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Spatial analysis of tuberculosis cases diffusion based on population density in Bekasi Regency in 2017-2021

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Abstract

Purpose: This research aims to examine the spatial relationship between tuberculosis cases and population density and their spatial diffusion patterns in Bekasi Regency in 2017-2021. **Methods:** Research using an ecological study design using spatial analysis to estimate and analyze the distribution of tuberculosis prevalence related to population density in 23 sub-districts in Bekasi Regency, compare data from 2017 to 2021, and evaluate the spatial correlation. The data is taken from secondary data from the Bekasi District Health Office for 2017-2021. **Results:** This study shows a spatial autocorrelation between tuberculosis cases and population density from 2017 to 2021 (I>E; *p-value* <0,05). There is spatial diffusion of cases characterized by expanding clusters with high tuberculosis cases. High-high cluster in 2017, there was one sub-district. In 2018 there was also one sub-district. In 2019 there were two sub-districts. In 2020, there were three sub-districts. And in 2021, there were five districts. **Conclusion:** This research shows a positive spatial autocorrelation in the incidence, influenced by population density in Bekasi Regency from year to year (2017-2021) with a clustering pattern.

Keywords: spatial analysis; tuberculosis; population density

INTRODUCTION

Tuberculosis is one of the top 10 diseases that cause death and is the leading cause of a single infectious agent (above HIV/AIDS) worldwide. Tuberculosis produces a cough that lasts more than three weeks, usually has sputum, and sometimes bleeds. The disease is spread through droplets of people infected with tuberculosis bacillus [1].

According to the World Health Organization, tuberculosis (TB) is still a health problem today. In 2020, there were 10 million people worldwide suffering from tuberculosis (TB), causing 1.2 million people to die yearly. Indonesia is one of the countries with the highest TB burden in the world, with an estimated number of TB cases reaching 845,000 with a death rate of 98,000, or equivalent to 11 deaths/hour [2].

In 2021 the number of tuberculosis (TB) cases found was 397,377 cases, an increase compared to all tuberculosis cases seen in 2020, which was 351,936. The highest cases were reported from large population provinces of West Java, East Java, and Central Java [3]. Health data from West Java Province in 2021 reported that the number of tuberculosis cases in Bekasi Regency was 10,041 people, the second highest number after Bogor Regency [4].

According to research in Semarang, one of the tuberculosis cases is influenced by population density in an area [5]. This is because people living in densely populated areas are more likely to come into contact

with people with tuberculosis. As a result, densely populated regions tend to have higher cases of tuberculosis. Other research found that the spread of droplets containing Mycobacterium tuberculosis occurs faster from one host to another in areas with high population density [6].

When viewed from a regional aspect, population density affects the spread of tuberculosis cases [7]. Furthermore, a study in China found a significant spatial autocorrelation in the spread of tuberculosis cases influenced by student population density in Nanning [8]. This research used spatial statistical analysis, linking spatial relationships into calculations. Spatial statistics is needed to see the effect of correlation on estimation, prediction, and design processes using certain spatial models. Spatial analysis is needed to find the relationship between the research area and the area around the study [9].

Regional analysis in identifying the spread of tuberculosis cases and their relationship to population density can help the government identify priority areas for tuberculosis treatment. Moreover, the results of the statistical spatial analysis carried out in a time series can describe the diffusion of tuberculosis cases from year to year. Previous research on the spread of tuberculosis in Sukabumi City showed that the pattern of tuberculosis spread in 2018 and 2019 shows spatial autocorrelation with random spatial patterns [9]. When associated with population density, research in Central Java found the spread of tuberculosis cases formed a clustering pattern from year to year but was statistically spatially insignificant [10]. However, no time-series spatial research on the spread of tuberculosis and its relation to population density in the Bekasi Regency. This study examines the spatial relationship between tuberculosis cases, population density, and spatial diffusion patterns for 2017-2021.

METHODS

This study uses an ecological study design using spatial analysis to estimate and analyze the distribution of tuberculosis prevalence related to population density in 23 sub-districts in Bekasi Regency, compare data from 2017 to 2021, and evaluate spatial correlation. This study used secondary data collected from several open data access, such as TB cases variable from West Java open data and population density from health profiles of Bekasi Regency from 2017 to 2021, which are accessible on each of the institution's official websites. The data analyzed are aggregated data on the number of TB cases per year and population density per sub-district per year.

This research was conducted in Bekasi Regency, West Java, from October to December 2022, with an area of 127,388 ha of 23 sub-districts. Furthermore, this region has two topography: the lowlands in the northern and the undulating plains in the southern part [11]. The population in this study is the entire population of Bekasi Regency, spread across 23 sub-districts. The sample of this study was residents who were confirmed to have tuberculosis and recorded by the Bekasi Regency Health Office.

Spatial pattern analysis in this study used the Global Moran's Index to detect global autocorrelation and continued with Local Indicators of Spatial Autocorrelation (LISA). This analysis used GeoDa software. The null hypothesis in this study is that there is no spatial autocorrelation between sub-district areas in Bekasi Regency (I = E). As an alternative hypothesis, there is a positive spatial autocorrelation between sub-district areas in Bekasi Regency (I>E). In this study, the significance level used was 95%, so an area is said to have statistically significant spatial autocorrelation if the significance value (p-value) is less than equal to 0.05 in the Global Moran's Index results and LISA analysis.

The Global Moran's Index and LISA are statistical analyses that can measure the relationship of spatial proximity at the observation site by considering that regions with spatial proximity will have similar attribute values. The Global Moran's Index and LISA range from -1 to +1, where a negative number indicates negative autocorrelation, a value of 0 indicates no autocorrelation, and a positive value indicates positive autocorrelation. If there is a negative autocorrelation, the adjacent regions tend to have different attribute values, but space will form a chessboard-like pattern. Conversely, if positive autocorrelation exists, the adjacent region will form a cluster with almost identical characteristics and attribute values. If the Global Moran's Index assesses autocorrelation in the region in general, in this case, it is Bekasi Regency. LISA is used to assess local spatial autocorrelation between sub-districts in Bekasi Regency. This analysis produced information in the form of a BiLISA Cluster Map, BiLISA Significance Map, and Bivariate Moran's I [12].

RESULTS

Patterns of spread of tuberculosis case prevalence related to population density

Table 1 shows Moran Index Results 2017 - 2021. To determine the pattern of the spread of tuberculosis prevalence and its relationship with population density in Bekasi Regency, a global spatial analysis was carried out with the Global Moran's Index. The spread of tuberculosis cases and their relationship with

population density showed a positive spatial autocorrelation between sub-districts in Bekasi Regency from 2017 to 2021. When connected with population density, the spread of Tuberculosis cases in the region offers a clustered pattern. The value of Moran's Index indicates this> Expected index (I > E). The result statistically shows a significant positive spatial autocorrelation (the Z score was positive, and the p-value < 0.05).

Table 1. Moran index 2017 - 2021

Year	Moran's Index	Expected Index	Variance	Z-score	p-value
2017	0,156	-0,0455	0,104	1,7549	0,044
2018	0,1928	-0,0455	0,1096	2,107	0,035
2019	0,2307	-0,0455	0,1139	2,4175	0,017
2020	0,317	-0,0455	0,1184	3,0759	0,007
2021	0,2688	-0,0455	0,1231	2,4775	0,019

Based on the whole, it appears that the value of Moran's Index from 2017 to 2020 has increased, which means that its spatial autocorrelation is increasing. However, in 2021 there was a decrease in the value of Moran's Index to 0.2688.

Cluster map overview of spatial diffusion patterns and the relationship between population density and tuberculosis cases 2017 – 2021

Based on local spatial analysis using LISA, a cluster map and a map of the significance of the relationship between population density and tuberculosis spread in Figure 1 and Figure 2. In 2017, of the 23 sub-districts in Bekasi Regency, two had significant positive spatial autocorrelation (p-value <0.05), Cibitung and Cibarusah. From the cluster map, Cibitung is in quadrant I (high-high) and has a positive spatial autocorrelation associated with population density. The area has a high number of Tuberculosis cases and is surrounded by districts with an increased number of Tuberculosis cases. On the other hand, there is one sub-district in quadrant III (low-low), namely Cibarusah. This positive spatial autocorrelation is associated with population density. Cibarusah district has a low number of Tuberculosis cases and is surrounded by other sub-districts with a low number of Tuberculosis cases.

Furthermore, in 2018, two sub-districts had significant positive spatial autocorrelation, namely Cikarang Barat and Serangbaru. Cikarang Barat Sub District is in quadrant I (high-high) because when related to population density, the district has high tuberculosis cases and is surrounded by districts with high cases. On the other hand, Serangbaru District is in

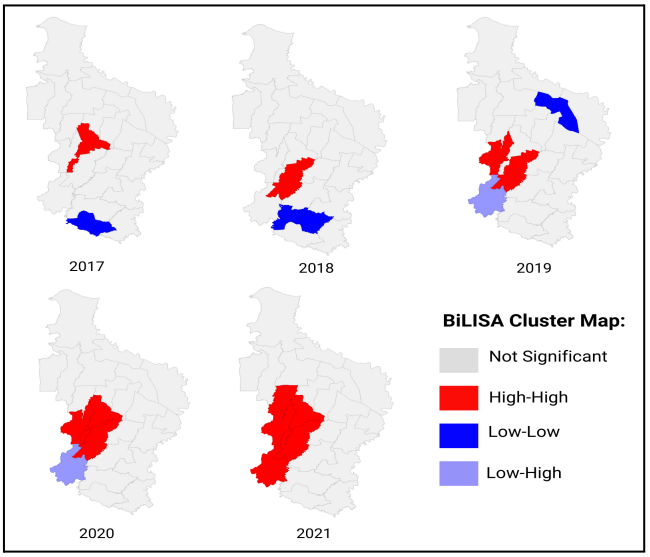

Figure 1. Cluster map of the relationship between population density and tuberculosis cases in Bekasi Regency 2017 – 2021

quadrant III (low-low) because it has low cases and is surrounded by districts that have low cases as well, if it is associated with population density.

Then, in 2019, there are four statistically significant sub-districts: Suka Karya, West Cikarang, South Tambun, and Setu. This year, there was an increase in sub-districts included in the high-high cluster, namely South Tambun District. Suka Karya, Cikarang Barat, and Tambun Selatan sub-districts have positive spatial autocorrelation, while Setu Subdistrict has negative spatial autocorrelation. Cikarang Barat and Tambun Selatan sub-districts are in Quadrant I (high-high) because if it is associated with population density, tuberculosis cases in the region are high and surrounded by areas with high cases. On the other hand, Suka Karya Subdistrict is in Quadrant III (low-low) because it has low tuberculosis cases and is surrounded by areas with low cases when connected with population density. Setu Subdistrict has a negative spatial autocorrelation and is in quadrant II (low-high) because it has relatively lower cases than the surrounding area.

In 2020, the high-high cluster is increasing, with four statistically significant sub-districts, and 3 of them are in quadrant I (high-high). The sub-districts in quadrant I are Cikarang Barat, Cibitung, and Tambun Selatan, which shows that the area has high cases surrounded by areas with high cases also if it is related to population density. The existence of this cluster seems to endanger Setu District in quadrant II (low-high) because this area still has low cases but is surrounded by areas with high cases when connected with population density.

