

Article

Mapping Of Epidemiological Variabeles For Diarrhea Cases In The Oesapa Community Health Center Working Area In 2024

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Abstract

Background: Diarrhea remains a major public health concern in developing countries like Indonesia, particularly among children under five. **Objectives:** Spatial analysis using Geographic Information Systems (GIS) can help visualize disease patterns, identify risk factors, and guide interventions. **Method:** This descriptive quantitative study employed a spatial mapping approach. A total of 416 diarrhea cases reported in 2024 at Health center Oesapa, Kota Kupang, were included using total sampling. Secondary data were obtained from health records. The dependent variable was diarrhea incidence; independent variables included age, gender, nutritional status, time, and location. **Results:** The results This study was conducted in the working area of Health center Oesapa, which includes five urban villages: Oesapa, Lasiana, Kelapa Lima, Oesapa Barat, and Oesapa Selatan. Based on data from 2024, a total of 416 diarrhea cases were recorded, with uneven distribution across these areas. The highest number of cases was found in Urban village Oesapa, with 160 cases (38.5%), followed by Lasiana with 148 cases (35.6%). Meanwhile, Oesapa Barat recorded 67 cases, Kelapa Lima 32 cases, and Oesapa Selatan had the fewest, with 9 cases. These findings indicate that Oesapa and Lasiana are high-priority areas for diarrhea prevention and control, as they fall into the high distribution category. **Conclusion:** Spatial mapping revealed that age, gender, nutrition, and environmental factors significantly affect diarrhea distribution. GIS provides an effective tool to identify high-risk areas and support targeted public health interventions.

Keywords: *Diarrhea, Spatial analysis, GIS, Epidemiology, Health center Oesapa*

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1. Introduction

Geographic Information System (GIS) is an effective tool for spatial analysis, functioning to identify the relationships between risk factors, disease distribution patterns, and disease autocorrelation, both communicable and non-communicable (World Health Organization, 2021). Diarrhea remains one of the major public health challenges, especially in developing countries like Indonesia. According to WHO, diarrhea is the second leading cause of death among children under five globally and is strongly linked to poor sanitation, inadequate access to clean water, and poor nutritional status in children. From a theoretical standpoint, this study is grounded in the epidemiologic triangle model, which posits that disease occurrence is the result of interaction among three key elements: host, agent, and environment. In the context of diarrhea, the host is primarily children under five with compromised immunity or poor nutritional status, the agent includes enteric pathogens (bacterial, viral, or parasitic), and the environment involves risk factors such as sanitation,

water access, and housing conditions. This model helps explain how environmental determinants influence the distribution and frequency of disease.

Additionally, the use of spatial analysis in public health can be traced back to John Snow's 1854 cholera map, which laid the foundation for modern epidemiology by visually identifying the source of an outbreak. In line with this, GIS enables researchers to visualize disease patterns geographically, providing a more accurate method to identify high-risk clusters, environmental exposures, and inequities in health service access.

This study also draws from the ecological model of health, which emphasizes the multi-level interaction between individuals and their environments, including physical, social, and policy environments. By using GIS as a tool, the study integrates this model to explore how neighborhood-level factors—such as access to clean water, waste management, and housing conditions—interact with individual-level variables to influence the incidence of diarrhea. Through spatial analysis using GIS, the distribution of diarrheal cases can be mapped more precisely by geographic region. This allows for the identification of hotspots, a better understanding of contributing environmental and demographic factors, and the development of targeted, location-specific interventions for disease prevention and control. Based on this background and theoretical framework, the author is interested in studying the epidemiological determinants and spatial distribution of diarrhea cases using a spatial analysis approach in the working area of Health center Oesapa, Kupang City.

2. Materials and Methods

2.1 Study Design and Setting

This study is a quantitative descriptive study using a Geographic Information System (GIS) approach, aimed at illustrating the distribution of diarrhea cases based on epidemiological variables, namely host (human), agent (cause of disease), and environment. The research was conducted in the working area of Health center Oesapa, Kupang City, which includes five urban villages: Oesapa, Lasiana, Kelapa Lima, Oesapa Barat, and Oesapa Selatan. The data collection and analysis were carried out from November to January 2024.

2.2 Population and Sampling

The population in this study consists of all diarrhea patients distributed across one sub-district, Kelapa Lima, totaling 416 individuals, including 215 toddlers, within the working area of the Oesapa Health Center in 2024. The sampling technique used was total sampling, in which the entire population meeting the criteria was included as the study sample.

