
Spatial Distribution Of Diarrhea Cases In East Nusa Tenggara 2021-2023

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Abstract

Diarrhea is a public health problem that remains a burden in Indonesia, including in East Nusa Tenggara (NTT) Province, with fluctuating incidence patterns every year. A spatial approach is needed to understand the distribution of cases and variations between regions. This study aims to map the spatial distribution of diarrhea cases and describe regional patterns based on population density and the percentage of open defecation (BABS) in East Nusa Tenggara Province in 2021–2023. This study is an ecological study with a cross-sectional approach using secondary data from the NTT Provincial Health Profile in 2021–2023. The unit of analysis is 22 districts/cities. The dependent variable is the number of diarrhea cases, while the independent variables include population density and the percentage of open defecation. Spatial distribution was carried out using QGIS version 3.28 through visualization of centroid maps and bivariate maps. The number of diarrhea cases in NTT during the 2021–2023 period showed a fluctuating pattern, with an increase in 2022 and a slight decrease in 2023. The distribution of cases was uneven across regions, with several districts such as East Sumba and South Central Timor showing high numbers of cases. Bivariate mapping results showed no consistent pattern between population density, the percentage of open defecation, and the number of diarrhea cases. The distribution of diarrhea cases in NTT showed a pattern that varied across regions and was not always in line with population density or the percentage of open defecation. This indicates that the incidence of diarrhea is multifactorial and influenced by various other factors at the regional level.

Keywords: Open Defecation, Diarrhea, Spatial Distribution, Population Density.

INTRODUCTION

Diarrhea is a condition where an individual defecates three or more times in 24 hours with a more liquid stool consistency, or defecates more frequently than usual. (Anggraini & Kumala, 2022) Diarrhea is caused by bacteria, viruses, and parasites that infect the digestive tract, including *Escherichia coli*, *Giardia lamblia*, and rotavirus as the main causes of diarrhea cases and deaths. (Thystrup et al., 2024).

Globally in 2021, diarrheal disease caused approximately 1.17 million deaths out of 4.67 billion total cases of diarrhea worldwide. (Liu et al., 2025) Diarrheal disease remains a major health problem in developing countries and is related to limited access to clean water, sanitation, and hygiene practices. (A. Ali et al., 2024) 2018 Basic Health Research (Riskesdas) data shows that the prevalence of diarrhea in Indonesia, based on diagnoses by health workers, is 6.8% for all ages. When reporting symptoms of diarrhea is added, the figure reaches 8%. The highest prevalence is among toddlers, at 11.5%. (Ministry of Health, 2018) Meanwhile, based on data from the 2023 Indonesian Health Survey (SKI), the prevalence of diarrhea across all age groups was 4.3%. When reported symptoms are included, the prevalence reaches 7.4%. (Ministry of Health, 2023).

In East Nusa Tenggara (NTT) Province, diarrhea remains a prominent public health problem and is reported annually. The 2022 East Nusa Tenggara (NTT) Provincial Health Profile data shows a significant downward trend in diarrhea cases from 2019 to 2021. (NTT Health Service, 2021) However, in 2022 there was a clear increase in cases again. (NTT Health Service, 2022) This pattern illustrates that despite various management efforts, diarrhea remains a public health challenge in NTT, with fluctuating cases requiring ongoing monitoring.

Some risk factors that cause diarrhea include poor sanitation, unsafe water conditions, and inadequate hand washing practices. (Behera & Mishra, 2022). Transmission of diarrhea can occur through water contaminated with *Escherichia coli* bacteria originating from human feces. (Utami et al., 2023) Diarrhea is transmitted through the fecal-oral route, where germs from feces enter the human body through contaminated water, food, or hands. Therefore, open defecation (ODS) can potentially

increase the risk of diarrhea because it can contaminate the environment, especially water and food sources. Furthermore, population density, along with sanitation conditions and access to health facilities, plays a role in influencing the distribution of diarrhea cases in a region.(Widyastuti et al., 2025)This shows that the higher the population density, the greater the potential for diarrhea transmission due to the high likelihood of contact with contaminated environments.