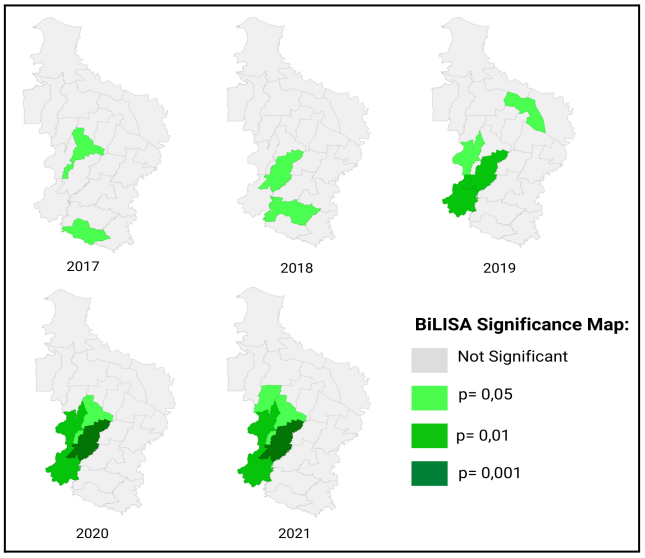

Figure 2. Map of the significance of the relationship between population density and tuberculosis cases in Bekasi Regency in 2017 - 2021

Finally, in 2021, there is an increase in high-high clusters to 5 statistically significant sub-district areas, namely Cikarang Barat, Cibitung, Tambun Selatan, Tambun Utara, and Setu. The addition comes from Setu and North Tambun Districts. In the previous year, the Setu sub-district still had a low number of cases but was surrounded by areas with high cases. In 2021 Setu District experienced an increase in cases like the surrounding area. North Tambun Sub District in previous years did not show the significance of the pattern of spreading cases. However, in 2021, the surrounding area affected the district and became significant in the high-high cluster.

DISCUSSION

Based on the results of the researchers, it was found that there was a significant positive spatial correlation between population density and tuberculosis cases in Bekasi Regency from 2017 to 2021 (p-value < 0.05). The relationship between population density and tuberculosis cases in Bekasi Regency forms a pattern that groups based on the cluster.

Furthermore, the results show that densely populated sub-districts tend to have high tuberculosis cases. Areas with high population density can potentially increase the risk of infection and facilitate disease transmission. People living in densely populated areas are easier to interact with tuberculosis sufferers so that the air mixed with droplets of tuberculosis sufferers can be more easily inhaled by healthy people [13]. In line with this finding, a study found statistically significant positive spatial autocorrelation where high tuberculosis cases were in densely populated areas [14]. Other research found that spatial autocorrelation between population density and tuberculosis is also closely related to AIDS cases in the region. On the contrary, another study suggested no significant spatial relationship between tuberculosis cases and population density [10]. In the Central Java region, BTA tuberculosis (+) is not only caused by population density, but other risk factors may be spatially significant but not included in the study.

Then, based on the significance of LISA, in 2017, Cibitung District significantly had cases, and the population density was quite high and running in harmony, where an increase in the number of cases also accompanied the increase in population density. Geographically Weighted Regression (GWR) analysis shows that an area's high population density positively correlates with the prevalence of tuberculosis in Java. On the other hand, Cibarusah has a low population density, and the tuberculosis cases found are also low and statistically show a meaningful relationship. Similarly, when a region has a low population density, the cases of tuberculosis found are also low [17].

In 2018, tuberculosis cases in West Cikarang were quite high, supported by a fairly high population density and statistically significant. We found a similar thing: areas with high population density also tend to have many tuberculosis cases [13]. In the study, the more densely populated the region, tuberculosis cases increased.

On the other hand, in 2018, significantly, Serangbaru had a low population density, and the tuberculosis cases found were also low. Whereas in the previous year, the area included in this cluster was Cibarusah. Research in Kebumen also found that every year, the areas included in the low-low cluster change [18]. When initially the area is densely populated, then experiences a decrease in density at a time, it also tends to be followed by a decrease in tuberculosis cases in the region [17].

Furthermore, in 2019, there was diffusion where clusters with tuberculosis cases and high population density increased to Cikarang Barat and Tambun Selatan. Then, in the same year, Setu Subdistrict tended to have a low population density and a fairly high number of tuberculosis cases. Still, compared to other surrounding areas, the cases tended to be lower. In Yogyakarta, areas with low densely populated but have quite high cases. Statistically, a significant correlation was found between population density and tuberculosis [19]. This condition lasted until the following year when Setu persisted with fewer cases of population density than its neighboring regions. However, that year, Cibitung experienced a significant increase in cases due to population density. Eventually,

the high-high cluster in the region became three districts. Research in China also found clusters (groupings) of regions with high tuberculosis cases, one of which was influenced by high population density [8].

Finally, in 2021, the spatial diffusion of cases in a high cluster of tuberculosis cases extends to Setu and North Tambun. From the movement of this pattern of spread of cases, it appears that the spread of tuberculosis is closely related to conditions in the surrounding area. When a region has low cases, but neighboring regions have a high prevalence of cases, especially related to infectious diseases, the region will gradually be affected, and cases will increase. Especially when there are risk factors that support the spread of the case, one of which is population density. Population density affects a person's likelihood of encountering tuberculosis sufferers, so densely populated areas tend to have a high rate of the case spreading when there is a high case of tuberculosis. In addition, areas with high population density also tend to have inadequate sanitation and poor hygiene, thereby accelerating the spread of tuberculosis [6]. Furthermore, this also affects the quality of health services obtained by sufferers. Where the area is densely populated, the possibility of the quality of health services is also limited [20].

Overall, there is an increase in territory included in the high-high quadrant every year. In 2017 and 2018, there was only one region with a high-high quadrant, but in 2019 it increased to two regions, then in 2020 to three regions, and 2021 to five regions. This is because the number of tuberculosis cases in neighboring regions influences the number of tuberculosis cases in a region. Furthermore, the more densely populated the region, the higher the number of tuberculosis cases [21]. This phenomenon encourages regions with low tuberculosis cases adjacent to high-high quadrant regions to be affected and eventually join the quadrant. Contrary to Pradana and Santosa's finding (2019), the tuberculosis group spread in Kebumen. Still, areas with high-high quadrants tend to fluctuate.

CONCLUSION

Based on this study, there was a positive spatial autocorrelation in the incidence of Tuberculosis, which was influenced by population density in Bekasi Regency from year to year (2017-2021). The spread of tuberculosis based on population density from 2017 to 2021 shows a clustered spread pattern. Furthermore, a significant relationship was found between population density and tuberculosis cases in Bekasi Regency from 2017 to 2021. If you look at the cluster mapping, which was in the high-high category in 2017, there was one sub-district area, and in 2018, there was one area. Then in 2019, there were two districts with the high-high category and one with the low-high category. In 2020 there are three districts with the high-high category, and in 2021 there are five districts with the high-high category. Clusters with the high-high category are increasing due to the high spread of tuberculosis cases. For this reason, Bekasi Regency Health Office and related stakeholders in TB disease control will focus on areas with high and low cases so that cases in these areas are not carried over to as high as the surrounding area.

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Maternal death causes before and during COVID-19 pandemic: a descriptive study in Banjarnegara Indonesia

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Abstract

Purpose: Maternal mortality in Indonesia in 2017 was 3rd highest in Southeast Asia. The Banjarnegara District in 2018 was ranked with the third highest maternal mortality rate in Central Java Province. In previous years, the most common cause of maternal death in the district was bleeding, but in 2021 the biggest cause was COVID-19. This study aims to examine cases of maternal mortality by analyzing maternal characteristics, causes, and health service coverage from 2019 to 2021. **Methods:** The design of this study is a descriptive epidemiological study of maternal death cases in Banjarnegara in 2019-2021 using secondary data from the district health office. In-depth interviews with health workers in the public health center and the district health office. **Results:** Maternal death cases in 2019-2021 were 81 cases. COVID-19 will be the leading cause of maternal death during the COVID-19 pandemic in 2021, accounting for 60%. **Conclusion:** Preeclampsia was the leading cause of maternal death before the COVID-19 pandemic, while COVID-19 infection emerged as the primary cause in 2021. Strategic measures are needed to increase access to well-coordinated health services to reduce maternal deaths related to COVID-19 and the other effects of the pandemic.

Keywords: maternal death; Banjarnegara; COVID-19; pandemic

INTRODUCTION

The World Health Organization (WHO) report stated that there were 810 maternal deaths every day in 2017 due to childbirth, most of which occurred in low- and middle-low-income countries [1]. Maternal mortality in Indonesia in 2017 ranks 3rd highest in Southeast Asia, with 117 maternal deaths per 100.000 live births [1].

In 2017 the public health development index of Banjarnegara was ranked the second lowest out of 35 regencies/cities in Central Java Province (0.4927). In 2018 the index was the lowest in Central Java Province. The district maternal mortality rate during the 2017-2019 period was still fluctuating, in 2017 137.66 per 100,000 live birth, decreased to 58.8 per 100,000 live birth, and increased again in 2019 to 139.83 per 100,000 live birth [2].

The coverage of K4 visits ranges from 85 - 88%. K4 coverage has not yet reached the national target of 90% and is the lowest K4 coverage in Central Java Province [3]. The coverage of birth attendance by health workers reaches 98% however, Banjarnegara District ranks third in Central Java Province with the highest number of maternal deaths [4]. Health workers' detection of the risk of pregnant women is an average of 23%, while by the community, it is 13% [2]. The high coverage of K1 and birth attendance by health workers quantitatively, but the number of maternal deaths is still high, and not all health centers in Banjarnegara district provide optimally integrated ANC services and the low risk of early detection of pregnant women and the postpartum period by health workers. In addition, the percentage of pregnant and maternity women who received services according to standards was still below the

target, namely 88.6% and 98.1% [5].

The COVID-19 pandemic, which began at the end of 2019 until now, has added to the challenges in reducing maternal death. Indonesia reported its first COVID-19 infection in early 2020. Several studies reported cases of maternal death due to COVID-19 infection [6,7]. Necessary up-to-date information on cases of maternal death during the COVID-19 pandemic as a reference in making a regional policy.

The assistance program for pregnant women with the One mother one cadre approach is an initiative and innovative program developed by one of the health centers in the district. This concept has been quite successful in being implemented in the district [8].

Although many countries have reported maternal deaths during the COVID-19 pandemic, information on maternal mortality rates in Indonesia before and during the pandemic remains limited. This research aims to provide up-to-date information on cases of maternal death before and during the COVID-19 pandemic in Indonesia. Several previous studies have only described cases of maternal death, this study will explore the causes of maternal death before and during the covid 19 pandemic, the location of maternal death, and the maternal period which is vulnerable to maternal death. This study examines cases of maternal death by analyzing the mother's characteristics, causes, and coverage of health services. The research results are expected to become recommendations and overcome the problem of maternal mortality in the district during the COVID-19 pandemic.