2.3 Data Collection

The population in this study consists of all diarrhea patients distributed across one sub-district, Kelapa Lima, totaling 416 individuals, including 215 toddlers, within the working area of the Oesapa Health Center in 2024. The sampling technique used was total sampling, in which the entire population meeting the criteria was included as the study sample.

2.4 Variables and Operational Definitions

Diarrhea Incidence : All individuals diagnosed by healthcare workers as suffering from diarrhea in the year 2024. **Age** the age of diarrhea patients calculated from birth until the occurrence of diarrhea, categorized into age groups based on data recorded in birth certificates/family cards/ID cards. **gender** the gender of patients based on data verified from birth certificates/family cards/ID card. **Nutritional Status** the nutritional status of patients measured based on the Weight-for-Age Index (W/A) for toddlers, classified into categories of malnutrition, underweight, normal, or overweight. **Distribution by Time**: Time refers to the period within one year when the diarrhea patient was first treated. **Distribution by Sub-district** the area where the diarrhea patient resides, as recorded on the patient's status card.

2.5 Data Analysis

This study was conducted using a descriptive analysis approach. In this study, descriptive analysis was used to provide an overview and explanation of the incidence rate of diarrhea based on epidemiological variables such as age, gender, nutritional status,

region, and time of occurrence. Spatial analysis was performed using Geographic Information System (GIS) to map and analyze the distribution patterns of diarrhea cases

2.6 Ethical Considerations

This research guarantees the confidentiality of respondents' data by previously receiving approval and filling out informed consent and has obtained Ethical Clearance from the Health Research Ethics. The study was approved by the Health Research Ethics Committee of the Faculty of Public Health, Universitas Nusa Cendana, Kupang, Indonesia, with Ethical Clearance number: 00613/KEPK FKM UNDANA/2025.

3. Results

The working area of Health center Oesapa was selected as the research site. The Oesapa Community Health Center (UPTD Health center Oesapa) covers the entire area of Kelapa Lima Subdistrict, consisting of five urban villages: Oesapa, Kelapa Lima, Oesapa Barat, Oesapa Selatan, and Lasiana. The epidemiological mapping of diarrhea cases conducted in the Health center Oesapa working area revealed variations in the distribution patterns of the disease based on location, age, gender, nutritional status, and time of occurrence. The mapping results indicated that the total number of diarrhea cases in this area reached 416, which were distributed across the five urban villages mentioned above.

Table 1. Total Number of Diarrhea Cases in the Working Area of Oesapa Community Health Center in 2024

NO	Urban Village	Community health center	Total Number of Diarrhea Cases				
			Woman		Man		Woman+ Man
			Total	%	Total	%	
1.	Oesapa	Oesapa	85	53,1	75	46,9	160
2.	Kelapa Lima	Oesapa	15	46,9	17	53,1	32
3.	Oesapa Barat	Oesapa	34	50,7	33	49,3	67
4.	Oesapa Selatan	Oesapa	4	44,4	5	55,6	9
5.	Lasiana	Oesapa	73	49,3	75	50,7	148
TOTAL			211	50,7	205	49,3	416

1) Mapping Results of Diarrhea Case Distribution by Age Group in the Working Area of Oesapa Community Health Center in 2024