Diarrhea is an endemic disease in Indonesia that has the potential to cause an Extraordinary Event (KLB) and can be accompanied by death, so it requires special attention in prevention and control efforts.(Freya et al., 2022)To understand the distribution patterns of diarrhea cases, spatial mapping efforts are needed to assist in determining priority areas for treatment. Map creation is part of a Geographic Information System (GIS), which can visually show patterns between variables within a region, the results of which can support more accurate and efficient decision-making.(Akmal, 2023)Based on this, mapping the distribution of diarrhea cases in East Nusa Tenggara Province over a three-year period (2021–2023) is necessary to obtain a more comprehensive picture of the incidence. Using a three-year period allows for the identification of patterns and changes in cases over time. Furthermore, mapping is conducted across all age groups, as diarrhea affects not only toddlers but also adolescents, adults, and the elderly, thus providing a more comprehensive picture of public health conditions.

This study uses a Geographic Information System (GIS)-based bivariate map to depict the distribution of diarrhea cases across all age groups, thus providing a more comprehensive visualization of regional patterns than conventional approaches. Therefore, the purpose of this study is to map the spatial distribution of diarrhea cases and present a bivariate map to identify regional distribution patterns that have a combination of population density and percentage of open defecation (BABS) with the level of diarrhea cases in East Nusa Tenggara Province in 2021–2023.

RESEARCH METHODS

This research is a quantitative ecological study using a cross-sectional approach. The study population comprised all regencies/cities in East Nusa Tenggara (NTT) Province, with a total of 22 regencies/cities serving as the units of analysis. This study is based on secondary data, namely the 2021-2023 NTT Provincial Health Profile, published online through the official website of the NTT Provincial Health Office. The dependent variable is the number of diarrhea cases at the regency/city level. Independent variables include the percentage of areas that have not achieved Open Defecation Free (BABS) status and population density. Population density is calculated as the number of residents divided by the area (people/km²).

Spatial visualization was performed using QGIS version 3.28. Diarrhea cases were visualized using a centroid symbol in the form of a yellow circle with five intervals. The higher the number of diarrhea cases, the larger the centroid size. The centroid intervals were 1–700 cases, 700–1400 cases, 1400–2100 cases, 2100–2800 cases, and 2800–20,000 cases. The combination of population density and the percentage of open defecation was visualized using bivariate analysis. Color gradations indicate the level of each variable. The horizontal axis shows the gradation of the percentage of open defecation from low (light purple) to high (dark purple). While the vertical axis shows the population density from low (light green) to high (dark green). The combination of both colors is used to describe the conditions of each region simultaneously.

RESULTS AND DISCUSSION

The following are the results of mapping the distribution of diarrhea cases based on population density and the percentage of open defecation in NTT based on data obtained from the Health Profile of the East Nusa Tenggara (NTT) Provincial Health Office for 2021-2023 using the QGIS application with centroids and bivariates.

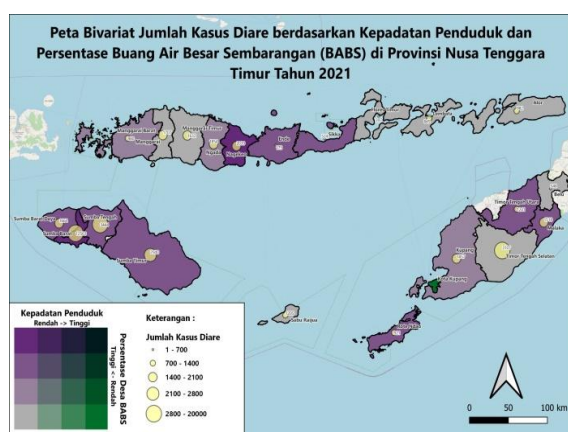


Figure 1. Bivariate Map of the Number of Diarrhea Cases Based on Population Density and Percentage of Open Defecation in East Nusa Tenggara in 2021