METHODS

This study is a descriptive epidemiological study of maternal death cases in Banjarnegara District before and during the COVID-19 pandemic in 2019-2021. Of the 35 Public Health Centers, 21 Public Health Centers reported cases of maternal death that were included in this study. The population in this study were all mothers who were reported to have died during pregnancy, childbirth, and the postpartum period, which were not due to accidents in Banjarnegara District based on their identity cards (KTP) 81 cases of maternal deaths occurred before and during COVID-19 pandemic.

Data collection was carried out through secondary data from the District Health Office and Public Health Centers that reported cases of maternal death. In addition, data collection was carried out through in-depth interviews with health center staff, especially midwives and the District Health Office. Data collection was carried out from February to December 2021. The data taken is retrospective data from 2019 -2021. The variables in this study were maternal characteristics, including age, parity, education, frequency of ANC, the medical cause of death, COVID-19 infection(based on a positive result on an antigen or PCR test), period of maternal death, and place of death.

Other variables, which are indirect causes such as geographical, sociocultural, and economic factors, are obtained from the results of interviews. Our research has received ethical approval from the health research ethic-committee of the Indonesian Ministry of Health Research and Development Agency No: LB.02.01/2/ KE.281/2021.

RESULTS

Cases of maternal mortality in Banjarnegara District are spread over several sub-district health centers. Figure 1 shows the distribution of maternal death cases in Banjarnegara District for 2019-2021 based on health center catchment areas. Maternal deaths occur in the western and southern regions of the district. Over a period of 3 years, 21 public health centers reported cases of maternal deaths, and three public health centers reported cases of more than two maternal deaths. During the COVID-19 pandemic, 16 public health centers reported maternal death due to COVID-19 infection. The Public health center that reported the most cases of maternal death due to COVID-19 was the Rakit 1 Public Health Center, with 3 cases reported.

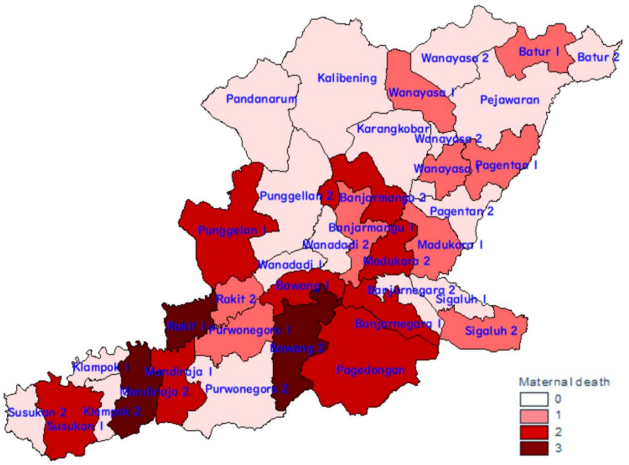

Figure 1. The distribution of maternal death cases in Banjarnegara District for 2019-2021 based on the area of the health center.

Table 1 shows maternal deaths in the last three years were dominated by the ages of 20-34 years, However, there were still maternal deaths at a young age (under 20 years). Maternal education was dominated by secondary education. Based on parity, most maternal deaths were multiparas. Pregnant

women with maternal mortality have a frequency of complete ANC. During the COVID-19 pandemic, the most common cause of maternal death was COVID-19 infection. Before the COVID-19 pandemic, preeclampsia was the most common cause of maternal death. In the last three years, the most maternal deaths based on the maternal period were during the postpartum, and during the covid 19 pandemic, the most maternal death occurred during pregnancy. Most deaths occurred in the hospital either before or during the COVID-19 pandemic.

Table 1. Characteristics of mothers in maternal death in Banjarnegara District in 2019-2021 (n=81)

Variable	%
Maternal age	
<20 Years	2,5
20-34 Years	69,1
≥35 Years	28,4
Maternal education	
Elementary School	27,2
Junior High School	38,3
Senior High School and College	34,6
Parity	
Primipara	12,3
Multipara	87,7
Frequency of ANC	
Complete (>4 times)	93,8
Never/ Incomplete (<4 times)	6,2
Causes of maternal death	
Hemorrhage	12,3
Hypertension/ Pre Eclampsia	13,6
Cardiovascular Disease	7,4
Infection	2,5
COVID-19	32,1
Other	32,1
Maternal period	
Prenatal	40,7
Intrapartum	4,9
Postpartum	54,3
Place of maternal death	
Hospital	86,4
Public Health Center/Clinic/Midwife Independent Practice	6,2
Not a health facility	7,4
Total	100

Source: Banjarnegara Health Office secondary data

Table 2 shows maternal death cases in Banjarnegara in the last three years. Maternal death is increasing yearly, especially in 2021, dominated by the main cause of COVID-19 infection. Preeclampsia was previously the most common cause of maternal death, but during the COVID-19 pandemic (2020-2021), COVID-19 infection emerged as the leading cause of maternal mortality. Maternal deaths caused by COVID-19 infection have started to be reported since 2020 and peaked in July - August 2021. Maternal death during the COVID-19 pandemic has doubled from before the COVID-19 pandemic.

Table 2. Causes of maternal death in Banjarnegara District before and during the COVID-19 pandemic

Causes	Year			Total
	Before Pandemic	During Pandemic		
	2019	2020	2021	
Hemorrhage	5	2	3	10
Cardiovascular Disease	2	3	1	6
Hypertension/ Pre Eclampsia	7	4	0	11
Infection	1	1	0	2
COVID-19	0	2	24	26
Other	7	7	12	26
Total	22	19	40	81

Table 3 shows that most maternal deaths in Banjarnegara District in the last three years were other causes such as cancer, lupus, and other diseases accompanying pregnancy and COVID-19 infection. Most maternal deaths due to COVID-19 infection occur during pregnancy. Most maternal death due to other causes occurs during the postpartum period.

Table 3. Causes of maternal death based on the maternal period in Banjarnegara District in 2019-2021

Causes	Maternal Period		
	Pregnancy	Intra partum	Post partum
Hemorrhage	0	2	8
Cardiovascular disease	3	0	3
Hypertension/ Pre-eclampsia	3	1	7
Infection	0	0	2
COVID-19	18	0	8
Other	9	1	16
Total	33	4	44

Table 4 shows that most of the maternal deaths occurred in the hospital. Most maternal deaths in hospitals were due to other causes, such as cancer, lupus, diabetes, and other comorbidities, and the second most common cause was due to COVID-19 infection.

Access to health services is quite easy for the community to reach. The number of health service facilities is 4 General Hospitals, where 2 are Comprehensive Obstetrics and Neonatal Services Hospitals; 35 Public Health Centers, where 13 Public Health Centers have Comprehensive Obstetrics and Neonatal Services; 39 auxiliary community health service centers, 1578 integrated service post, 1 Regional Health Laboratory, 66 pharmacies dan 17 Clinics.

Table 4. Causes of death based on places of maternal death, Banjarnegara District in 2019-2021

Causes	Place of maternal death		
	Hospital	Public health center/clinic/ midwife independent practice	Not health facility
Hemorrhage	9	1	0
Cardiovascular disease	3	1	2
Pre-eclampsia	7	2	2
Infection	1	0	1
COVID-19	24	1	1
Other	26	0	0
Total	70	5	6

Related factors of maternal death are not only due to medical causes but also other indirect factors such as economic and socio-cultural factors. There are still delays in deciding to seek care at health facilities. Decision-making is more dominant in the husband, the head of the family. This condition is exacerbated by people who don't believe in COVID-19 and are afraid to visit health facilities.

Lack of public knowledge of the impact of COVID-19, especially on pregnant women, can harm the fetus and themselves. Other factors, such as culture and traditions within the family, still play a role in the postpartum care process. Postpartum mothers can only consume white rice without added animal proteins and limit water consumption because it is thought to slow wound healing. This condition can reduce the condition of postpartum women who need enough nutrition to restore the body's condition and help with breastfeeding. Other socio-cultural factors were contrary to family planning services, so mothers were found to be at high risk and having birth intervals <2 years and more than five children. Several pregnant women refuse to be vaccinated.

DISCUSSION

According to the World Health Organization (WHO), maternal death is the death of a woman that occurs during pregnancy, childbirth, or 42 days after delivery [1]. Cases of maternal mortality in Banjarnegara are still high in the last three years (2019-2021), with 81 cases reported. This study provides the latest information regarding the causes of maternal deaths amid the COVID-19 pandemic. In line with the WHO report, the maternal mortality rate in several developing countries is still high, including Indonesia.

The cause of the high maternal mortality rate is inadequate facilities and infrastructure, uneven distribution of human resources in maternal services, inappropriate competencies, lack of interprofessional collaboration in health service facilities, lack of patient safety quality standards in the referral system, and unequal access based on local geographical conditions [9,4]. Pregnant, maternity, and postpartum women are at-risk groups that require special attention related to maternal health services. Maternal deaths can be prevented when detecting risk factors earlier [9].

Cases of maternal mortality in Banjarnegara District are dominated by women of reproductive age (20-34 years), namely 69.1%. Baharuddin's research at 11 hospitals in Indonesia also reported that 64% of maternal deaths occurred between the ages of 21 and 35 [10]. Several studies also show the same result that most maternal deaths occur at reproductive age [11,12,13]. Even though they are in a healthy reproductive period, maternal death can occur due to complications during childbirth related to other causative factors such as medical history and other medical factors. Research in China also illustrates the same results, namely the highest number of cases of maternal death aged 20-29 between 1990-2017, but the highest maternal mortality rate was at the age of 40-49 years [14]. Although the prevalence of maternal deaths occurs at the age of 20-34, a significant risk factor for maternal death is age <20. Maternal deaths in hospitals were strongly related to age groups, especially those at high risk <20 years [15]. Therefore prevention of early pregnancy or at the age of <20 years is necessary to prepare for a safe pregnancy.

Cases of maternal death were dominated by junior high school. The results of previous research explained that the more educated a person is, the higher the chance of identifying danger signs in pregnancy. It is estimated that 4.9 times more highly educated women are more likely to know and detect early danger signs in their pregnancy [16].

Most cases of maternal death were in multiparas. A previous study showed a relationship between parity and maternal mortality [17]. Primiparas and multiparas increase the risk of childbirth. Primiparas are associated with unpreparedness and physiological immaturity of the reproductive organs. Multiparas are

associated with the emergence of complications of pregnancy and childbirth [15].

Most cases of maternal death occurred in mothers who made complete ANC visits. This study is opposite to the previous study, which stated that complete ANC examinations and the quality of services decrease the risk of maternal death [18]. Other studies have also revealed that antenatal care that is not regular or <4 times has a risk of 4.57 times the risk of death compared to mothers who regularly perform ANC [19]. One of the goals of antenatal care is to detect complications early in pregnancy so that regular ANC complications can be found quickly and maternal death can be prevented with proper treatment of complications found [20]. A complete ANC visit not only be in number but must also be followed by quality services and comprehensive ANC.