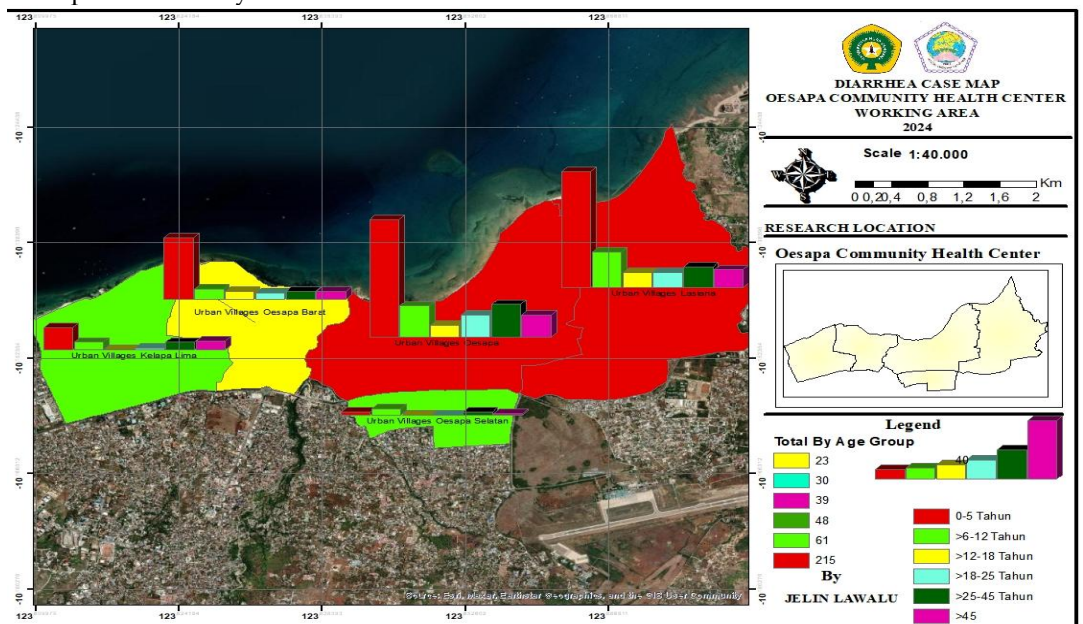


Figure 1. Mapping of Diarrhea Cases by Age Group in the Working Area of Oesapa Community Health Center

Based on data from the five working areas of the Oesapa Community Health Center—namely Urban village Lasiana, Oesapa, Oesapa Barat, Oesapa Selatan, and Kelapa Lima—the mapping of diarrhea cases by age group shows that the 0–5 years age group recorded

the highest number of cases, with 215 cases. This category is marked in red on the map, indicating a very high incidence rate. The second highest number of cases occurred in the 6–12 years age group, with 61 cases, represented in green, indicating a lower incidence compared to the youngest group. Meanwhile, the 25–45 years age group recorded 48 cases, followed by those aged 45 and above with 39 cases. The 18–25 years group had 30 cases, and the 12–18 years group reported the lowest number, with only 23 cases. The map clearly indicates that children under five years old are the most vulnerable to diarrhea and therefore require special attention in public health interventions.

Table 2. Total Number of Diarrhea Cases by Gender in the Working Area of Oesapa Community Health Center in 2024

NO	Urban Village	Community health center	Total Number of Diarrhea Cases				
			Woman		Man		Woman + Man
			Total	%	Total	%	
1.	Oesapa	Oesapa	85	53,1	75	46,9	160
2.	Kelapa Lima	Oesapa	15	46,9	17	53,1	32
3.	Oesapa Barat	Oesapa	34	50,7	33	49,3	67
4.	Oesapa Selatan	Oesapa	4	44,4	5	55,6	9
5.	Lasiana	Oesapa	73	49,3	75	50,7	148
Total			211	50,7	205	49,3	416

The diarrhea case data recorded at the Oesapa Community Health Center shows that 211 cases (50.7%) occurred in females, while 205 cases (49.3%) were reported in males. This indicates that, overall, females experienced slightly more diarrhea cases than males, although the difference is not particularly significant. Despite the small gap in case numbers between females and males in the Oesapa Health Center’s working area, several factors may contribute to the higher number of cases among females. These include household roles, frequent contact with sick children, biological differences, and dietary patterns and hygiene practices.

2) Mapping Results of Diarrhea Case Distribution by Gender in the Working Area of Oesapa Community Health Center in 2024