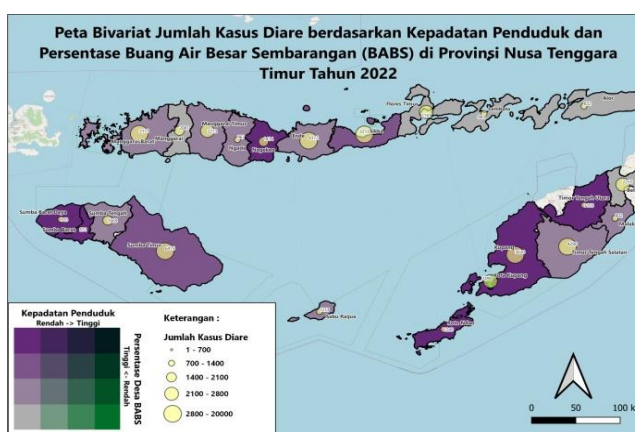


Figure 2. Bivariate Map of the Number of Diarrhea Cases Based on Population Density and Percentage of Open Defecation in East Nusa Tenggara in 2022

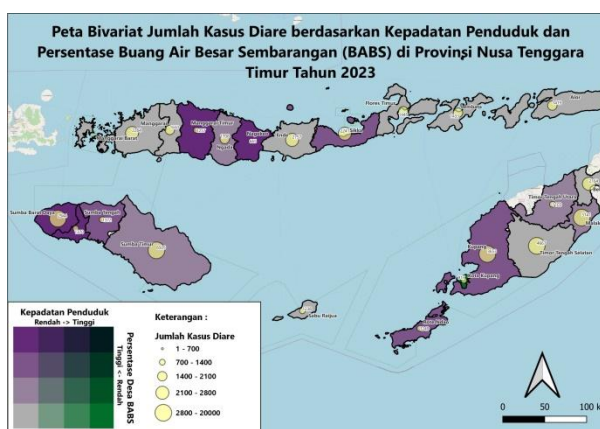


Figure 3. Bivariate Map of the Number of Diarrhea Cases Based on Population Density and Percentage of Open Defecation in East Nusa Tenggara in 2023

Mapping results in 2021 showed the distribution of diarrhea cases in NTT reached 41,603 cases, with the largest concentration in West Sumba. While some areas with high rates of open defecation did not always have high rates. Mapping results in 2022 showed the number of cases increasing to 47,839, with East Sumba recording the highest number of cases, demonstrating that high population density does not always correspond to high rates of diarrhea. Mapping results in 2023 showed 47,060 cases, with East Sumba again being the region with the highest number of cases. This pattern shows variations in the distribution of cases that do not always align with population density or the percentage of open defecation.

The number of diarrhea cases in East Nusa Tenggara (NTT) Province during the 2021–2023 period showed a fluctuating trend. In 2021, cases tended to be concentrated in several regions, with the highest number in West Sumba Regency (12,563 cases), followed by Southwest Sumba (3,444 cases) and South Central Timor (3,107 cases). In 2022, the number of cases increased and the distribution became more evenly distributed across regions. Significant increases occurred in several regencies/cities, such as Ende Regency, which increased from 175 cases to 4,327, and Kupang City,

which previously recorded no cases, increased to 2,496 cases. In 2023, the number of cases generally decreased in several regions, but some regencies, such as East Sumba, still had high case numbers. Overall, the trend of diarrhea cases over the three years showed a fluctuating pattern.

Mapping results show that the distribution of diarrhea cases is uneven across regions. Areas with high case numbers appear to be concentrated in several regencies, such as East Sumba, South Central Timor, and Malaka. Meanwhile, areas with high population densities, such as Kupang City, do not always show high case numbers. Conversely, some areas with low population densities, such as East Sumba, consistently show high case numbers.

Bivariate mapping results show no consistent pattern between population density, open defecation (OD) rates, and diarrhea cases. Some areas with high ODD rates show a high number of cases, while others have similar conditions but relatively low numbers. Furthermore, population density does not always correlate with diarrhea cases, with high-density areas not always reporting a high number of cases.