The most dominant maternal mortality occurred during the puerperium. Other research also shows that the most dominant maternal mortality is in the postpartum period [13,21]. The classic triad of causes of maternal death most commonly found in the puerperium includes bleeding, preeclampsia, and comorbidities [22]. In the COVID-19 pandemic, most maternal deaths occurred during pregnancy, similar to a previous study in which pregnant women in the 2nd and 3rd trimesters with COVID-19 infection can experience cardiopulmonary complications and death [6]. The risk of maternal death in pregnancies with COVID-19 infection is 22 times greater than in mothers not infected with COVID-19 [7]. Strategic measures are needed to increase access to well-coordinated health services to reduce COVID-19 related deaths and the other pandemic effects.

Research in Suriname shows that most maternal deaths occur in hospitals (81%) [13]. In line with this study, maternal deaths occurred mostly in hospitals (86.4%). The hospital is the highest referral service facility for cases of maternal complications. Delays in referrals can cause many deaths in the hospital, so the referred mother is already in critical condition. Interprofessional collaboration in maternal services is needed to detect and get the right diagnosis if complications are found during pregnancy, childbirth, and the puerperium.

Causes of maternal before and during the COVID-19 pandemic

The most common cause of maternal death in this study is COVID-19 infection in 2021. Maternal deaths due to COVID-19 infection were discovered in 2020 and peaked from July to August 2021. Before the COVID-19 pandemic, the most common cause of maternal death was preeclampsia before the COVID-19 pandemic.

Previous studies reported severe manifestations of COVID-19 infection in pregnant women, and most severe COVID-19 infections in pregnant women cause death [6,23]. COVID-19 infection during pregnancy is associated with the emergence of a risk of morbidity and mortality in postpartum mothers and babies born [7]. The high risk of severity of COVID-19 infection in pregnant women is related to physiological changes in pregnancy, such as changes in the metabolic system, cardiovascular system, and several other organ systems [24]. The COVID-19 infection triggers a cytokine storm in the body of pregnant women, inhibiting the immune system and worsening the condition of pregnant women [25]. COVID-19 vaccination and prevention of infection in pregnant, maternity, and postpartum women need to be improved to prevent pregnant women from being infected with COVID-19.

The causes of maternal death before the Covid pandemic were dominated by preeclampsia and other causes such as lupus, kidney, and cancer. Previous studies have shown that a history of illness increases the risk of maternal death by around 27.74 times [18]. Special monitoring of pregnant women with a history of pre-pregnancy disease needs to be carried out strictly by various healthcare professionals.

In this study, 13.6% of the causes of maternal death were found to be preeclampsia before the COVID-19 pandemic. Preeclampsia is a major cause of maternal death that affects fetal growth, premature birth, placental abruption, fetal distress, and even fetal death in the womb. In addition to the risks to the fetus during pregnancy, there is growing evidence that preeclampsia has long-term adverse effects on the offspring, such as cardiovascular sequelae, including hypertension and vascular function in children born to mothers with preeclampsia [26].

Postpartum hemorrhage was 12.3%. Postpartum hemorrhage is a major cause of maternal morbidity and mortality worldwide. Pregnant women are considered at risk of labor complications, including postpartum hemorrhage. Therefore, early detection and intervention of postpartum hemorrhage are needed through interprofessional collaboration to save the mother [27]. Postpartum hemorrhage is caused by several factors, namely uterine atony, tearing of the birth canal, retained placenta, remaining placental tissue left in the uterus, abnormalities in the blood clotting process, and uterine rupture [28].

Sunaryo's study in 2019 on the implementation of mentoring one pregnant woman with one cadre in Banjarnegara showed good results. This assistance had a positive effect on reducing maternal mortality in

2020. This program can increase the readiness and maturity of standardized birth planning to minimize factors that cause maternal death [8]. Research in several countries regarding the assistance of pregnant women by doulas (trained women) who continuously provide physical, emotional, and informational assistance to pregnant women during pregnancy, childbirth, and childbirth reduces the number of cesarean deliveries. It reduces maternal anxiety during the delivery process, thereby reducing the incidence of birth complications that impact cases of maternal mortality [29,30].

Assistance to pregnant women from families, cadres, and professional workers is important to increase mothers' motivation and confidence in preparing for safe delivery [31]. Other studies showed that accompanying health cadres to pregnant women affect prenatal care [32]. The one-mother assistance program with one cadre is a good choice to be implemented in the community.

This study provides up-to-date information regarding maternal death in Banjarnegara for the last three years, which can be used as initial information in determining local government policies to reduce maternal mortality, especially during the COVID-19 pandemic, primarily through the one mother and one cadre assistance program. Health officers can apply it in the community through the support of local health facilities. Community health practitioners can empower cadres through this program to reduce maternal mortality cases in the future.

CONCLUSION

The maternal death cases in Banjarnegara were still high during the COVID-19 pandemic. Before the pandemic, preeclampsia was the leading medical cause of maternal mortality, whereas, during the pandemic, COVID-19 infection emerged as the primary cause. Besides, social, economic, and cultural factors indirectly affect maternal mortality. Strategic measures are needed to increase access to well-coordinated health services to reduce maternal deaths related to COVID-19 and the other effects of the pandemic.

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Mapping the spread of dengue hemorrhagic fever (DHF) with the level of insecurity in Kepahiang Regency in 2021

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Abstract

Purpose: This study aims to map the distribution of dengue cases in Kepahiang Regency based on the distribution of dengue cases, population density, and air temperature. Furthermore, mapping was carried out based on the level of vulnerability and priority of sub-district-based dengue disease management in Kepahiang Regency. **Method:** Research using a descriptive method using Geographic Information System (GIS) with scoring and overlay techniques. The data was taken from secondary data from the Kepahiang Regency Health Office and Kepahiang Regency Meteorology and Geophysics Agency in 2021. **Results:** This study shows that out of 8 sub-districts, there is one with a high level of vulnerability with priority handling, namely Kepahiang Regency. The priority of dengue insecurity can be an effort to prevent and handle dengue disease by the Government. **Conclusion:** Mapping the level of dengue insecurity in Kepahiang Regency using parameters (dengue cases, population density, and temperature) resulted in 1 in 8 sub-districts being in priority 1 with a high level of insecurity, priority 2 (1 sub-district) with a moderate level of insecurity, priority 3 (1 sub-district) with a low level of insecurity, and priority 4 (5 sub-districts) with a very low level of insecurity.

Keywords: dengue hemorrhagic fever; degree of insecurity; GIS

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INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is an infectious disease caused by the Dengue virus and transmitted through mosquito vectors of the species Aedes *aegypti* or *Aedes albopictus* [1]. Dengue cases were first reported in Jakarta and Surabaya in 1968, with 58 cases and 24 deaths (CFR 41.3%). Within 50 years (1968-2017) it succeeded in reducing the mortality rate (CFR) of DHF to less than 1%. In 2017, the national DBD CFR fell to 0.72%. Over the past decade (2008-2017), the incidence (IR) of DHF ranged from 26.1 per 100,000 inhabitants to 78.8 per 100,000 inhabitants [2]. Dengue morbidity is also related to the public's understanding of dengue prevention and needs improvement. Efforts to prevent and control dengue fever aim to reduce cases / IR and mortality / CFR. The national target is < 49 IR DBD and IR per 100,000 population [2]. Four dengue virus serotypes are endemic to Indonesia: Den1, Den2, Den3, and, Den4.

The dominant serotype in Indonesia is Den3 (50.08%), followed by Den1 (20.7%). In the 2019 dengue fever, 138,127 cases were reported, and up to 919 deaths from DHF (IR = 51.48, CFR = 0.67% per 100,000 population). Currently (as of August 19, 2020), 34 provinces are exposed to dengue fever, and 470 regencies/cities are infected with dengue fever from 514 regencies/cities throughout Indonesia. In 2021, there were 73,518 dengue cases in Indonesia. This number decreased by 32.12% compared to the previous year, 108,303 cases, with an average of 27 cases per

100,000 population infected with dengue fever [1]. Based on data from the Kepahiang Regency Health Office, Kepahiang Regency is one of the dengue fever-prone areas. The number of dengue cases reported in 2021 was 86, with an incidence rate of 60.7 per 100,000 population [3].

DHF is a disease that can threaten public health, so it needs to be prevented from spreading. Factors of mobility and population density, temperature, and humidity of the air can cause dengue transmission. Increasing population density will increase the chances of spreading dengue cases so that it can be carried out by mapping [4,5]. Complex data management requires an integrated information system to process spatial and non-spatial data effectively and efficiently. Geographic Information Systems (GIS) can be used as a solution to these problems [5,6].

Furthermore, the information obtained is in the form of geographical information. Geographic Information Systems (GIS) can visualize data and modify shapes, colors, and symbols, providing beneficial convenience in the health field [5]. GIS is a tool to monitor the condition of an area for the incidence of dengue disease. GIS will provide final results in maps that facilitate identifying and searching dengue-prone areas in Kepahiang Regency [4]. To support the implementation of dengue eradication programs, mapping can use the creation of area models against diseases using overlay analysis. Analysis overlays can generate a spatial model by applying a score [7].

Previous research was conducted in South Minahasa which carried out mapping of dengue fever based on cases presented in the map and then related to the number and density of the population descriptively without presenting dengue fever's factor by map [5]. Research on mapping dengue cases was also carried out in Aceh Regency with dengue cases, and mosquito density with GIS in the work area of one of the health centers, namely the Lhoknga District Health Center, then the handling of the spread of dengue cases was carried out only based on mosquito density, while dengue transmission could be caused by several other factors such as population density and temperature [6]. Another dengue fever research by mapping conducted in the city of Padang using overlay analysis explained that the overlay technique is an analysis that overlaps two or more variables to produce intervariable relationships that can be presented in one map [8].

The spread of dengue cases in Kepahiang Regency is still being processed manually, and there has been no assessment of the spread of dengue cases based on geography. Using GIS will be able to facilitate information that will provide a priority scale determination for the government and help the dengue eradication program by determining priority areas for handling dengue disease in Kepahiang Regency. For this reason, this study aims to map the spread of dengue disease (spread of dengue cases, population density, and temperature) using GIS.

METHODS

The research method is carried out descriptively which will describe the incidence of dengue hemorrhagic fever (DHF) in the Kepahiang Regency Puskesmas Working Area in 2021. The data used comes from secondary data in 2021 from the Kepahiang Regency Health Office (the number of dengue cases and the population density of each sub-district) and the Kepahiang Regency Meteorology and Geophysics Agency (air temperature). The analysis will use administrative units of Kepahiang Regency based on sub-districts, as many as eight sub-districts that will be processed using QGIS devices.

The research phase will begin with collecting secondary data, creating data classification, and inputting variable attributes (dengue cases, population density, and air temperature). The data were analyzed using scoring and overlay techniques. The scoring technique in GIS is the process of assigning scores to a polygon map that presents a specific event in the spatial analysis stage, which in turn, the assessment will present the degree of interrelation or severity of a certain impact on the event spatially. While the overlay technique in GIS comes from combining maps with specific information.

The DHF case and temperature parameters refer to previous studies with [8], then density classification based on to find the score range with the following formula [9] :

$$z = \frac{x-y}{k}$$

Information:
z = Hose class/category width
x = Highest score value
y = Score value
k = Number of category classes

Then the three variable scores are summed up to determine the classification of dengue insecurity levels. The classification results obtained are a total score of 10-12 (high vulnerability level), a score of 8-9 (medium vulnerability level), a score of 6-7 (low vulnerability level), and a score of 3-5 (very low insecurity level). Districts with high levels of vulnerability will be priority areas for dengue fever.

