PNEUMONIA CASES AMONG TODDLERS BASED ON EXCLUSIVE BREASTFEEDING COVERAGE, UNDERNUTRITION STATUS, AND POPULATION DENSITY IN SIDOARJO REGENCY IN 2019, 2020, AND 2021

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ABSTRACT

Introduction: Pneumonia is the leading infectious cause of death among children worldwide accounting for 14% of all under-five deaths. Sidoarjo Regency has the highest incidence of toddlers with pneumonia in East Java**. Aims:** This study aimed to map and analyze the distribution of pneumonia cases among toddlers in the Sidoarjo Regency based on the risk factors of exclusive breastfeeding coverage, lack of nutrition status, and population density. **Methods:** This research was a descriptive study using secondary data obtained from the Sidoarjo Regency Health Profile in 2019, 2020, and 2021. This study's analysis unit included all 18 sub-districts in Sidoarjo Regency. Mapping was done using QGIS software version 3.10, "A Coruña." **Results:** The findings showed that the Waru Sub-district was vulnerable to the incidence of pneumonia in toddlers because, apart from consistently having a high prevalence of cases over the last three years, it was also accompanied by high-risk factors, including low coverage of exclusive breastfeeding, high incidence of undernourished toddlers, and high population density. **Conclusions:** It can be concluded that intervention activities such as socializing and advocating programs of exclusive breastfeeding and balanced toddler nutrition with PMT and immunization are better prioritized in Waru Sub-district.

Keywords: Pneumonia, Toddlers, Exclusive Breastfeeding, Undernutrition, Child Health

INTRODUCTION

Toddlers are a very vulnerable group to developing nutritional and infectious diseases, including pneumonia (Hidayah and Wulandari, 2014; Karmany, Rahardjo and Murti, 2020)). Pneumonia, also known as wet lung, is an acute inflammatory or infectious disease that attacks the lung tissue (alveoli), where the causative agents are microorganisms such as viruses, fungi, and bacteria (Indonesian Ministry of Health, 2022). Pneumonia infection can attack one or both lungs until inflammation occurs, which causes the alveoli of the lungs to fill with fluid or pus, causing the sufferer to have difficulty breathing (NHLBI, 2022). Pneumonia can attack all ages, but children under five are more susceptible to infection with pneumonia and causing death (Beletew et al., 2020). The World Health Organization states that pneumonia is the leading infectious cause of death among children worldwide. In 2019, pneumonia accounted for 14% of all under-five deaths, killing as many as 740,180 toddlers worldwide (WHO, 2022).

Pneumonia continues to be a major health challenge for children worldwide, especially in developing nations (McAllister et al., 2019). In Indonesia, the pneumonia control program is also given more priority due to the high mortality rate of toddlers caused by this disease. It can be seen from the 2021 Indonesia Health Profile data pneumonia accounted for the highest mortality rate in the toddler group

aged 29 days – 11 months, which is 14.4%. In addition, pneumonia accounts for the second-highest mortality rate among toddlers, as much as 9.4% (Indonesian Ministry of Health, 2021). In 2021, the number of pneumonia sufferers in toddlers in Indonesia reached 278,261 cases. East Java is the highest contributing province, with 74,071 cases (Indonesian Ministry of Health, 2021). Sidoarjo Regency is the district/city with the highest number of toddlers with pneumonia in East Java, with 9,308 cases (East Java Province Health Office, 2021). Given the high incidence of pneumonia in toddlers, it is imperative for the government to pay serious attention to this issue (Karmany, Rahardjo and Murti, 2020).

Many factors put a toddler at risk of pneumonia, including being infected by a patient, not getting complete basic immunization, having poor nutritional status, lack of exclusive breastfeeding, low birth weight, not being given vitamin A, and living in an unhealthy environment (Misnadiarly, 2008; Champatiray et al., 2017; Karmany, Rahardjo and Murti, 2020)). An unhealthy environment can be in the form of a high population density in the area where the toddler lives. Sidoarjo Regency has the characteristics of a high population density, namely 2,916 people per km^2 (Sidoarjo Central Bureau of Statistics, 2020). A previous study stated that there was a significant relationship between the level of population density and the incidence of toddler pneumonia with a p-value of 0.038 (Syani and Raharjo, 2015).

Toddlers with undernutrition status will also increase the risk of being infected with S. Pneumniae bacteria, which can cause pneumonia (Zain, Garna and Rachman, 2019). A study conducted by Amru Devi Putri and Selvia (2021 found a significant association between nutritional status and pneumonia incidence in toddlers, as evidenced by a p-value of 0.00 . Another factor that causes toddlers to be at risk for pneumonia is exclusive breastfeeding. Exclusive breastfeeding plays a crucial role as foundation of health in child development and survival (Handajani, Pamungkasari and Budihastuti, 2018). The proportion of exclusive breastfeeding coverage in Sidoarjo Regency was already quite good. In 2020 it reached 67.9%, and in 2021 it reached 76.9% (Sidoarjo Regency Health Office, 2021) (Sidoarjo Regency Health Office, 2022). Most sub-districts in Sidoarjo Regency have high coverage of exclusive breastfeeding, but several sub-districts still have low coverage. Previous study has shown a significant correlation between a history of exclusive breastfeeding and the incidence of pneumonia in toddlers (Rigustia, Zeffira and Vani, 2019).

Monitoring the underlying factors of pneumonia cases in toddlers is essential to identify appropriate prevention strategies and health service planning. This is because pneumonia poses a large economic burden on both inpatient and outpatient services (McAllister et al., 2019). Therefore, this research aimed to describe and analyze the distribution of pneumonia cases among toddlers in the Sidoarjo Regency based on the risk factors for exclusive breastfeeding coverage, undernutrition status, and population density from 2019 to 2021. The pattern of distribution of pneumonia based on these risk factors was described in the form of a map using one of the software from Geographic Information Systems (GIS), namely QGIS.

