF.

Open containers on both urban and rural areas in Buleleng District are significantly related and have the same high risk of causing DHF. Containers in urban and rural areas are rarely cleaned and larvicidated thus this creates the potential for disease transmission. The main breeding place for the Aedes aegypti mosquito vector is water reservoirs in the form of puddles or containers around residences or public places, usually not exceeding a distance of 500 meters from the residence. DHF transmitting mosquitoes usually cannot breed in standing water that is in direct contact with the ground. Our findings are in line with the results of a study conducted (Husna *et al.*, 2020) which found that open containers had a 1 times higher risk of causing DHF than water containers in closed conditions. The study conducted by (Gama and Betty, 2010) confirmed our findings that the number of containers above 3 units has a 6.75 times higher risk of causing the incidence of DHF compared to containers below or equal to 3 units.

Open rubbish bins in urban areas in Buleleng District are significantly associated and have a higher risk of causing DHF compared to rural areas. This is because the dominant waste in rural areas is dry waste and more dry leaves or dry tree branches, hence the potential for breeding places and mosquito habitats in this area tends to be small. In urban areas, on the contrary, it was found that the condition of the waste tends to be slum and dominant with household plastic waste and mixed with food wrappers which are in humid conditions and are infested with flies. This has the potential as a mosquito vector perching

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medium. The condition of open rubbish bins will have a high chance of being infested with mosquitoes, one of which is a mosquito that transmits DENV (Pusdatin Kemenkes RI, 2018).

Open waste disposal in urban and rural areas in Buleleng District is not significantly related and has a low risk of causing DHF. This is because household waste in urban and rural areas is managed and absorbed properly thus it does not cause pollution which is a breeding ground for DENV transmitting mosquitoes. The dominant vector of DENV transmitting mosquitoes live in places where there is standing water, one of which is household liquid waste that pools so that open waste disposal has the potential to become a mosquito habitat and is at risk of transmitting dengue disease (Pusdatin Kemenkes RI, 2018).

The distance of housing area in urban and rural in Buleleng District is not significantly related and has a low risk of causing DHF. This is because the layout of housing in urban and rural areas in Buleleng District is done well and is not in a slum condition hence there is a low risk of causing DHF. Our findings are not in line with the study conducted (Husna *et al.*, 2020) which found that residents who have houses less than 40 meters away from other houses have a 2.5 times higher risk of DHF than residents whose houses are more than 40 meters apart another house building. Infectious disease studies also reported that crowded housing conditions and slums tended to be more susceptible to disease.

Research Limitations

Our study has the potential to experience systematic inclusion or exclusion bias in research subjects because it is not able to select more than one type of control population. Our research also has the potential to experience confounding bias because it is not able to perform the matching process on the control to obtain the same characteristics as the case and in data analysis process no control or adjustment is made to the confounder.

CONCLUSION

The presence of larvae, open containers, and open rubbish bins in urban or rural areas and the presence of larvae are risk factors for DHF outbreaks during the COVID-19 pandemic.

SUGGESTIONS

It should develop an integrated DHF control program by intensifying active surveillance approaches and mobilizing the community to intensify the implementation of mosquito nets eradication in their respective neighborhoods every week with draining, burying, and closing plus larvasidation.

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