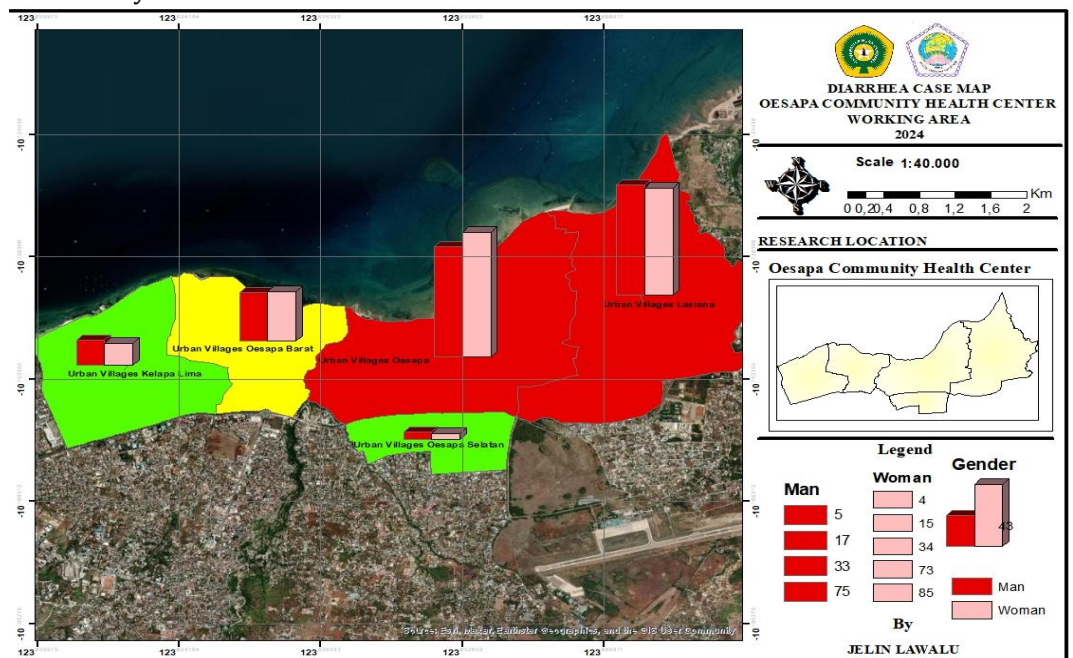


Figure 2. Mapping of Diarrhea Cases by Gender in the Working Area of Oesapa Community Health Center

Based on data from the five working areas of the Oesapa Community Health Center, which include Urban village Lasiana, Oesapa, Oesapa Barat, Oesapa Selatan, and Kelapa Lima, the mapping of diarrhea cases by gender shows that females recorded the highest number of cases, with a total of 215 cases, while males accounted for 205 cases. Although the difference in case numbers between males and females is relatively small, the findings

suggest that females may be slightly more vulnerable to diarrhea in this area. This disparity could be influenced by several factors, such as the domestic roles of women, increased exposure to sick children, biological differences, and behavioral aspects related to consumption and hygiene practices. The distribution map further supports this observation, with cases among both genders spread across all five urban villages, showing higher intensity in areas with denser populations and inadequate environmental sanitation.

Table 3. Total Number of Diarrhea Cases by Nutritional Status in the Working Area of Oesapa Community Health Center in 2024

No	Urban Village	Nutritional Status		
		Stunting	Wasting	Underweight
1.	Oesapa	3.254	2.658	3.715
2.	Kelapa Lima	1.340	1.171	1.656
3.	Oesapa Barat	1.794	1.303	2.058
4.	Oesapa Selatan	341	296	399
5.	Lasiana	3.125	2.003	3.138

Table 3 shows that the number of diarrhea cases in the working area of Oesapa Community Health Center in 2024 is closely related to the nutritional status of the population, which is categorized into three main conditions: stunting (short stature due to chronic malnutrition), wasting (low weight-for-height), and underweight (low weight-for-age). According to the recorded data:

Urban village Oesapa reported the highest number of cases in all categories, with 3,254 cases of stunting, 2,658 cases of wasting, and 3,715 cases of underweight. Urban village Lasiana also showed significantly high figures, with 3,125 stunting cases, 2,003 wasting cases, and 3,138 underweight cases. Urban village Oesapa Barat recorded 1,794 stunting cases, 1,303 wasting cases, and 2,058 underweight cases. Urban village Kelapa Lima had lower numbers, with 1,340 cases of stunting, 1,171 cases of wasting, and 1,656 cases of underweight. Urban village Oesapa Selatan reported the lowest figures, with 341 stunting cases, 296 wasting cases, and 399 underweight cases. Overall, the high number of diarrhea cases in several urban villages is strongly associated with poor nutritional status. Children suffering from stunting, wasting, or underweight tend to have weakened immune systems, making them more vulnerable to infectious diseases, including diarrhea.

3) Mapping Results of Diarrhea Case Distribution by Nutritional Status in the Working Area of Oesapa Community Health Center in 2024