RESULTS

Kepahiang Regency is a district in Bengkulu Province which is geographically located between 101°55'19" to 103°01'29" east longitude (BT) and 02°43'07" to 03°46'48" South Latitude (LS). Kepahiang Regency has an area of approximately 66,500 hectares or 665 km^2. Kepahiang Regency has eight districts: Merigi, Ujan Mas, Kepahiang, Tebat Karai, Seberang Musi, Kabawetan, Muara Kemumu, and Bermani Ilir Districts [3].

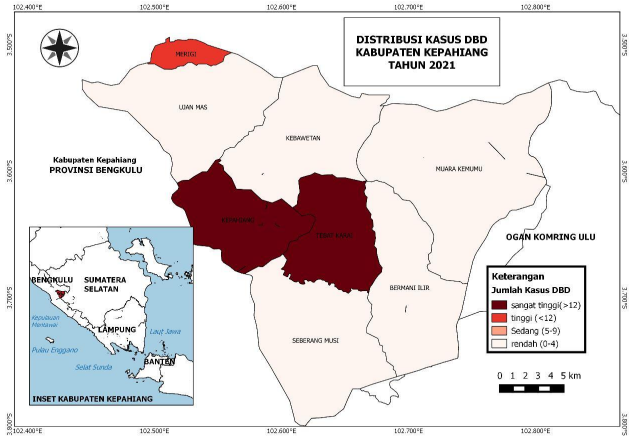

Figure 1. Map of the distribution of dengue cases in Kepahiang Regency in 2021

Figure 1 explains the spread and the number of dengue cases in Kepahiang Regency in 2021 was 86. Classified into four categories (low, medium, high, and very high). The spread of dengue cases is very high (>12 cases) in 2 sub-districts, namely Kepahiang and Tebat Karai Districts marked with dark green. The high category (10-12 cases) occurred in 1 sub-district, namely Merigi District. Then there is no spread of moderate category DHF cases because there are no sub-districts that have a total of 5-9 cases, and the low category (=<4 cases) occurs in 5 districts, namely Ujan Mas, Seberang Musi, Kabawetan, Muara Kemumu, and Bermani Ilir Districts. Spatially, very high cases are seen close to each other.

Figure 2 explains the population density of Kepahiang Regency in 2021 by sub-district. The population density classification is categorized into four categories (low, medium, high, and very high). Districts with high categories (>3.7 people/km^2) are in Kepahiang and Merigi Districts, there are no sub-districts in the high category because the population density is not 2.5-3.6 people/km^2. Furthermore, the medium category (1.3-2.4 people/km^2) in districts of Ujan Mas, Tebat Karai, Kabawetan, Muara Kemumu, and the low category (0-1.2 people/km^2) in

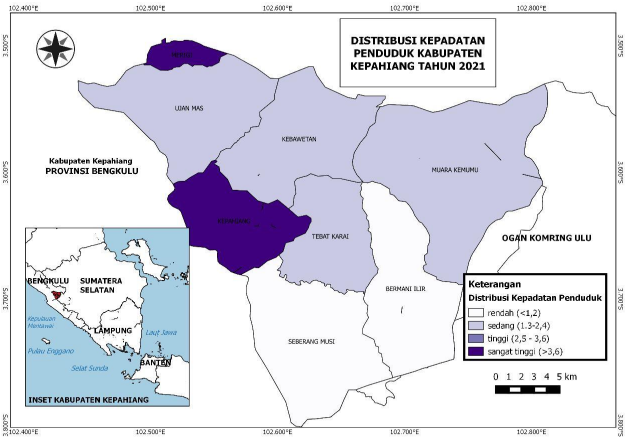

Figure 2. Map of dengue density distribution in Kepahiang Regency in 2021

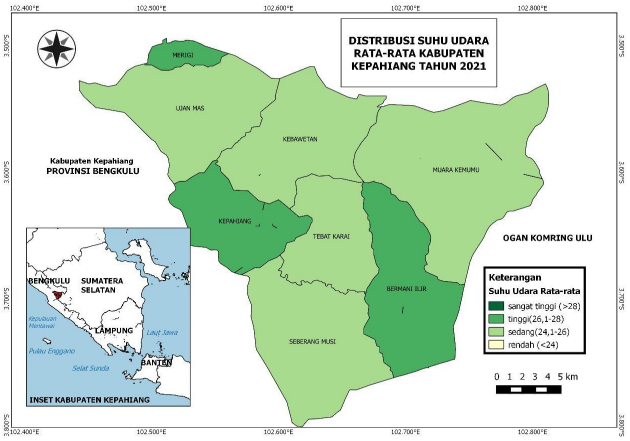

Figure 3. Map of the average temperature distribution of dengue fever in Kepahiang Regency in 2021

Seberang Musi and Bermani Ilir Districts. Regarding space, the population density is located above and in the middle of Kepahiang Regency.

Figure 3 explains the distribution of average air temperatures in 2021 of each sub-district is classified into four categories (low, medium, high, and very high). The darker the color indicates the higher the temperature in the district. On the map, it is known that districts with very high average air temperatures (>28^{0}C) do not exist. Then in the high-temperature category (26.1-28^{0}C), there are three districts, namely Kepahiang, Merigi, and Bermani Ilir districts, the medium-temperature category (24.1-26^{0}C), there are five districts, and in the low-temperature category (< 24^{0}C) there are none. This shows that the air temperature varies in each sub-district even though it is in 1 sub-district. The spatial map shows that the districts with high temperatures are in the middle, top, and bottom of the Kepahiang Regency area. Overall they are seen to have moderate to high temperatures.

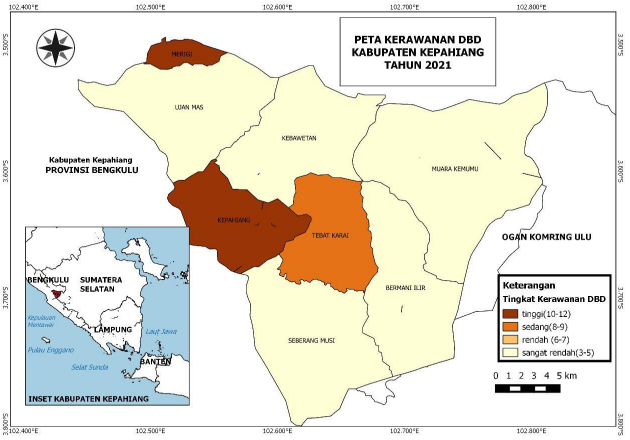

Figure 4. Dengue insecurity level map of Kepahiang Regency in 2021

Based on the level of dengue insecurity from 8 sub-districts, sub-districts that have a darker color, namely Kepahiang and Merigi Regencies, are high levels of vulnerability. The level of insecurity is in Tebat Karai district, there are no sub-districts at a low level of insecurity, and there are five sub-districts at a very low level of insecurity (Seberang Musi, Bermani Ilir, Muara Kemumu, Kabawetan, and Ujan Mas districts).

The data processing results use the Geographic Information System, with assessment techniques and *variable overlays* (dengue cases, population density, air temperature) to determine priority areas for dengue fever management.

Table 1. Priority area table for DBD handling

Number	District	Priority areas
1	Kepahiang	High (10-12)
2	Ujan mas	Very low(3-5)
3	Merigi	High (10-12)
4	Kabawetan	Very low(3-5)
5	Across the musi	Very low(3-5)
6	Tebat karai	Medium(8-9)
7	Bermani ilir	Very low(3-5)
8	Mumu Estuary	Very low(3-5)

DISCUSSION

The incidence of DHF can be caused by several factors such as the virus that causes DHF, humans, mosquito vectors, and the environment. Population density is one of the causes of the human factor because the increasing population growth not supported by behaviors and lifestyles to maintain environmental cleanliness will increase the spread of dengue cases [10]. This study is in line with research in Padang in 2022 which states that the denser the population of an area, the higher the likelihood that mosquito bites and dengue transmission will spread rapidly in an area [8]. The theory and results of previous research align with the research results on the spread of dengue cases that occurred in Kepahiang Regency with high and medium-density categories. The district with a high-density category is Kepahiang Regency.

Several studies have found a strong correlation between high-risk areas for dengue infection and dense urban areas. Environmental and social factors from some regions seem to influence the incidence of dengue fever. High population density allows for rapid urbanization and intensive mobility that can support the distribution of the virus and increase the likelihood of contact between DHF vectors and humans [11]. Due to the lack of proper water infrastructure, dense human settlements can offer lucrative breeding opportunities for mosquitoes using containers filled with natural and artificial water to lay eggs [12]. Environmental degradation, urban land expansion, and poor sanitary conditions facilitate favorable conditions for parasitic infections, which can increase the risk of dengue outbreaks in the region. In addition, the habit of storing water for domestic purposes at home due to the lack of water supply, especially during the dry season, increases the likelihood of mosquitoes laying eggs and the spread of mosquitoes from house to house, leading to an excess of the dengue virus [13]. The high population density causes a narrow air scope and is suitable as a breeding ground for *Aedes Aegypti* mosquitoes. Aedes Aegypti mosquitoes love human blood, and the Kepahiang subdistrict is a high-density district, which is why the Kepahiang subdistrict is at priority level 1.

The incidence of dengue based on temperature is stated in the results of a study in Cimahy City which states that the average temperature in Cimahi City is 24,34 ^{0}C. This temperature is in accordance with the optimum temperature of mosquito development which according to WHO is between 25-27°C [14]. Temperature reduction affects the survival of adult mosquitoes so it will affect the transmission of the dengue virus, and will affect mosquito bite and reproduction patterns, and increase mosquito population density. The theory and results of previous research align with the research results on the spread of dengue cases that occur in the Kepahiang district with high and moderate air temperatures. Kepahiang Regency generally consists of highlands and has a mild climate with a high average air temperature category. However, moderate temperature points of dengue infection were identified in 5 sub-districts, including Ujan Mas, Muara Kemumu, Kabawetan, Tebat Karai, and Seberang Musi. Similar findings were reported in Sri Lanka that the distribution of dengue

vectors appears limited by altitude. Unlike in Sri Lanka, the specific factors underlying the conditions in Kepahiang District are unclear but can be affected by the prevention and control of dengue fever by those carried out by the Health Office [15].

Kepahiang Regency in 2021 has two districts that have a high level of dengue insecurity, namely Kepahiang and Merigi Districts, at a moderate vulnerability level with priority 2, namely Tebat Karai district, then priority 3 in 5 districts, namely Kabawetan, Bermani Ilir, Ujan Mas, Muara Kemumu and Seberang Musi. High population density and high temperatures lead to a large number of dengue cases, with district prioritization prevention efforts can be focused on areas with high levels of insecurity.