METHODS
Study Design

This descriptive research used an ecological study design. This research was conducted in Sidoarjo Regency, East Java Province, with the unit of analysis being all sub-districts in Sidoarjo Regency, totaling 18 sub-districts, including Candi Sub-district, Prambon, Krembung, Porong, Tarik, Tulangan, Wonoayu, Sukodono, Sidoarjo, Buduran, Sedati, Waru, Jabon,

Gedangan, Taman, Krian, Balongbendo and Tanggulangin sub-district.

Measurement Data

The secondary data from the Sidoarjo Regency Health Profile in 2019, 2020, and 2021 were used, where the data are valid and reliable because they were obtained through the official website of the Sidoarjo District government which is publicly available. Data on pneumonia cases, exclusive breastfeeding coverage, undernutrition in toddlers, and population density in Sidoarjo Regency were collected from the Sidoarjo Regency Health Profile from 2019 to 2021. The variable prevalence of pneumonia in toddlers was measured by calculating the number of pneumonia cases in toddlers in one year divided by the number of toddlers in that year and multiplied by a constant of 100. The exclusive breastfeeding coverage variable was measured by calculating the number of exclusively breastfed toddlers per district divided by the number of toddlers multiplied by 100%. Then the population density variable was measured by dividing the total population in a certain year by the area of km^2 in that year.

Data Analysis

Data were analyzed descriptively to describe the magnitude of the measured health problem. The researcher also explained the data on the prevalence of pneumonia cases using a time trend graph of increasing cases using Microsoft Excel 2016. To see the magnitude of the problem by region, the researcher conducted a descriptive mapping analysis by integrating several variable data using the QGIS (Quantum Geographic Information System) mapping software version 3.10 "A Coruña".

RESULT
Trends of Pneumonia Cases

The graph above shows the development of pneumonia cases among toddlers in Sidoarjo Regency in 2019, 2020, and 2021 based on time trends. In the graph can be seen that there was an increase in the prevalence of pneumonia cases among under-fives in Sidoarjo District in 2021, which was 4,01 per 100 under-fives compared to 2020, where the prevalence was only 3,53 per 100 under-fives. The prevalence of pneumonia cases decreased in 2020 from 6,63 per 100 under-fives in 2019 to 3,53 per 100 under-fives in 2020 (Sidoarjo Regency Health Office, 2020).
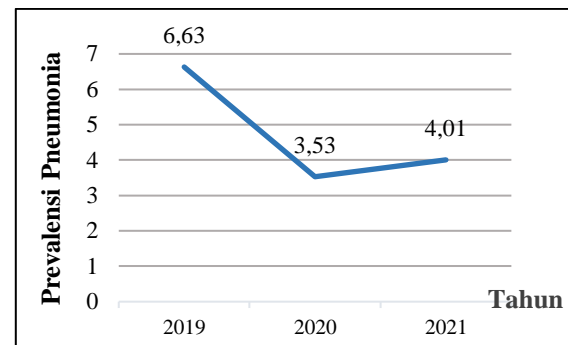
Figure 1. Time Trend of Pneumonia Prevalence per 100 Toddlers in Sidoarjo 2019, 2020, 2021.
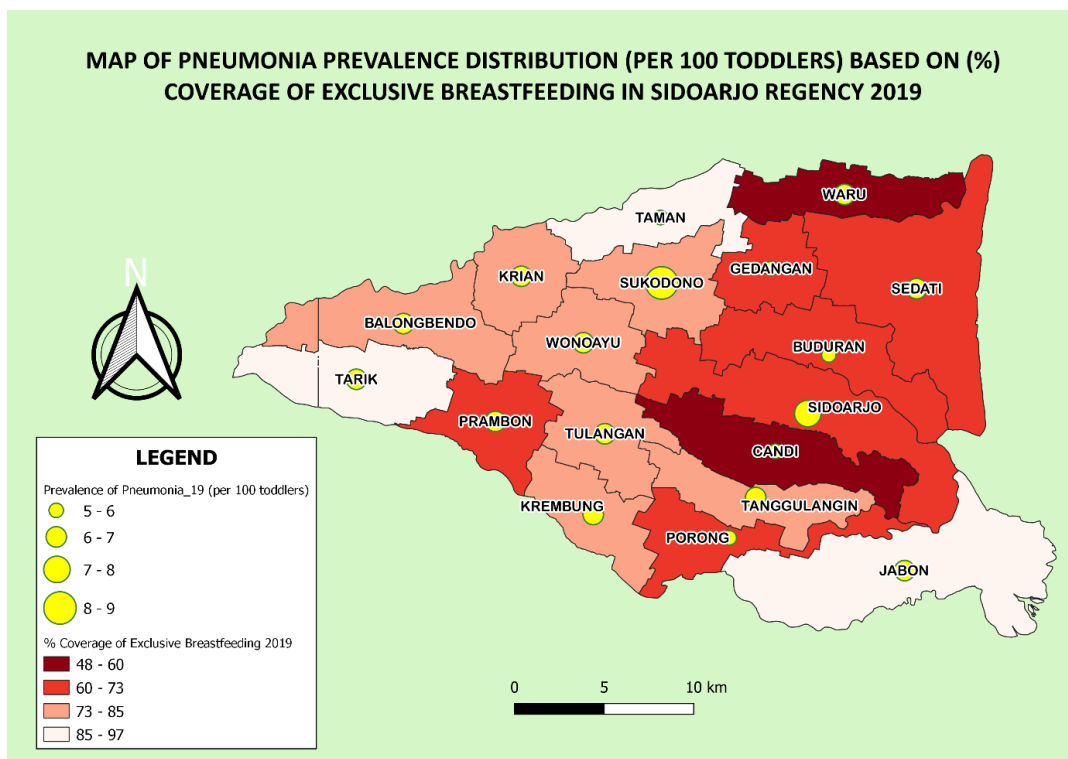
The Overview of Cases