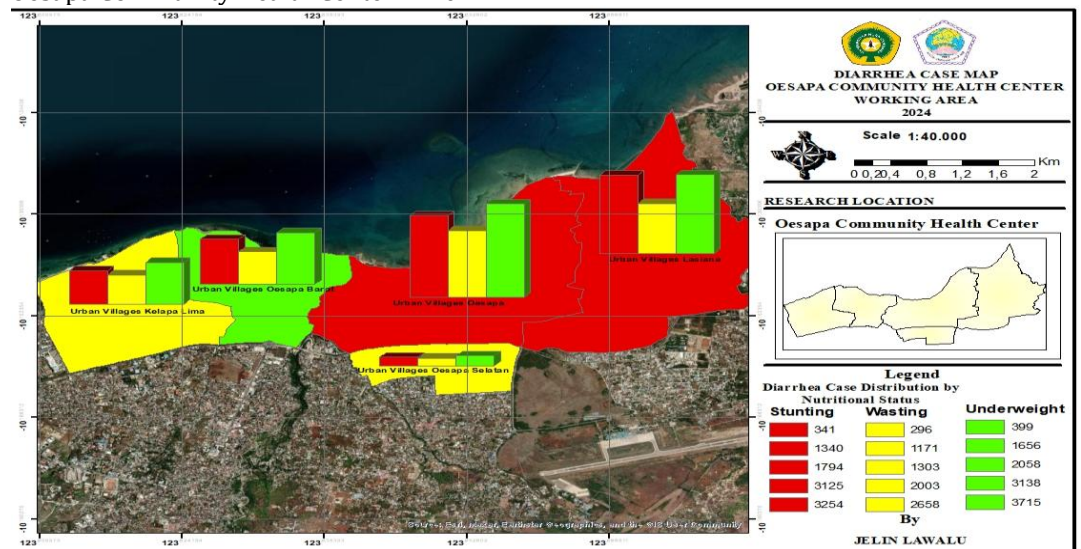


Figure 3. Mapping of Diarrhea Cases by Nutritional Status in the Working Area of Oesapa Community Health Center

The map of diarrhea case distribution by nutritional status in the working area of Oesapa Community Health Center in 2024 illustrates a correlation between the community's nutritional conditions and the number of recorded diarrhea cases. The case

classification is divided into three categories based on the number of cases: low, moderate, and high, which are represented by the colors green, yellow, and red, respectively.

Table 4. Total Number of Diarrhea Cases by Time Distribution in the Working Area of Oesapa Community Health Center in 2024

No	Urban Village	Time												Tot
		Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agu	Sept	Okt	Nov	De	
1.	Oesapa	17	15	20	9	9	6	17	25	14	16	8	4	160
2.	Kelapa Lima	0	5	9	1	0	1	2	6	5	2	1	0	32
3.	Oesapa Barat	3	4	2	2	6	5	8	14	11	5	4	3	67
4.	Oesapa Selatan	0	1	1	0	2	0	2	0	1	1	1	0	9
5.	Lasiana	23	35	11	4	5	2	10	14	10	17	8	9	148
Total Number of Diarrhea Cases														416

Table 4 shows the distribution of diarrhea cases in the working area of Oesapa Community Health Center in 2024, revealing a fluctuating pattern throughout the year. Out of a total of 416 cases, several months experienced notable spikes, while others recorded relatively lower numbers. Overall, the months of January, February, March, and August represented the periods with the highest number of diarrhea cases. Urban village Lasiana recorded the highest spikes in January (23 cases) and February (35 cases), while Urban village Oesapa showed significant increases in March (20 cases) and August (25 cases). This pattern is likely influenced by environmental factors, particularly the rainy season, which heightens the risk of water and food contamination, accelerating the spread of diarrheal diseases. The number of cases tended to decrease during certain months, such as June and December, when most urban villages recorded lower figures. For instance, Urban village Oesapa reported only 6 cases in June and 4 cases in December, suggesting the presence of seasonal factors affecting diarrhea transmission.

By area, Urban Vilagges Oesapa recorded the highest number of cases throughout the year, totaling 160 cases, followed by Urban village Lasiana with 148 cases. The high numbers in these areas may indicate inadequate sanitation or limited access to clean water, increasing the risk of diarrhea. Meanwhile, Urban village Oesapa Barat reported 67 cases, with the highest spike in August (14 cases). Urban village Kelapa Lima recorded a total of 32 cases, with the peak occurring in March (9 cases) and August (6 cases). In contrast, Urban village Oesapa Selatan had the lowest number of cases, with only 9 cases throughout the year, and no cases recorded in April, July, or December, suggesting that sanitation and clean water access in this area may be relatively better than in other villages.