Mapping done with GIS can help prevent the spread of disease if dengue cases reappear. Wisnu Irawan as the Head of Disease Prevention and Control (P2P), the Kepahiang community is still haunted by dengue fever in the winter due to many puddle containers [16]. Prevention efforts can be carried out with the cooperation of the government and community participation by providing counseling and environmental interventions. Counseling efforts are carried out regarding dengue fever by instilling messages and beliefs about the dangers of dengue fever, and how to prevent and overcome it [17]. Furthermore, environmental interventions by the community to be able to carry out prevention by applying 3M (Draining, Closing, and Burying), maintaining the cleanliness of the environment, food, and beverages, as well as it is recommended using mosquito nets or put on mosquito repellents. This is due to the low awareness of a healthy lifestyle and cleaning the living environment (15). Meanwhile, the government can help provide larvicides (abate) in all water reservoirs to inhibit the growth of *Aedes spp* larvae [18].

Consideration of the use of mapping in the government depends on its usefulness, such as identifying areas lacking health workers, allocating medicines, searching for health facilities, and mapping infectious diseases. Mapping is basically used for visualization and descriptive purpose, but the use of GIS and spatial analysis can then be used as a decision-making tool for the government in handling health problems [17].

CONCLUSION

This study concluded that mapping the level of dengue disease in Kepahiang Regency using parameters (dengue cases, population density, and air temperature in 2021) showed from 8 to sub-districts, namely at the level of dengue insecurity priority 1 (2 to sub-district), priority 2 (1 sub-district), and priority 3 (5 sub-districts). The spread of dengue cases has a variety of factors, such as population density and the environment. Regional mapping using geographic information systems can help visualize dengue disease insecurity level data displayed in the form of symbols and colors to assist the government in targeting prevention efforts against areas with a high priority level to reduce the spread of dengue cases.

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Young children nutritional status in Samarinda: does exclusive breastfeeding play a role in stunting prevention?

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Abstract

Purpose: This study aimed to investigate the relationship between exclusive breastfeeding and stunting incidence in young children aged 0-59 months. **Method:** This is an observational study with a cross-sectional approach. There were 100 mothers with young children aged 0-59 months as respondents from Palaran, Samarinda. The dependent variable was children's height-for-age nutritional status, as in normal or stunting, and the independent variable was exclusive breastfeeding. Young children's height was collected by checking their Maternal and Child Health (KIA) book. Parity, family income, mother's education, mother's knowledge, and family support information were also collected by interview. Bivariate analysis was measured with the Chi-square test. **Results**: There is no association between exclusive breastfeeding and stunting (p-value>0.05). We also found no association between stunting and parity, family income, mother's knowledge, and family support (p-value<0.05). However, we found a significant relationship between stunting and mother education. **Conclusion:** Exclusive breastfeeding is not associated with stunting in Palaran, Samarinda. Further research is needed to determine the factors associated with stunting in Samarinda.

Keywords: stunting; exclusive breastfeeding; toddlers; mother's education

INTRODUCTION

Stunting is the impaired growth and development of children caused by chronic and recurrent malnutrition and is usually associated with poverty, poor nutritional status and maternal health, frequent infection, and/or poor social stimulation. *Stunting* is characterized by the length-to-age ratio below -2 standard deviations [1]. Stunting has short-term and long-term impacts on children, including the increased risk of morbidity and mortality, higher risk of decreasing development capacity and learning ability, higher risk of infection and communicable diseases as adults, and decreased productivity [2].

Globally, under-five child stunting decreased from 39.9% in 1990 and 21.9% in 2018, including in Indonesia [3]. Indonesia's National Basic Health Research showed a decrease in stunting prevalence from 37.2% in 2013 to 30.8% in 2018. Nevertheless, it is still far from the national target of 14% in 2024. In East Kalimantan, 29.2% of children were stunted [4], while in Palaran District, there was only 13.7%. Even though this prevalence has met the national target of 14%, stunting is still an important issue to be thoroughly resolved.

A proper strategy is needed to effectively support Indonesia's accelerated stunting reduction program. Exclusive breastfeeding was reported to be effective in supporting optimal growth in children under five and plays a protective role against stunting [5]. Although

some studies found that formula milk feeding can provide greater weight and length gain than breast milk, the increase is considered to occur too quickly and can cause babies to become overweight [6]. In addition, giving formula milk is also not recommended in areas with poor sanitation and a high risk of water sanitation [7]. Therefore, there is a need for more studies on exclusive breastfeeding in stunting prevention in remote areas or with limited resources. By conducting such studies, we can better understand the efficacy of exclusive breastfeeding and its potential to mitigate stunting in areas with limited access to resources.

The prevalence of exclusively breastfeeding mothers worldwide is still low, namely 41% and 37% in lower to middle-income countries [8]. The practice of exclusive breastfeeding in Indonesia, although widely practiced, has a prevalence of only 37.3% [4]. Breastfeeding is reported to be more common among the poor in Indonesia, but only a few provide it exclusively [9].

Other factors are thought to influence exclusive breastfeeding for young children. Family support, especially father/husband, significantly influenced the behavior and decision on exclusive breastfeeding [10]. Parity has been reported to influence exclusive breastfeeding, although the relationship is still inconclusive [11–13]. Several studies have reported a relationship between the level of education of mothers and fathers and exclusive breastfeeding [13, 14]. Mothers' knowledge about the benefits of exclusive breastfeeding influences the mother's decision to initiate early breastfeeding and provide exclusive breastfeeding [15].

Palaran is one of the districts in Samarinda City, East Kalimantan, which will support the *Ibu Kota Nusantara* starting in 2024. Qualified and productive human resources are needed to support Indonesia's more advanced development, strengthening the stunting reduction accelerated program by intensifying exclusive breastfeeding for young children. Therefore, it is necessary to study the relationship between stunting and exclusive breastfeeding, considering several other factors, namely parity, socioeconomic: parity education, mother's knowledge regarding the benefits of exclusive breastfeeding, and family support.

METHODS

The research design uses an observational study with a cross-sectional approach. The respondents to this study were mothers with toddlers aged 0-59 months and willing to be respondents. The total sample in this research was 100 respondents, and they lived in the work area of the Palaran Health Center, Palaran District, Samarinda, East Kalimantan. The sampling method uses PPS (probability proportional to size) by taking the size of the group or population into account, including Rawa Makmur Village (55 respondents), Handil Bakti Village (23 respondents), and Simpang Pasir Village (22 respondents). As for a brief description of the research site, it has an area of 128 km^2, inhabited by around 32,853 people consisting of 17,310 men and 15,543 women spread over three sub-districts. Palaran District is an industrial center engaged in the timber sector and its supporting industries. The livelihoods of the Palaran Health Center working area are mostly private workers (52.35%) and entrepreneurs or traders (31.3%). This research was conducted from October to November 2022.

The dependent variable in this study was the incidence of stunting in toddlers as measured by height and age data obtained from the Maternal and Child Health (KIA) handbook with a maximum duration of 2 months ago. These data were cross-checked with the existing data on Community Health Workers (CHWs) who routinely weighed toddlers every month. These toddlers were considered stunted if they had a length-for-age nutritional status of -2 SD on the Z-score. The independent variable in this study was exclusive breastfeeding, defined as toddlers receiving only breast milk from 0–6 months. Exclusive breastfeeding is based on the question, "Are toddlers given exclusive breastfeeding?" "What foods or drinks do the toddlers consume when they are 0–6 months old?" and "At what age (month) do the toddlers start getting food or drinks other than breast milk?".

Investigators also examined the effect of confounding variables on the study's results. These variables are parity, family income, the mother's education, knowledge of exclusive breastfeeding, and family support in providing exclusive breastfeeding. Data on the mother's knowledge and family support, parity, family income, and mother's education were from the interviews.

A univariate analysis was performed to describe the characteristics of each variable studied. Meanwhile, we performed bivariate analysis to examine the relationship between the percentage of mothers who provided exclusive breastfeeding and mothers who did not and the incidence of stunted. Bivariate analysis used the chi-square test. The Fisher's Exact Test is used if the expected value is less than 5. Logistic regression analysis aims to test whether the independent variable can predict the probability of occurrence of the dependent variable. This study also conducted a multivariate analysis using a logistic regression test. A logistic regression test was carried out to determine the effect of exclusive breastfeeding on the incidence of

stunting in toddlers in the work area of the Palaran Health Center, which includes three villages, and to analyze the impact of independent variables by considering confounding variables.

RESULTS

Table 1 shows the demographic characteristics of the respondents among 100 mothers in the Palaran District. As many as 30% of toddlers experienced stunting based on their nutritional status and body length/age, and 33% did not get exclusive breastfeeding. 71% of mothers had a higher education level. 60% were senior high school graduates, and 11% were college or university graduates. As many as 29% had an education level below senior high school. The majority of respondents did not work, or they were housewives. Nearly 50% of respondents had a family income below the minimum wage. In addition, most mothers had good knowledge about exclusive breastfeeding (83%), and their families well supported almost all respondents to provide exclusive breastfeeding (94%).

Table 2 shows that most toddlers received exclusive breastfeeding (67%), but as many as 23.9% were stunted. As many as 33% of toddlers did not get exclusive breastfeeding, and 42.4% were stunted. The analysis showed no significant relationship between exclusive breastfeeding and stunting (p-value > 0.05).

Table 1. Characteristics of respondents (n=100)

Variable		%
Toddlers nutritional status	Stunting	30.00
	Normal	70.00
Exclusive breastfeeding	No	33.00
	Yes	67.00
Parity	>2 births	40.00
	≤2 births	60.00
Mother's education	Elementary	7.00
	Junior high school	22.00
	Senior high school	60.00
	College graduates	11.00
Mother's job	Civil servant	3.00
	Private employees	4.00
	Entrepreneur	5.00
	Not working	88.00
Family income	< Regional minimum wage	42.00
	≥ Regional minimum wage	58.00
Mother knowledge	Not good	17.00
	Good	83.00
Family support	Not supported	6.00
	Supported	94.00

Regional Minimum wage East Kalimantan 2022, IDR 3,014,497.00

Table 2. Relationship between toddlers' nutritional status and exclusive breastfeeding, family income, mother education, parity, mother knowledge, and family support

Independent variable		Dependent variable: Toddlers nutritional status						OR (95% CI)	P-value
		Short		Normal		Total			
		n	%	n	%	n	%		
Exclusive breastfeeding	No	14	42.4	19	57.6	33	100	2.349 (0.965-5.719)	0.095
	Yes	16	23.9	51	76.1	67	100		
Family Income	<Region minimum wage	16	38.2	26	61.9	42	100	1.484 (0.640-3.442)	0.200
	≥Region minimum wage	14	24.1	44	75.9	58	100		
Mother Education	Low	14	48.3	15	51.7	29	100	1.681 (0.685-4.124)	0.021*
	High	16	22.5	55	77.5	71	100		
Parity	>2 births	11	27.5	29	72.5	40	100	1.162 (0.498-2.711)	0.824
	≤2 births	19	31.7	41	68.3	60	100		
Mother Knowledge	Not good	6	35.3	11	64.7	17	100	3.727 (1.267-10.962)	0.816
	Good	24	28.9	59	71.1	83	100		
Family Support	Not supported	2	33.3	4	66.7	6	100	1.016 (0.176-5.853)	1.000
	Supported	28	29.8	63	70.2	94	100		
Total		**33**	**33**	**67**	**67**	**100**	**100**		

* Significant relationship

Table 3 shows that a mother's education was related to the incidence of stunting. Other factors, including family income, parity, the mother's knowledge, and family support, were not related to the incidence of stunting.