Table 1 illustrates the prevalence of pneumonia cases in toddlers, the percentage of exclusive breastfeeding coverage, cases of undernutrition, and population density in each sub-district at Sidoarjo Regency according to the Sidoarjo Health Profile in 2019, 2020, and 2021. Table 1 shows that the sub-districts that had a consecutive decrease in cases from 2019 to 2021 included Tarik, Candi, Wonoayu, Buduran, Taman, and Balongbendo. Sukodono sub-district had the highest prevalence of pneumonia cases among toddlers in 2019, which was 8.6 per 100 toddlers. The district with the highest prevalence in 2020 was Jabon Sub-district, which was 7.5 per 100 toddlers, while, in 2021, Sidoarjo sub-district had the highest prevalence of 6.4 per 100 toddlers, followed by Wonoayu sub-district (4,4) and Waru sub-district (4,3). Then it can be seen that the sub-districts with the lowest
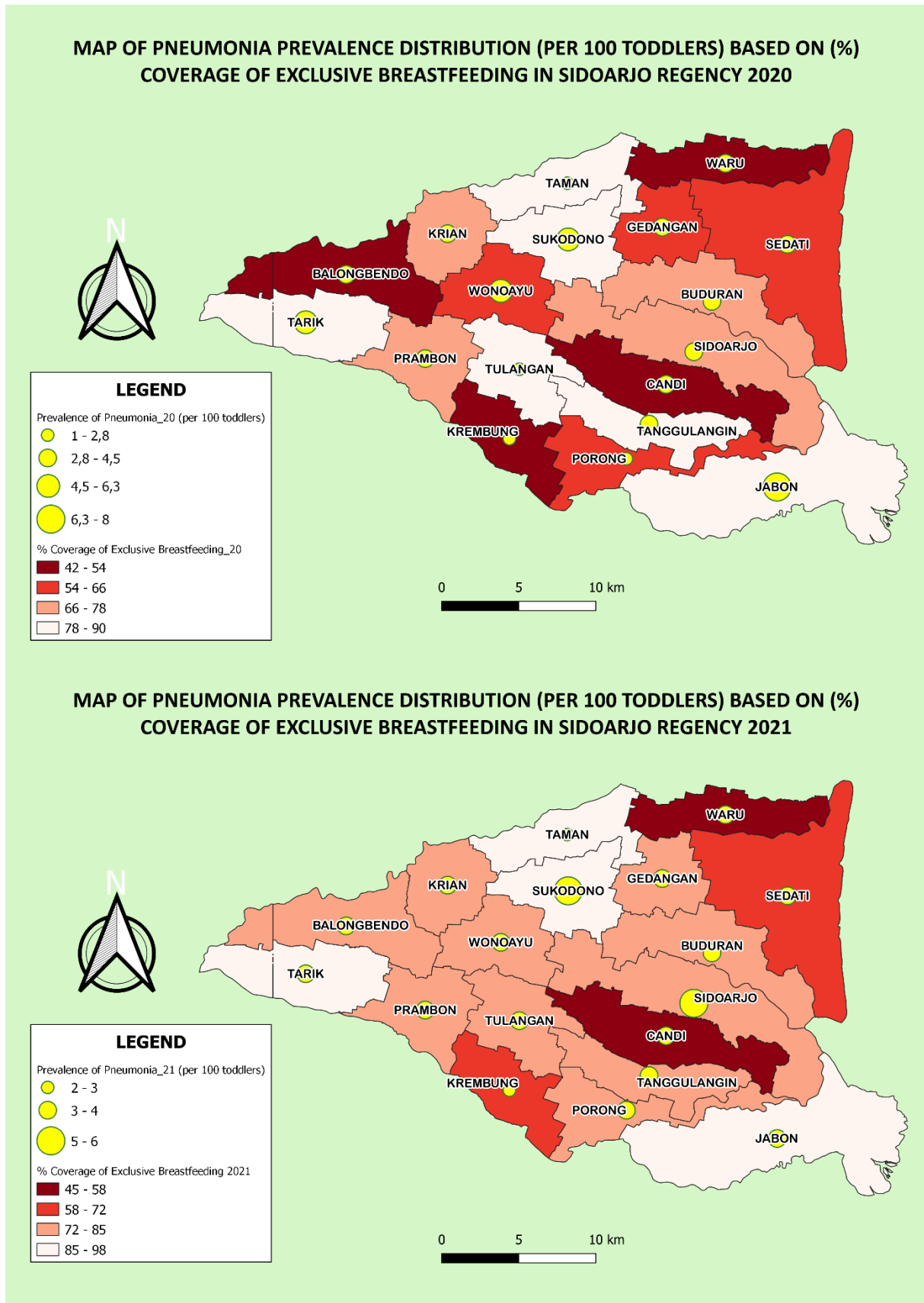
exclusive breastfeeding coverage for three consecutive years were Candi sub-district and Waru sub-district. On the other hand, Waru sub-district had the highest case number of undernutrition toddlers for two consecutive years at 13,6%. In addition, the sub-district with the highest population density for three consecutive years is also occupied by Waru sub-district, which in 2021 reached 8.015,6 per km^2.