4) Mapping Results of Diarrhea Case Distribution by Time (Temporal Distribution) in the Working Area of Oesapa Community Health Center in 2024

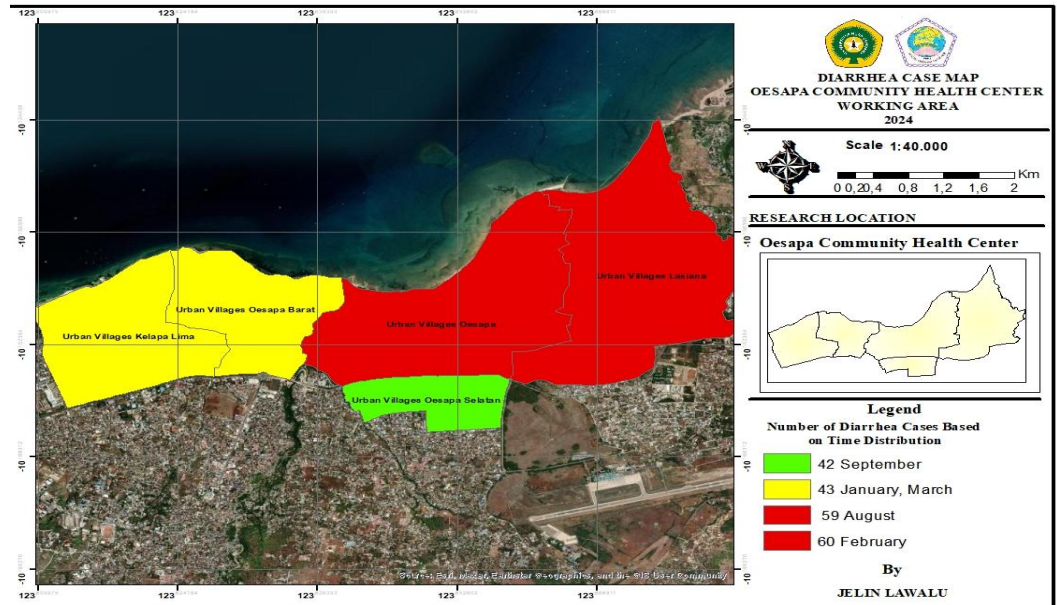


Figure 4. Mapping of Diarrhea Cases Based on Temporal Distribution in the Working Area of Oesapa Community Health Center

Based on data from the five working areas of Health Center Oesapa namely Urban village Lasiana, Oesapa, Oesapa Barat, Oesapa Selatan, and Kelapa Lima the mapping of diarrhea cases by time of occurrence over the course of one year shows a fluctuating distribution pattern. The highest number of cases was recorded in February, with a total of 60 cases. This was followed by August, with 59 cases, and both January and March, each reporting 43 cases. Meanwhile, September recorded 42 cases. This pattern indicates that increases in diarrhea cases tend to occur during the early and mid-year periods. Such trends are likely influenced by seasonal factors, particularly the rainy season, which can worsen environmental sanitation and elevate the risk of water and food contamination. Therefore, environmental health monitoring and preventive measures should be strengthened during these high-risk periods to help reduce diarrhea incidence in the Oesapa Community Health Center’s working areas.

5) Mapping Results of Diarrhea Case Distribution Based on the Area of Occurrence in the Working Area of Oesapa Community Health Center in 2024