Discussion

The total number of diarrhea cases in NTT Province fluctuated between 2021 and 2023. The number of cases increased from 2021 to 2022, then decreased slightly in 2023. However, there was no consistent pattern of increase or decrease over the three years. The distribution of cases also showed regional variation, with some districts/cities consistently having high numbers of cases, while others had relatively low numbers. This study's findings align with the concept of disease epidemiology, which states that disease in a population is influenced by various determinants, including environmental conditions and population characteristics. (Pakaya et al., 2025) This statement supports the findings of this study, which found that the distribution of diarrhea cases varies across districts/cities in NTT. These differences in distribution indicate that various factors play a role in each region. Furthermore, although toddlers are the most vulnerable group, diarrhea can affect all age groups, so differences in population characteristics can influence the distribution of diarrhea cases. (Firmansyah et al., 2021).

Transmission of diarrhea can occur through contaminated media such as water, food, and hands, so that in areas with high population density the opportunity for exposure through these media becomes greater and has the potential to accelerate the spread of agents that cause diarrhea. (Stürchler, 2023) However, this condition does not always align with the distribution of cases within a region. The results of the distribution analysis show that population density is not always proportional to the number of diarrhea cases. The number of cases is not always high in several districts/cities with high population density. Conversely, some areas with low population density actually have a high number of cases. This result is consistent with research on the distribution of diarrhea cases in Bali, where although there was an increasing strength of the relationship between population density and diarrhea cases, population density was not statistically significant. (Fadhilah, 2025) Overall, this variation indicates that not all areas with high population density have a high caseload, although in some areas, high population density is accompanied by relatively high cases. The incidence of diarrhea is influenced by various factors such as the quality and availability of clean water, environmental sanitation conditions, including access to adequate latrines, and hygiene behaviors such as handwashing. (Rananda, 2025) Therefore, although high population density can increase the risk of transmission, environmental factors and community hygiene behavior play a more important role in determining the number of diarrhea cases in an area.

Open defecation (BABS) plays a role in increasing the risk of diarrhea because it can contaminate the environment, especially water and food, through the fecal-oral route. (Kamiludin & Azizah, 2025) Poor sanitation conditions allow pathogenic germs from feces to spread and infect humans, thus increasing the incidence of diarrhea. The results of this study indicate that several districts/cities with high rates of open defecation have high total cases of diarrhea. However, lower total cases were also found in districts/cities with high rates of open defecation. In general, not all areas with high rates of open defecation are followed by high cases of diarrhea, although this pattern is found in several districts/cities in NTT. Research (Firdausi et al., 2023) In a study in Sidoarjo

Regency, households with poor defecation practices were 3.58 times more likely to experience diarrhea. Factors contributing to this behavior include knowledge, attitudes, habits, economic status, and toilet ownership. (Yulia et al., 2024) The findings of this study indicate that not all districts/cities with high rates of open defecation are accompanied by high numbers of diarrhea cases. This finding is supported by research in the Bengkulu Community Health Center (Puskesmas) work area, where not all environmental sanitation factors, such as clean water facilities and toilet ownership, are significantly associated with diarrhea incidence. (H. Ali, 2024) This shows that the environment is not always directly related to the occurrence of diarrhea.

CONCLUSION

The distribution of diarrhea cases exhibits a fluctuating pattern, with uneven distribution across districts/cities. Furthermore, no consistent pattern was found between population density and the percentage of open defecation and the number of diarrhea cases. Areas with high population density and percentage of open defecation are not always accompanied by high diarrhea cases. This indicates that diarrhea incidence is multifactorial and influenced not only by population density and open defecation behavior, but also by other regional factors.

The recommendation is that local governments and health agencies in NTT Province continue to implement comprehensive diarrhea control efforts across the region, not solely based on population density or open defecation rates. Furthermore, regional-based monitoring and evaluation should be strengthened to identify other factors contributing to variations in diarrhea cases across districts/cities. Further research is also recommended to consider other, more specific variables at the regional level to more comprehensively explain the distribution of diarrhea cases.

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