Table 1. Prevalence of Pneumonia Cases, % Exclusive Breastfeeding Coverage, and % Cases of Undernutrition Toddlers, and Population Density in Sidoarjo (2019, 2020, 2021)

Sub-districts	Prevalence of pneumonia (per 100 toddlers)			% Exclusive Breastfeeding Coverage			% Undernutrition Toddlers			Population density (per km²)		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021
Tarik	7.2	5.5	3.5	91.6	88.0	98.2	6.6	10.3	7.0	2069	2099.6	2135.2
Prambon	7.1	3.5	4.0	68.1	70.3	73.8	9.4	8.9	7.0	2614	2651.7	2698.7
Krembung	6.6	1.7	3.2	73.1	52.9	64.6	5.0	8.0	9.5	2533	2570.2	2612.7
Porong	4.9	0.9	4.2	64.6	59.9	82.9	11.6	8.0	8.0	3097	3141.5	3188.5
Jabon	7.0	7.5	3.8	96.8	90.1	93.3	12.1	11.4	11.4	766	776.9	790.3
Tanggulangin	6.7	4.1	4.2	74.5	80.0	71.6	10.0	1.8	1.8	2679	2718.2	2766.0
Candi	5.0	4.1	3.7	48.1	41.8	45.4	4.0	9.5	9.5	3979	4037.4	4110.0
Tulangan	6.6	2.0	3.7	83.8	83.1	74.0	10.5	9.9	9.9	3505	3555.8	486.5
Wonoayu	7.0	4.5	4.4	78.2	64.3	75.8	10.1	10.2	10.2	2557	2594.5	2638.6
Sukodono	8.6	4.9	5.5	80.9	81.0	94.3	13.0	9.2	9.2	3764	3819.3	3881.3
Sidoarjo	7.8	3.4	6.4	70.8	70.1	75.9	8.3	4.6	4.6	5119	15580.3	3582.0
Buduran	6.3	4.0	3.8	69.4	73.5	81.9	9.6	9.7	9.7	2447	2482.5	2526.9
Sedati	6.8	3.5	3.7	70.2	65.8	67.5	11.4	4.9	4.9	1397	1417.5	1442.1
Waru	6.5	3.9	4.3	51.1	46.5	58.0	11.9	13.6	13.6	7824	7937.6	8314.4
Gedangan	6.4	3.4	3.6	64.6	57.8	82.6	10.6	11.4	11.4	6495	6589.6	6685.5
Taman	5.8	2.0	2.0	89.2	78.5	89.0	5.4	8.7	8.7	7806	7919.5	8015.6
Krian	6.9	3.6	3.9	83.0	69.0	81.7	3.5	1.2	1.2	4387	4450.6	4404.4
Balongbendo	6.9	4.2	4.0	78.8	50.3	74.6	12.6	12.6	11.4	2571	2607.8	2649.2