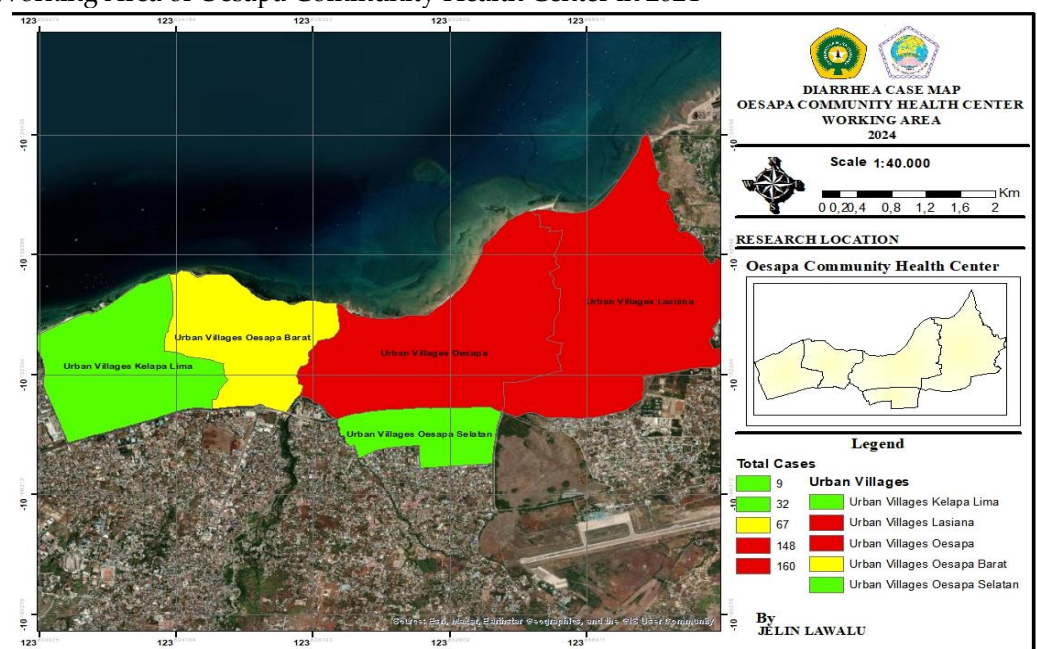


Figure 5. Mapping of Diarrhea Case Distribution Based on the Area of Occurrence in the Working Area of Oesapa Community Health Center in 2024

Based on data from the five working areas of Oesapa Community Health Center, which include Urban village Lasiana, Oesapa, Oesapa Barat, Oesapa Selatan, and Kelapa Lima, a total of 416 diarrhea cases were recorded in 2024. The spatial mapping of case distribution showed that Urban village Oesapa had the highest number of cases, with 160 cases, followed by Urban village Lasiana with 148 cases. These two areas are marked in red on the map, indicating a high incidence rate. Meanwhile, Urban village Oesapa Barat recorded 67 cases and is categorized as a moderate-risk area, represented in yellow. Urban village Kelapa Lima had 32 cases, and Urban village Oesapa Selatan recorded the fewest cases, with only 9 cases. Both of these areas fall under the low incidence category and are marked in green on the map. This mapping indicates that Urban village Oesapa and Lasiana should be prioritized for diarrhea prevention and control efforts due to their high case concentrations.

4. Discussion

Health center Oesapa is one of the community health centers in Kupang City, East Nusa Tenggara Province, serving several urban villages with a population that continues to increase every year. The working area of Health center Oesapa includes the urban villages of Oesapa, Oesapa Barat, Oesapa Selatan, Lasiana, and Kelapa Lima, which have varying population densities. Population density is calculated based on the number of residents living in an area compared to the area's size in square kilometers.

Data collection by Health center Oesapa shows that diarrhea remains one of the dominant diseases spreading across all urban villages in its working area. High population density, combined with suboptimal environmental sanitation, contributes significantly to the high incidence of diarrhea. Therefore, continuous monitoring and targeted public health interventions are necessary in areas with the highest case burden.

1. Distribution of Diarrhea Cases by Age

Diarrhea is still a significant public health problem, especially in areas with inadequate sanitation. Based on mapping results at the research location, Oesapa urban village in Kelapa Lima subdistrict, Kupang City, diarrhea cases were mostly found in children. Children are the most vulnerable group to gastrointestinal infections, particularly when their living environment is unhealthy. One of the main causes of diarrhea in children in this area is contamination of clean water sourced from community wells. Many wells are located very close to open waste disposal sites. This proximity allows organic waste to seep into the soil and contaminate the well water with harmful microorganisms such as *Escherichia coli*. Since well water is used for drinking, cooking, and household needs, children who consume or are exposed to this water are at high risk of diarrhea. Furthermore, improper household waste disposal worsens the situation. Liquid waste, such as used wash water and bathwater, is dumped carelessly into open drains or directly into the surrounding environment. This causes stagnant water and damp conditions that create ideal breeding grounds for various pathogens and disease vectors such as flies. The dirty environment is further exacerbated by communal water use, where one well is shared by many households without proper supervision or water treatment systems. When many people use the same water source without maintaining hygiene, the potential for disease transmission increases. This water is often used to serve food and drinks to children without prior heating or sterilization.

This aligns with research by Yantu Sintia (2021) on the relationship between clean water facilities and household latrines with diarrhea incidence in toddlers in Waleure village, which found that inadequate clean water facilities—with cracked walls and floors, lack of covers, and proximity to pollution sources under 10 meters—allow bacteria and germs to enter wells and cause diarrhea in toddlers. The large presence of flies around open waste disposal sites also contributes to diarrhea transmission. Flies often land on waste and then move to food or eating utensils used by children, indirectly transferring pathogenic germs to children's digestive systems, whose immune systems are not yet fully developed. Children generally play around the house without full parental supervision. They often

touch soil and dirty objects and then put their hands or those objects into their mouths. This behavior is a main route for diarrhea-causing germs to enter children's bodies. All these factors contribute to the high number of diarrhea cases in children in this area. This is consistent with World Health Organization (WHO) data stating diarrhea is the third leading cause of death among children aged 1–59 months globally. In Indonesia, the Ministry of Health records the highest diarrhea incidence in children under two years old, which tends to decrease with age. Therefore, addressing diarrhea in children cannot focus solely on treatment but must start with improving environmental sanitation, providing clean water, and increasing community awareness about the importance of clean and healthy living behaviors, especially for families with young children.