Table 3. Multivariate modeling

Variable	Modeling number				
p-value for	**1**	**2**	**3**	**4**	**End**
Independent variable					
Exclusive breastfeeding	0.093	0.105	0.122	0.118	0.099
Confounding variable					
Parity	0,261	0,293	0,317	-*	-
Family income	0,254	0,241	0,258	0,221	-*
Mother's education	0,011	0,014	0,016	0,024	0,020
Mother's knowledge	0,451	0,596	-*	-	-
Family support	0,501	-*	-	-	-
OR – Exclusive breastfeeding	2,304	2,223	2,094	2,094	2,170
OR changes	-	3,51%	9,11%	9,11%	5,81%

Notes * = variable excluded from modeling.

Table 4 shows no significant relationship between exclusive breastfeeding and stunting. However, among children under five, not receiving exclusive breastfeeding increases the likelihood of stunting by 2.2 times, even after controlling for mother education.

Table 4. Multivariate test results

Variable	n	p-value	OR	95% CI
Exclusive breastfeeding		0.099	2.170	0.866 – 5.439
Yes	67	0.550	1.351	0.504 - 3.619
No	33	0.032	3.955	1.122 - 13.941
Mother's education		0.020	3.026	1.191 – 7.685

DISCUSSION

As many as 30% of toddlers were stunting, and 33% were not exclusively breastfed. This study found no significant relationship between exclusive breastfeeding and toddler stunting. We also found no relationship between family income, parity, mother's knowledge, family support, and stunting. There was a significant relationship between stunting and mother education.

Exclusive breastfeeding was a protective factor against stunting, mainly in low-income populations [5]. The immunity factor of breast milk can strengthen a child's immune system, thereby reducing the risk of recurrence of diarrhea and infectious diseases [16]. This study found no relationship between exclusive breastfeeding and stunting, in line with several studies in Indonesia [17, 18]. However, this result was different from studies in Pekanbaru [19], Mamasa [20], Bontang [21], and Surakarta [22].

Exclusive breastfeeding is not the only risk factor for stunting. Stunting can be caused by individual, household, and environmental factors. Infectious disease and recurrent diarrhea were the risk factors of stunting, but the risk decreases if the child is breastfed exclusively [23]. However, exclusive breastfeeding is not the only protective factor. Sanitation, availability of clean water, and adequate nutrition intake are also protective factors from recurrent infectious diseases and diarrhea [5, 18].

Our study did not find any relationship between family income and stunting. This result does not align with previous studies in Indonesia [18, 24]. Low family income increases the risk of stunting through non-nutritious food intake due to difficulty accessing high-quality food. They also have a higher risk of exposure to infectious diseases due to the difficulty in accessing clean water, the inability to live in a proper environment, and the lack of access to basic health facilities [23].

We found a relationship between the mother's education level and stunting, which aligns with previous studies [25, 26]. Several mechanisms might explain how a mother's education level can affect stunting. First, the mother's education affects the child's birth weight. In contrast, mothers with higher education tend to do antenatal care so that the growth and development of the fetus are better monitored. The second mechanism is through child feeding practices. Children of mothers with higher education will likely get adequate nutrition from breast milk and complementary foods in the first two years. Third, knowledge about diseases that children may suffer from in the first two years. Mothers with higher education may better understand diseases and are more likely to have better jobs and income, making it easier to access nutritious food and health facilities [27]. However, not-working status and a family income below the minimum wage may relate to a mother's ability to absorb information on feeding practices.

No parity and stunting relationship is in line with a study in Gorontalo [28]. Cases, where stunted children are born to mothers with low parity may be due to socioeconomic level. In the current study, 16 out of 30 mothers with stunted children have low economic levels; thus, mothers cannot fulfill the children's nutritional needs.

This study found no relationship between mothers' knowledge and stunting. This result is consistent with a study in Pekauman, Banjarmasin [29]. When the

mother's knowledge is in a good category, there will be appropriate applications or actions regarding exclusive breastfeeding and stunting prevention based on her knowledge. However, behavior is influenced by other factors, including socio-cultural, environmental, and socio-economic factors [30], so mothers' high knowledge does not always guarantee their children's nutritional status.

No significant relationship between family support stunting in this study is in line with a study in Padang [31]. The low mother's compliance may explain this to breastfeeding exclusively. Even though the family support in exclusive breastfeeding is high, if the mother's compliance does not match it, efforts to prevent stunting will not be optimal.

Although there have been some studies on exclusive breastfeeding and stunting, this research is unique in choosing the location. Palaran District is in a humid tropical forest area, further enhancing existing novelty and diversity. We use anthropometric data recorded in the Mother and Child Book (*Buku KIA*) and re-examined by community health workers.

CONCLUSION

Stunting is more common in toddlers under the supervision of mothers with lower levels of education than in toddlers under the supervision of mothers with higher levels of education. This study found no relationship between exclusive breastfeeding and the incidence of stunting in toddlers in Palaran District, Samarinda. Further research needs to look at other factors affecting stunting problems in toddlers besides those studied. One of the efforts to prevent stunting is to increase access to public education so that mothers can receive higher education, which can increase their insight and knowledge regarding proper childcare. Mothers can also gain increasing knowledge through counseling and outreach involving the Palaran Health Center. This step equips mothers to face pregnancy and caring for toddlers, especially in meeting the nutritional needs of toddlers.

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Congenital heart disease screening program in elementary schools: a research-based policy

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Abstract

Purpose: CHD is a condition where heart abnormalities develop before birth and can lead to severe complications such as heart failure and premature death, especially among younger adults. Delayed diagnosis and treatment worsen the situation for CHD patients. Early screening can prevent CHD and ensure timely interventions. This study discusses the latest advancements in CHD screening for primary school children and the valuable insights gained from the program. **Method**: The CHD screening program in Yogyakarta province involved three stages: consolidation, implementation, and incorporation. During the consolidation stage, key decision-makers in the province and local health offices were involved. Primary healthcare workers and primary school teachers were trained to deliver the screening during the implementation stage. Stakeholders, health workers, and teachers were invited to discuss the results, and the Provincial Governor's office was engaged during the incorporation stage. **Results**: In 2018–2019, 18 CHDs were identified from 6,116 school-age children in 4 districts in Indonesia. The screening program was led by academics in the Universitas Gadjah Mada through 3 stages: consolidation, implementation, and incorporation. Strong collaboration with local stakeholders has contributed to the program's success in engaging 130 schools, 60 community health centers, and 190 health workers. Several opportunities for improvement are: strengthening the capacity and number of health providers at health centers to screen CHDs using 12-lead electrocardiography, addressing patients' reluctance to visit the health facility due to the COVID-19 pandemic, and motivating parents to have their children checked. **Conclusion:** CHD screening using 12-lead electrocar- diography and auscultation should be part of primary school health screenings. Academics can train health workers, and local governments can provide funding and prepare health facilities for follow-up treatment.

Keywords: cervical cancer; level of knowledge; counseling; CHD screening; school health program

INTRODUCTION

Congenital Heart Disease (CHD) refers to a heart defect caused by heart development abnormality during embryogenesis, which is one of the primary causes of death in the first year of life, and some cases are associated with genetic defects [1]. In 2017, CHDs were responsible for over 250,000 deaths globally, with higher mortality and morbidity rates observed in countries with lower income and higher fertility rates, including the Southeast Asia region [2]. Given Indonesia's large population and high fertility rate, the country is likely to have a substantial burden of CHD cases. However, national data on CHDs is limited. According to the Indonesian Ministry of Health, the prevalence of CHD was 10 per 1,000 live births [3].

Prevention and management of birth defects in Indonesia have become one of the priorities in maternal, neonatal, and child health (MNCH) recently, and screening of neonates using pulse oximetry is included as mandatory screenings before discharge after birth [3]. Most children born with atrial septal defect (ASD), one of the most common CHDs, have mild symptoms or are asymptomatic, thus undiagnosed until adulthood [4]. From 2012 to 2017, there were 1012 adults with CHDs, indicating that neonatal screening may have missed a significant number of cases. A study showed that out of 838 children aged <18 with CHDs, 23% were diagnosed after 5 years old [6]. Without early treatment, CHDs could cause excess lung circulation and increased right heart volume load, leading to pulmonary arterial hypertension (PAH). The delayed diagnosis and treatment cause major health and economic problems since PAH treatment is costly and decreases patients' quality of life and productivity [2, 7].

Studies in Egypt, India, and Nigeria identified CHD prevalence of 1.0, 10.4, and 6.6 per 1000, respectively, by examining clinical signs and performing echocardiography simultaneously [8-10]. A study in rural China, using the same method as the other studies, managed to detect 285 cases of CHDs in 21,861 school-age children, thus demonstrating a prevalence of 13.0 per 1000 [11]. A recent study in 6,116 primary school children in Indonesia, using the 2-step clinical screening using electrocardiography and auscultation followed by confirmation using echocardiography, identified a CHD prevalence of 2.9 per 1000. This offers a more efficient approach to detecting CHDs in school-age children. Using the tiered early detection method, CHD can be detected early before more severe clinical manifestations appear, and corrective action can be performed [12].

Patients with CHD found in adulthood have shown symptoms and signs of complications. The most common is PAH, heart failure, and Eisenmenger syndrome [13]. Patients with CHD who experience this complication have high morbidity and mortality rates, and because most of them occur in young adults who are of productive age, their quality of life and productivity will decrease [5]. In addition, the government's cost burden for CHD management is also high due to the long-term treatment and high medicines prices. Therefore, early case finding through screening allows CHDs to be completely corrected and requires a shorter-term and less expensive treatment. To reduce the prevalence of CHD in adulthood, preventive measures in the form of early detection of CHDs in childhood need to be carried out through a screening program that is simple, applicable, and acceptable by children, families and communities, and effective. A simple but thorough cardiac examination method can effectively identify children with CHDs that often present without typical symptoms and signs. These cases should have an early corrective treatment to prevent complications in adulthood [14].

Many CHDs in adulthood in Indonesia indicate a lack of detection for diagnosis in early childhood, even in infants. While the routine health screening program for school-age children has been rolled-out nationwide, it does not include screening for CHDs. This article describes the processes, facilitators, and barriers in initiating and implementing CHD screening in primary school-age children in Yogyakarta province, thus providing lessons learned for other districts or provinces in Indonesia and other regions in low- and middle-income nations.

METHODS

Study period. This study had three stages. First, the consolidation stage (August 2015–May 2021), which was qualitative research by conducting focus group discussions, workshops, and in-depth interviews with health workers, the provincial health office, provincial education-youth-sports offices, and key stakeholders, followed by training for health workers to perform the screening.

Second, the implementation phase (April 2018 – ongoing), which was quantitative population research with a descriptive observational study method that examines primary school children in 2 stages: 1) primary screening: clinical examination using the 12-lead electrocardiography and auscultation at school, and 2) secondary screening: confirming the abnormal

findings using echocardiography at the referral facilities. As of 2022, this has recruited 7000 samples.