MAP OF PNEUMONIA PREVALENCE DISTRIBUTION (PER 100 TODDLERS) BASED ON (%) COVERAGE OF EXCLUSIVE BREASTFEEDING IN SIDOARJO REGENCY 2019
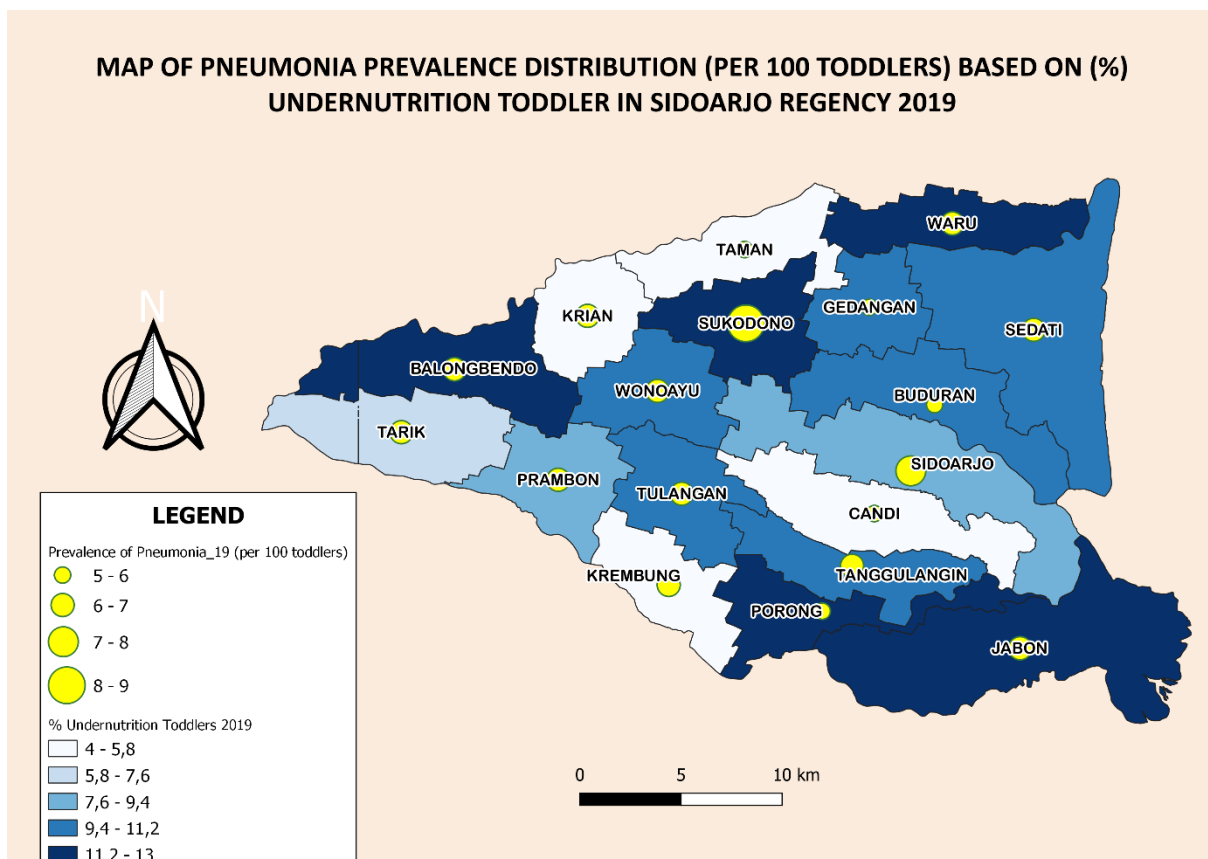
Figure 2. Map of Pneumonia Prevalence Distribution (per 100 toddlers) Based on Percentage (%) Coverage of Exclusive Breastfeeding in Sidoarjo Regency in 2019, 2020, 2021.
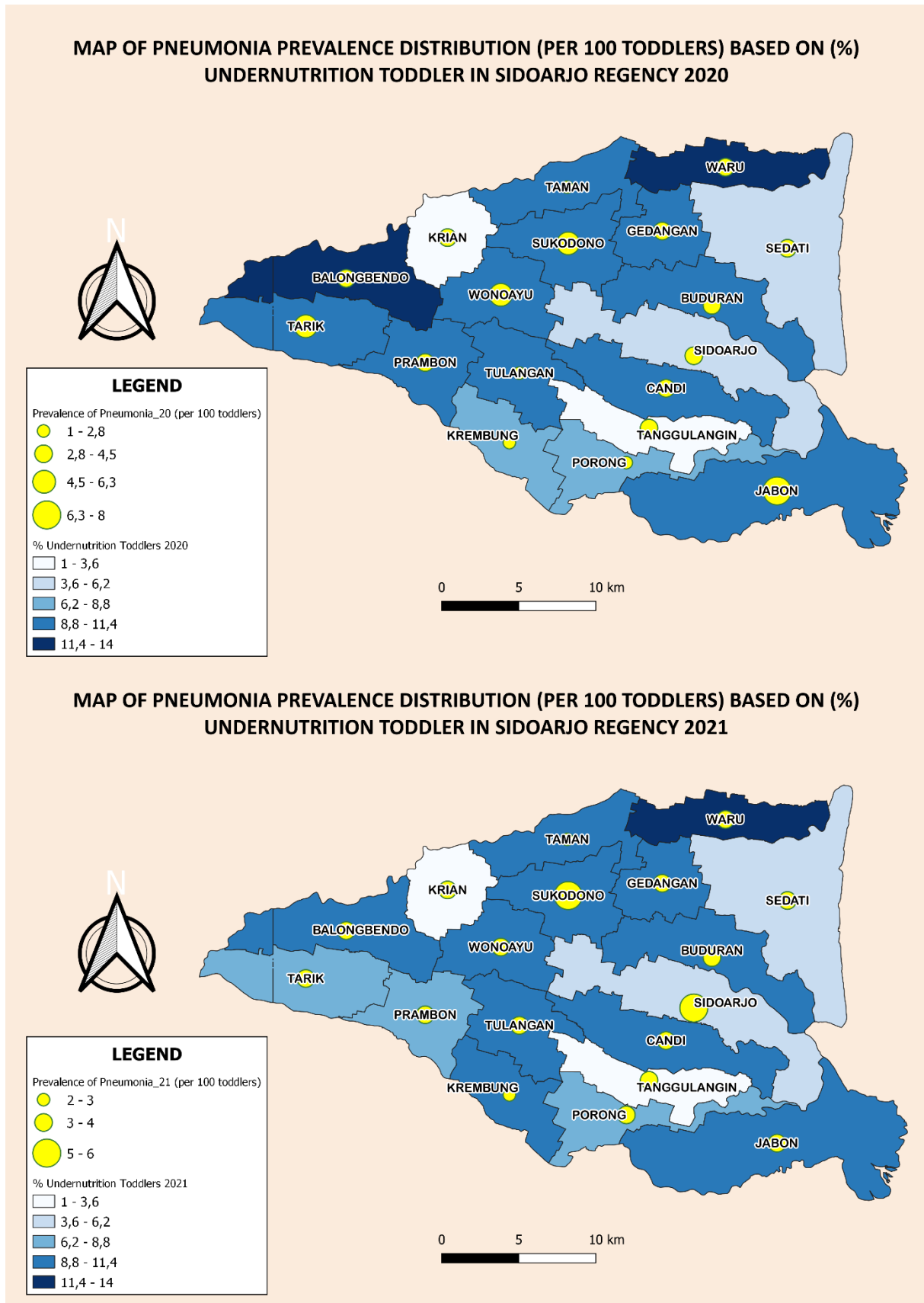
Figures 2 illustrates the distribution of the prevalence of pneumonia cases based on the percentage (%) of exclusive breastfeeding coverage in toddlers in 2019, 2020, and 2021 in the Sidoarjo Regency. The color gradation layer on the map shows exclusive breastfeeding coverage in each Sidoarjo Regency sub-district. The darker color indicates that the exclusive breastfeeding coverage in that sub-district is low, and vice versa. Meanwhile, the magnitude of pneumonia cases on the map is illustrated by the presence of yellow centroid dots, where the larger the centroid point indicates the higher the prevalence of pneumonia cases in that sub-district.

From the map that has been presented, it can be seen that Candi and Waru sub-districts have the densest layer colors for three consecutive years, indicating the low coverage of exclusive breastfeeding in those areas. The size of the centroid point seen also illustrates that Candi District had a fairly high number of pneumonia cases. This also occurs in the Waru sub-district, where, from 2019 to 2021, the map layer shows quite dense colors, especially in 2019, which means that the coverage of exclusive breastfeeding was still low. This is also accompanied by the large centroid point in Waru sub-district, indicating many cases in that area. However, this is inversely proportional to the sub-districts of Tarik, Sukodono, and Jabon. Although the coverage of exclusive breastfeeding was high, the centroid points or the magnitude of pneumonia cases in these areas were still high. This is different from the Taman sub-district, which had high exclusive breastfeeding coverage and a low number of pneumonia cases.