2. Distribution of Diarrhea Cases by Gender

Based on mapping and analysis of diarrhea cases by gender in Oesapa urban village, the number of cases in girls was higher than in boys. Of the total 416 recorded cases, 211 cases (50.7%) occurred in girls, while 205 cases (49.3%) occurred in boys. Several factors may increase diarrhea risk in girls, one of which is their social role within the home environment. Girls are often involved in light domestic activities from an early age, such as helping their mothers clean the house, wash clothes, or handle food. More frequent interaction with potentially unhygienic environments increases the likelihood of exposure to diarrhea-causing pathogens such as bacteria, viruses, and parasites. However, it should be emphasized that gender itself does not directly influence diarrhea occurrence. The difference in case numbers between girls and boys is more influenced by environmental, social, and behavioral factors, not biological gender. In other words, the risk of diarrhea depends more on exposure levels to infectious agents and sanitation conditions than on gender itself.

3. Distribution of Diarrhea Cases by Nutritional Status

The distribution of diarrhea cases by nutritional status shows a close relationship between malnutrition and diarrhea incidence. WHO emphasizes that malnourished children are at highest risk of severe diarrhea. Immunological studies show that malnutrition, especially protein-energy deficiency, weakens immune responses and damages intestinal mucosal defenses, causing malnourished children to suffer more frequent and severe diarrhea. This condition aligns with the vicious cycle concept of malnutrition-infection, where chronic diarrhea reduces nutrient absorption, while poor nutritional status worsens infection severity. Spatial analysis mapping of cases by nutritional status category shows high clusters in urban villages with higher malnutrition prevalence. This spatial approach is useful for identifying malnutrition-prone areas so that nutritional interventions such as supplementation or education can be targeted, consistent with the social determinants of health framework that places nutritional status as a key determinant of epidemiological vulnerability.

4. Distribution of Diarrhea Cases by Time

According to 2024 data from Health center Oesapa, Oesapa urban village recorded the highest diarrhea cases with 160 cases. The cases show a seasonal pattern with peaks in August and March, likely related to changing environmental conditions and water source hygiene (WHO, 2023). The types of diarrhea-causing pathogens vary by season. Bacteria and parasites tend to increase during the rainy season due to damp conditions favoring microbial growth, while viruses like rotavirus occur more often during the dry season when access to clean water decreases (WHO, 2023). This seasonal pattern highlights the importance of health interventions focusing on improving sanitation and clean water access especially before and during the rainy season to reduce diarrhea incidence (WHO, 2023).

5. Distribution of Diarrhea Cases by Urban Village

Spatial mapping shows clear clustering of diarrhea cases in the Health center Oesapa working area. Oesapa and Lasiana urban villages appear in red, indicating high case numbers, while Kelapa Lima and Oesapa Selatan show lower case numbers. This pattern is

consistent with spatial epidemiology principles that disease cases tend to form geographic clusters. For example, the positive global spatial autocorrelation index Moran's I indicates that areas with high case numbers cluster close to each other. Local cluster analysis techniques such as Getis-Ord Gi or spatial scan statistics can confirm hotspots or areas with significantly higher disease concentrations compared to surrounding areas. A study in Ghana found that excess diarrhea cases clustered significantly, especially in peri-urban areas. Such spatial findings underscore the importance of a place-based approach considering local environmental factors such as population density, sanitation, and land use patterns which likely influence regional differences. Spatial analysis using GIS enables precise identification of high-risk areas so public health interventions can be focused on cluster areas to improve sanitation in red zones, increasing the efficiency of diarrhea control programs.

5. Conclusions

Summarize the main findings, reassert their importance, and provide a concise, evidence-based conclusion. Avoid overstating results or making policy recommendations unsupported by the data. Emphasize contributions to knowledge and suggest actionable recommendations only where justified.

6. Acknowledgments

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7. Conflicts of Interest

I hereby declare that there is no conflict of interest where this research is carried out without commercial and financial considerations that can be potential conflicts of interest in the future.

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