Third, the incorporation stage (July 2020 – ongoing), in which, on top of the existing stakeholders involved since the consolidation stage, stakeholders from the Provincial Government were engaged. Engaging the Provincial Government, particularly the Bureau of Law, Bureau of Research, and the Governor itself, allowed the researcher to advocate the development of laws and regulations for implementing CHD early detection programs for primary school children. At this stage, the research team also developed academic manuscripts, which served as the scientific justification for the laws and regulation development.

Study population. The screening program was conducted in 5 districts in Yogyakarta province: Yogyakarta municipal, Sleman, Bantul, Kulon Progo, and Gunung Kidul. The number of schools selected per district was based on 2017 data of total school students. Puskesmas selection was based on the performance, equipment, and recommendation by the District Health Offices that supervise each community healthcare facility (puskesmas).

RESULTS

Consolidation: stakeholder engagement

For this CHD screening, collaborations with provincial and district governments were established. We worked with the Provincial and District/Municipal Health Offices, Provincial Education Youth & Sports Office, puskesmas, and primary schools. A total of 25 local stakeholders' representatives were interviewed, with four discussion sessions involving health workers at puskesmas and teaching staff at primary schools.

Consolidation: Health worker training. At least one general practitioner and one nurse from each puskesmas were invited to attend the training. In 2018 – 2019, there were 45 general practitioners and 45 nurses who received two times training for 6 hours each. Invited GPs and nurses were those specializing in managing school student health programs. The training topics covered: updated diagnosis and management of CHD, heart physical examination, ECG interpretation, and CHD screening procedures in students. A quiz is held to assess the improvement in participants' knowledge and skill after the training.

Implementation: screening procedure

To ensure that the integration of a new program into an existing routine is successful, , it is important to consider the roles and responsibilities of each stakeholders involved. In the case of the CHD screening program, the health personnel from the puskesmas and school teachers and volunteers played a critical role in conducting the routine health examinations and administering the CHD screening. By incorporating the CHD screening into the existing routine, the program was able to take advantage of the infrastructure and resources that were already in place. Additionally, the supervision provided by the research team members ensured that the screening program was implemented correctly and efficiently. This approach not only improved the efficiency of the screening process but also helped to promote sustainability by making use of existing resources and involving multiple stakeholders in the process.

The CHD screening program employs a comprehensive two-stage approach involving multiple diagnostic methods, trained healthcare professionals, and specialized facilities to identify potential cases of CHD among primary school children. The primary screening methods were a combination of heart examinations focusing on cardiac auscultation using a stethoscope and a 12-lead electrocardiogram conducted by general practitioners and nurses from puskesmas who have been trained. The children identified with abnormal findings in the primary screening were invited to secondary screening using transthoracic echocardiography by cardiologists in district hospitals or *Pusat Jantung Terpadu* (Integrated Heart Center) Dr Sardjito Hospital. The procedure is described in Figure 1.

Implementation: heart abnormalities and CHD identification

Despite a small refusal and being unable to attend due to fear of covid 19, this screening program shows the benefits of early screening. Twelve puskesmas participated during the first- and second-year periods. Of 6367 children screened, 6116 completed the primary screening procedures (96.1%). The reasons for incomplete screening were refusals and fear of the 12-lead electrocardiogram. In the screening process, 6116 children were screened, and 329 (5.38%) had abnormal findings. Of these 329 children, 260 underwent secondary screening, while 22 refused, and 47 could not attend due to pandemic-related social restrictions. Among the 260 children who completed both primary and secondary screenings, 18 (6.9%) were found to have an abnormality detected through transthoracic echocardiography. These findings indicate the importance of early screening in detecting abnormalities in children, especially during a

pandemic, where access to healthcare can be limited.

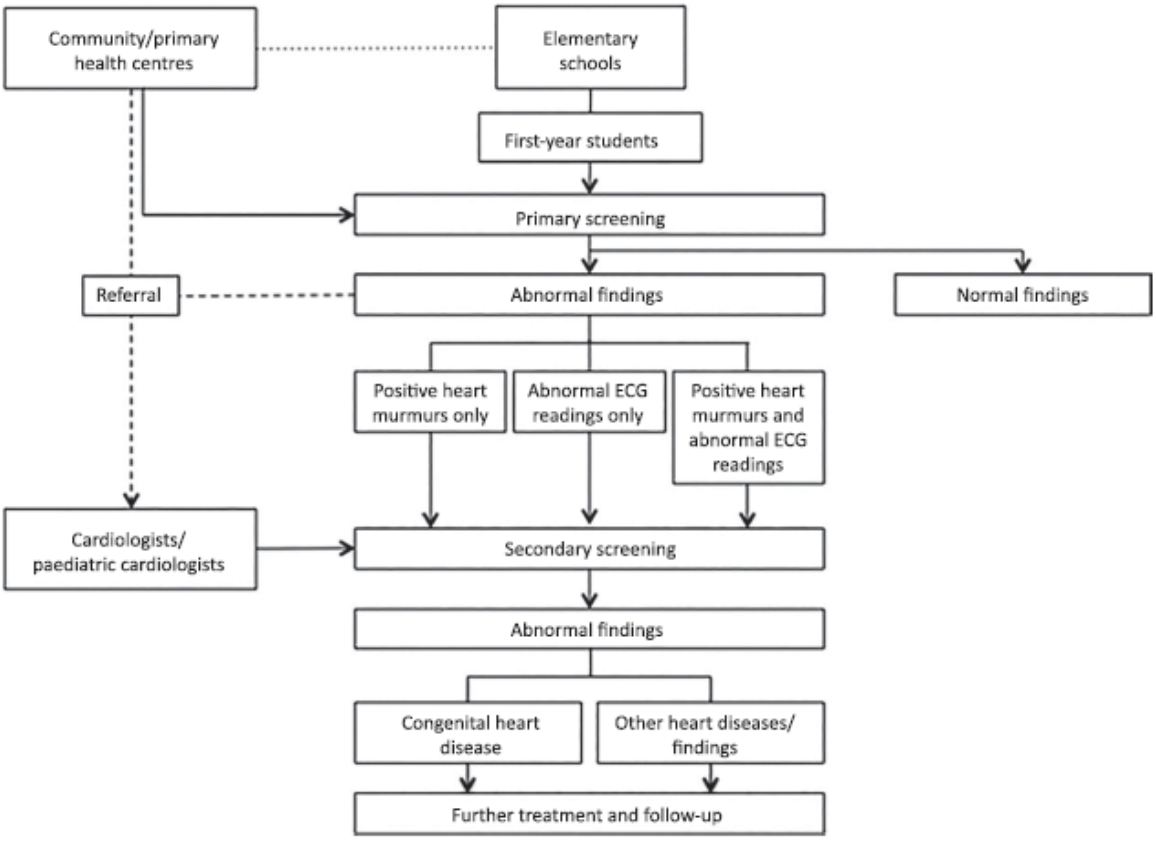

Figure 1. The procedure of congenital heart disease screening for first-grade primary school children (12)

Implementation: challenges and opportunities

Although the health providers involved in the screening program have been trained, lack of confidence, staff turnover, and staff overload due to the COVID-19 pandemic have caused sub-optimal roles of general practitioners and nurses in CHD training. The supervisors from the research team were the main persons who conducted the CHD primary screen rather than the trained puskesmas health personnel. Motivating puskesmas' health providers to be more involved in the CHDs screening program may require several strategies, such as: increasing the training hours with real practical sessions, providing an MoH-accredited certificate that allows the health providers to get credit points to their employees, and ensuring that the knowledge and skills are shared within staff in the same puskesmas to anticipate staff turnover. Another challenge was using a 12-lead electrocardiogram, which could be complicated to use by newly trained health providers. Developing simpler equipment, like a 6-led electrocardiogram, could strengthen the role of puskesmas' health providers.

Incorporation: policy planning & formulation

Collaborative efforts and policy support are crucial for improving public health outcomes. The research team has consistently conducted a series of discussions with the expertise, stakeholders (i.e., Yogyakarta Provincial Research Council, Yogyakarta provincial health office, Yogyakarta provincial education office), puskesmas, and school staff to explore possibilities of conducting a wider screening program. Building on these discussions, the team also engaged in an advanced conversation with the Governor Office, including the governor, bureau of law, and bureau of research. As a result of these discussions, the Governor agreed that early detection of CHD in children could improve the Yogyakarta people's quality of life. Subsequently, further meetings were held to discuss more technical matters, such as the form of regulations backed by the academic paper and the parties involved in the preparation. These meetings involved the Health, Education, Youth, and Sports offices and Law Bureau at the provincial and district levels. Following these meetings, the research team completed an academic paper, which was discussed at the law bureau in April

2021. This led to the issue of Yogyakarta Governor Regulation 103/2021 on the Provincial Action Plan on Community Health Movement, which mandated the provincial social security agency (Bapel Jamkesos) to cover the cost of secondary screenings and initial treatment not covered by national health insurance. Since the implementation of this regulation, the screening program has been started, and up to August 2022, 20 children identified with CHD through the screening program have received treatment.

DISCUSSIONS

This study showed how an academic-led study on CHD screening programs for primary school children, through a continuous and relentless approach to engaging multi-stakeholders, has succeeded translated into policy. The study involved a significant proportion of the affected population, showed direct benefit to the health providers by training them in the CHD screening method, and engaged local stakeholders from multiple sectors (i.e., education and health) and the local leader. The research team was academic staff in the local university and teaching hospitals (Universitas Gadjah Mada and Sardijto hospitals) and published a sound evidence-based finding from the study, which was highly needed to support the establishment of local regulation.

Strategic policy planning can have an impact on policy-making. Good planning also involves various sectors so that they can collaborate to produce firm policy [15,16]. This article demonstrates good planning and execution, from consolidation and implementation to incorporating such programs into the existing policies. The primary CHD screening is feasible to be performed yearly in first-grade elementary school students and can be integrated as a single activity with the mandatory annual health screening program. The secondary screening by transthoracic echocardiography was easily accepted by the school students. The transthoracic echocardiography was performed without any difficulties. However, the willingness of school students and parents to get secondary screening required some motivation because they needed extra time to come to the district hospital or our heart center.

Congenital heart disease (CHD) is a heart defect from birth. The number of patients with CHD in adulthood in Yogyakarta and Indonesia indicates a lack of early detection/screening or diagnosis in early childhood, even in infants. This causes many CHD patients to go undetected and too late to be treated. Thus increasing morbidity and mortality, as well as the high economic burden due to expensive and long treatment due to complications [17]. Screening with 12-lead electrocardiography can help detect children with CHD who have no symptoms [14].

Currently, no simple and effective CHD screening program is implemented in Indonesia. The role of this screening program is important, considering that this program can prevent high morbidity and mortality rates. The screening program using the 12-lead-electro-cardiography and auscultation method is expected to be inexpensive, simple, and efficient screening program. Through *Peraturan Gubernur DIY 103/2021 tentang Rencana Aksi Daerah Gerakan Masyarakat Hidup Sehat*, this program is expected to be implemented in all elementary schools in Yogyakarta. All stakeholders involved are expected to be able to implement this program.

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