Figure 3. Map of Pneumonia Prevalence Distribution (per 100 toddlers) Based on Percentage (%) of Undernutrition Toddlers in Sidoarjo Regency in 2019, 2020, and 2021.
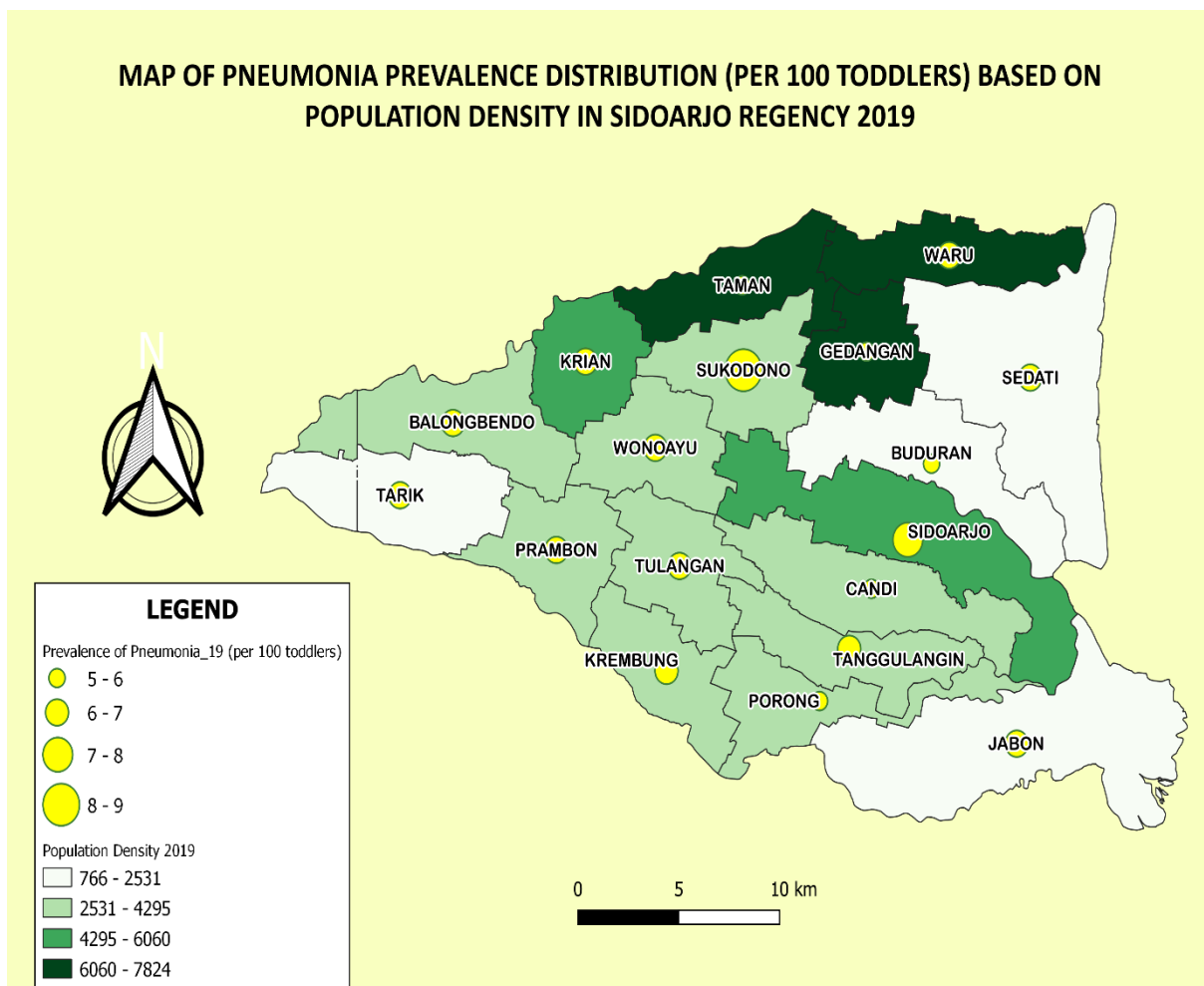
Figure 3. Map of Pneumonia Prevalence Distribution (per 100 toddlers) Based on Percentage (%) of Undernutrition Toddlers in Sidoarjo Regency in 2019, 2020, and 2021.
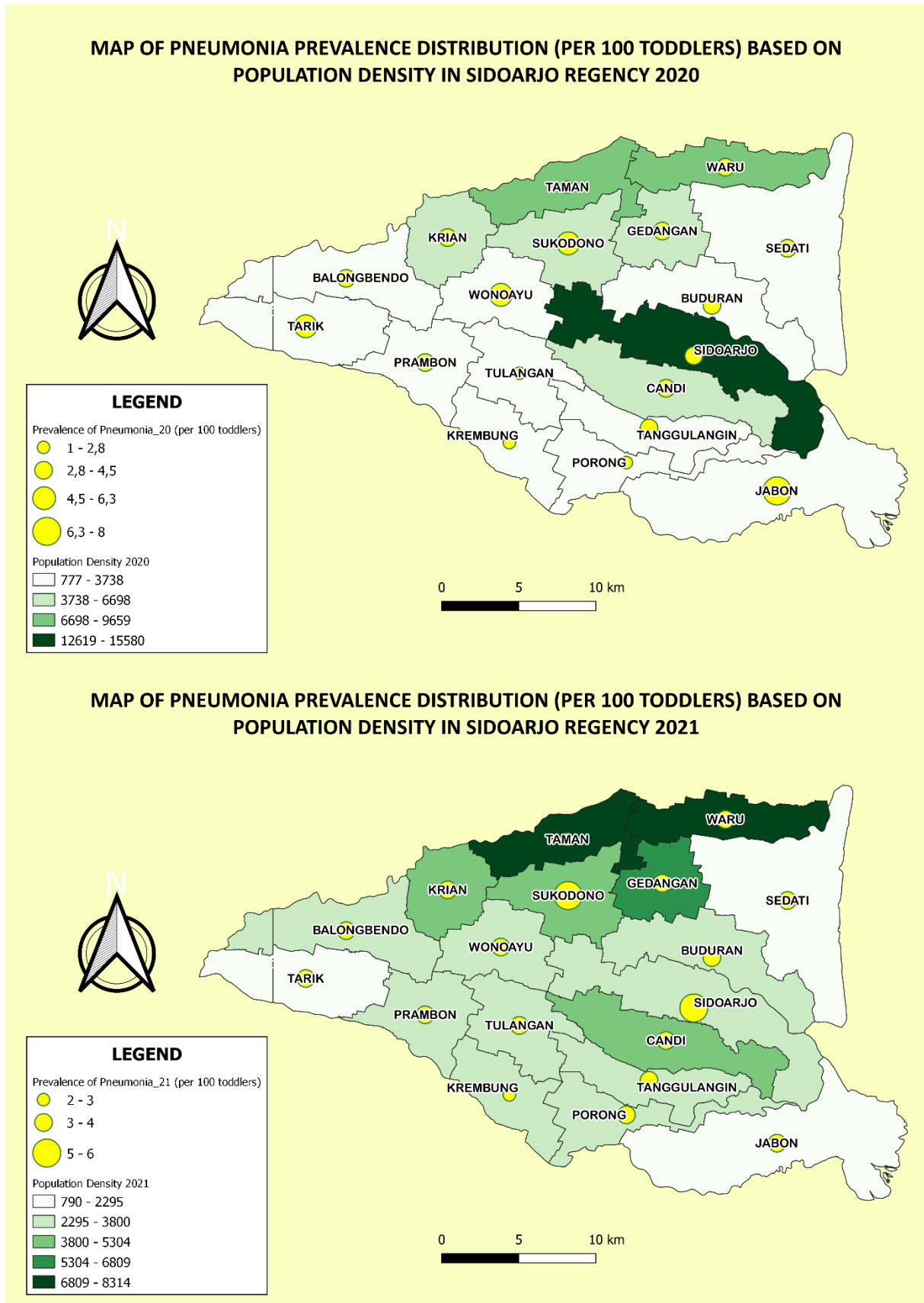
Figure 3 llustrates the distribution of pneumonia case prevalence by percentage (%) of undernourished children in the Sidoarjo Regency in 2019, 2020, and 2021. The color gradation layer on the map shows the magnitude of malnutrition cases in each sub-district in the Sidoarjo Regency. The darker the color, the higher the undernutrition cases in the sub-districts, and vice versa. Meanwhile, the magnitude of pneumonia cases on the map is depicted by the yellow centroid points. The larger the centroid points, the higher the number of cases in the sub-districts. Based on the map above, it can be seen that Waru sub-district had the most intense layer color for three consecutive years, indicating a high number of cases of undernutrition toddlers. This is matched by the high number of pneumonia cases among toddlers in Kecamatan Waru for the last three years. Then it can also be seen that in 2019 the Sukodono sub-district area had a very dense color, which means the case of toddlers with undernutrition status are very high. This is accompanied by high cases of pneumonia among toddlers in Sukodono sub-district, which is indicated by the size of the centroid points in the area. However, in 2020 and 2021 the density of colors and the size of centroid points in Sukodono sub-district decreased, which indicates the case of pneumonia in toddlers and cases of toddlers with undernutrition in the area decreased.

Figure 4. Map of Pneumonia Prevalence Distribution (per 100 toddlers) Based on Population Density in Sidoarjo Regency in 2019, 2020, and 2021.

Figure 4. Map of Pneumonia Prevalence Distribution (per 100 toddlers) Based on Population Density in Sidoarjo Regency in 2019, 2020, and 2021.

Figure 4 shows a map of the distribution of the prevalence of pneumonia cases based on population density in the Sidoarjo Regency in 2019, 2020, and 2021. The color gradation layer on the map shows the population density in each sub-district in Sidoarjo Regency. The darker the color, the higher the population density, and vice versa. Based on the map above, it can be seen that Waru sub-district had the highest population density for three consecutive years. In addition, Waru sub-district also had a centroid point for the large distribution of pneumonia cases from 2019 to 2021.

DISCUSSION

Pneumonia is a disease of acute respiratory infections caused by microorganisms such as bacteria, viruses, or fungi that attack the lungs, especially the alveoli, causing the alveoli or air sacs in the lungs to become inflamed and swell because they are filled with pus ((Indonesian Ministry of Health, 2022; Rahima, Hayati and Hartinah, 2022) . Pneumonia can attack all ages, especially toddlers, who are vulnerable to infectious diseases. Clinical manifestations of pneumonia can range from mild to serious symptoms, which can be in the form of coughing with or without the presence of mucus, fever, flu, chills, to difficulty breathing or rapid breathing. (Susanti, 2017; NHLBI, 2022;). There are many factors that put a toddler at risk of developing pneumonia. Previous studies have proven that there is a correlation between risk factors such as exclusive breastfeeding, undernutrition, and population density with pneumonia in toddlers. This study observed the distribution of pneumonia among toddlers in the Sidoarjo Regency based on these three risk factors. The data were then processed and presented to determine the disease risk pattern.

Disease mapping in a certain area is needed to determine the pattern of risk and disease distribution, especially pneumonia. The process of documenting data that has been recorded is processed in the form of graphical data in the form of maps, tables, and graphs. Therefore, the situation that occurs in an area will be easier to read and handling can be adapted to the conditions or circumstances in each of these regions (Susanti, 2017). Mapping pneumonia in toddlers will show the condition of cases in each region in the Sidoarjo Regency. Areas prone to this case will also be known based on risk factor data, % coverage of exclusive breastfeeding, % of undernutrition toddlers, and a population density that can affect its distribution.

This study showed that the spread of pneumonia for three consecutive years occurred in all areas in Sidoarjo Regency. The high cases of pneumonia in each sub-district varied from one to another depending on the conditions and factors that affected each sub-district. Based on the research findings, it can be seen that Waru sub-district was the most vulnerable area where the prevalence of pneumonia in toddlers was very high for three consecutive years. In addition, Waru sub-district had the highest population density in 2021, when it reached 8,015.6 per km^2. This is in line with research conducted by Benincà et al. (2017), whose analysis showed that areas with a high incidence of detected pneumonia cases are characterized by high population density. Conversely, areas with a low incidence of pneumonia cases are characterized by a low population density. Other research also states that areas with high population density affect the incidence of pneumonia in toddlers with a p-value of 0.038 (Syani and Raharjo, 2015). The denser an area, the greater the potential for the spread of disease because population density affects air circulation in the environment, which has the potential for contamination from outside which can facilitate the transmission of the spread of disease (Syani and Raharjo, 2015).

Based on the results of study, Waru sub-district also had the highest risk factors for cases of undernutrition in toddlers in the last three years. Previous studies have demonstrated a correlation between the occurrence of pneumonia in toddlers and their nutritional status, where children with adequate nutrition status have a 1.74 times lower risk of pneumonia than children with poor nutritional status (Mustikarani et al., 2019). Other studies also found that children with poor nutritional status have a 2.2 times greater risk of suffering from bacteremic pneumonia, and severely Undernutrition children under five have a 13.5 times greater likelihood of dying from pneumonia than children with good nutrition (Negash et al., 2019). Pneumonia often occurs in toddlers who have poor nutritional status and are combined with unhealthy environmental conditions (Sundari, 2014). The nutritional status of toddlers greatly influences their immune systems. Children with poor nutritional status will be more susceptible to pneumonia than children with normal nutrition due to weak immune systems (Rahmawati, 2016). Furthermore, infectious diseases can cause toddlers to lose or decrease their appetite resulting in malnutrition (Yuliastuti, 2014).

In addition, Waru sub-district also had low coverage of exclusive breastfeeding for three consecutive years. Exclusive breastfeeding is breastfeeding only for babies without the addition of other liquids such as formula milk, lemon juice, honey, or water (Karmany, Rahardjo and Murti, 2020). Breast milk is ideal for optimal infant and toddler health, growth, and development (Glanny Anindya et al., 2020). Toddlers who are not receiving exclusive breastfeeding are at a significantly higher risk of developing pneumonia, with the risk being eight times greater than that of children who are exclusively breastfed. This is due to the fact that breast milk contains a variety of vital nutrients, hormones, growth factors, and other substances that can help to prevent allergies or inflammatory infections, and boost the child's immunity against diseases. (Sutriana, Sitaresmi and Wahab, 2021). It can be said that breastfeeding also affects toddler nutrition; toddlers who get exclusive breastfeeding will have their nutrition fulfilled according to their needs (Susanti, 2017).

Mortality rate among toddlers in Indonesia is still relatively high if compared to other ASEAN countries, therefore an exclusive breastfeeding program has been launched, which is expected to contribute significantly to reducing child mortality rates (Ekawati, Parlindungan and Morita, 2015). However, in several areas, such as the Waru and Candi sub-districts, the exclusive breastfeeding coverage is still low; this can be caused by the low awareness of mothers about the benefits of exclusive breastfeeding (Champatiray et al., 2017). Based on Government Regulation Number 33 of 2012 concerning Exclusive Breastfeeding, the government has established national policies regarding the exclusive breastfeeding program, including advocating and socializing the exclusive breastfeeding program and fostering, supervising, and evaluating the implementation and achievement of the exclusive breastfeeding program. It is hoped that the campaign, advocacy, and socialization related to this program can increase mothers' knowledge about the importance of exclusive breastfeeding for toddlers and pay attention to their nutritional status. A good understanding of exclusive breastfeeding can motivate mothers to have a strong desire to breastfeed their babies as early as possible and continue to provide exclusive breastfeeding for up to six months (Handajani, Pamungkasari and Budihastuti, 2018). This also applies to the toddlers nutritional status. Another appropriate intervention to improve toddlers' nutritional status is to provide complementary feeding. Exclusive breastfeeding, immunization, and balanced

nutrition are strategies to increase children's immunity and prevent infection in children so children under five can avoid the risk of pneumonia (Susanti, 2017; Karmany, Rahardjo and Murti, 2020).

This study has the advantage of depicting the distribution and development of pneumonia among toddlers continuously for three consecutive years, thus showing which areas are most prone to pneumonia in children under five and which areas are less prone. In addition, this study was also able to show which areas were most at risk of pneumonia in toddlers based on risk factors. However, this study has limitations in describing the risk factors analyzed, as there should be many factors that influence pneumonia but this study only described cases based on three factors: malnutrition status, exclusive breastfeeding coverage, and population density. This was influenced by the availability of data obtained by researchers.

CONCLUSIONS

The study's findings lead to the conclusion that the Waru sub-district had a consistently high incidence or prevalence of cases over the last three years. Furthermore, Waru sub-district is also a vulnerable area for pneumonia among toddlers because in addition to high cases, it is also accompanied by high risk factors including low coverage of exclusive breastfeeding, high incidence of undernutrition children, and high population density.

So it can be concluded that intervention programs for preventing and managing pneumonia cases are better prioritized in Waru sub-district. Interventions can be carried out in many ways, such as providing advocacy, socialization, and campaigns for mothers to improve implementation and mothers' knowledge about the importance of exclusive breastfeeding for toddlers while paying attention to the toddlers' nutritional status. Besides that, the right intervention

to improve toddlers' nutritional status is to provide complementary feeding. It can be said that intensifying exclusive breastfeeding, immunization, and balanced nutrition programs is the right strategy to increase children's immunity and prevent infection in children so that children under five are protected from the risk of pneumonia, which can cause death. It is hoped that further research can analyze the correlation of each variable using statistical testing.

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