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Mapping of Syphilis Cases Using Geographic Information System (GIS) in Denpasar City in 2024

I Wayan Laksamana Putra Adinatha*, Nyoman Ngurah Adisanjaya, Rai Riska Resty Wasita, Putu Okta Wijayanti
Universitas Dhyana Pura, Indonesia
Email: laksamanaputra568@gmail.com*, adisanjaya@undhirabali.ac.id, riskaresty@undhirabali.ac.id, oktawijayanti@undhirabali.ac.id

Abstract. Cases of sexually transmitted infections (STIs), especially syphilis, continue to show an increase in various regions of Indonesia, including Denpasar City. This disease not only causes serious medical impacts but also has implications for social aspects and community productivity. This study was conducted with the aim of describing the distribution pattern and classifying syphilis cases in Denpasar City in 2024 through a Geographic Information System (GIS) approach. The study used a quantitative method with a descriptive design. Secondary data analyzed amounted to 297 cases, obtained from the Denpasar City Health Office and the *Kerti Praja* Foundation, with a research sample of 170 cases based on the calculation of the Slovin formula. Patient location points were determined through address data converted to GPS coordinates, then processed using ArcView 3.3 software to produce distribution maps and classification of cases using the Kingma method. The results indicated that there were 170 cases of syphilis in four regions. The highest number of cases was recorded in South Denpasar with 85 cases (high category), followed by West Denpasar with 52 cases (medium category), while North Denpasar had 22 cases and East Denpasar had 11 cases (both low category). The majority of cases were found in the productive age group of 26-45 years, followed by the age group of 12-25 years. In addition, cases occurred more frequently in men (136 cases) than in women (34 cases). This mapping is expected to serve as a basis for developing more targeted prevention strategies and health interventions, especially for productive and vulnerable age groups.

Keywords: Syphilis, Sexually Transmitted Infections, Geographic Information System, Case Mapping, Denpasar City

INTRODUCTION

Sexually Transmitted Infections (STIs) are one of the global public health challenges that have shown an increasing trend in recent years. One of the STIs that is again a major concern is syphilis, whose prevalence has increased significantly in various regions, including Indonesia. Based on data from the Ministry of Health of the Republic of Indonesia (*Kemenkes RI*, 2023), there is a surge in syphilis cases nationally, which is also reflected in the Denpasar City area. This increase in cases demonstrates the need for evidence-based and location-based intervention approaches to effectively understand and control the spread of disease.

The causes of syphilis can be attributed to several factors, including risky sexual behaviors, lack of knowledge about sexual health, and social stigma that discourages individuals from seeking treatment. According to research by Hidayati et al. (2021), these factors contribute to the increasing prevalence of syphilis among the young population in Indonesia, which points to the need for better education and interventions in sexual health.

The impact of the increase in syphilis cases on the community is significant, including an increase in the economic burden on the health system, social stigma on infected individuals, and psychological impacts that can affect quality of life. Research by Sari et al. (2022) shows that an increase in syphilis cases can lead to an increase in mortality and morbidity, as well as a decrease in the productivity of the community as a whole.

According to data from the Ministry of Health of the Republic of Indonesia, syphilis cases in Indonesia from January to September 2024 recorded 8,984 cases, with 216 cases occurring in children under the age of 15. Meanwhile, the Ministry of Health of Bali Province recorded 1,011 cases from January to September 2024, with distribution by age: 25–49 years (648 cases), 20–24 years (261 cases), 15–19 years (68 cases), 50 years and older (28 cases), 0–4 years (5 cases), and 5–14 years (1 case).

Geographic Information Systems (GIS) have a very important role in the world of health, especially in the monitoring and control of infectious diseases. GIS provides the ability to map the spread of diseases spatially, identify high-risk areas, and analyze the relationship between environmental factors and disease incidence. Through GIS, decision-making in health policy can be done more effectively because it is supported by accurate and location-based visual information. This technology also enables the implementation of more efficient, focused, and targeted health interventions (Thamsi & Wakila, 2024; Hidayat & Putera, 2024).

Several studies have shown the application of spatial analysis to understand the spread of syphilis cases in various cities in Indonesia. In Surabaya, Rahmawati (2021) found a concentration of syphilis cases in areas with high population density, showing a relationship between the urban environment and the increase in cases. In Makassar, research by Sukarna et al. (2020) revealed an uneven spatial pattern in the distribution of infectious diseases, including syphilis, which shows the importance of location-based monitoring. Meanwhile, in Yogyakarta, the results of a study by Sudaryanto (2021) noted the link between socioeconomic factors and the distribution of syphilis cases, with the use of GIS for mapping priority intervention areas.

In Denpasar City itself, syphilis cases show an increasing trend that deserves attention. Based on data from the Denpasar City Health Office, in 2022 there were 315 cases of syphilis. This figure increased to 437 cases in 2023, and until the first semester of 2024, there were 259 cases. This surge underscores the need for a more in-depth analysis of the geographic distribution patterns of cases.

The efforts of the Denpasar City Health Office in dealing with the increase in syphilis cases include increasing sexual health education programs, providing more accessible health services, and campaigns to reduce stigma against infected individuals. According to the annual report of the Denpasar City Health Office (2023), these measures are expected to reduce the number of syphilis cases in the region.

Thus, research on mapping syphilis cases in Denpasar City in 2024 using the GIS approach is very important. This research not only provides a visual overview and analysis of the spread of the disease, but can also be used as a basis for making more targeted and sustainable public health policies.

Based on the background described above, the researcher wants to conduct research entitled "Mapping syphilis cases using the Geographic Information System (GIS) in Denpasar City in 2024."

The formulation of this research problem focuses on two main things, namely how syphilis disease will be distributed in Denpasar City in 2024 and how to classify the spread of the disease. This study aims generally to describe the distribution of syphilis cases with a Geographic Information System (GIS) based approach, and specifically to map the spread and determine the classification of syphilis cases in Denpasar City in 2024.

The benefits of this research are expected to help the Denpasar City Health Office in obtaining spatial information about syphilis cases in order to reduce morbidity rates through more targeted promotive and preventive strategies. For the author, this study expands insights related to the use of GIS in health data management, while for educational institutions, the results of the research can be a scientific reference to support the development of science in the field of medical records and the application of spatial-based health information technology.

RESEARCH METHOD

This study uses a quantitative approach with a descriptive design to describe the distribution of syphilis cases in[A1] Denpasar City in 2024. Secondary data of 297 cases were obtained from the Health Office and the *Kerti Praja* Foundation, with a sample of 170 cases using the Slovin formula and proportional allocation. The research location covers the entire Denpasar City area during the January-December 2024 period. The research instruments include GPS, ArcView, and observation applications. The research procedure consists of the preparation stage (literature study and licensing), implementation stage (collection of medical record data and determination of coordinates), and the final stage (analysis and mapping of cases with GIS). Data were collected through official reports, then processed using GIS to create thematic maps, regional classification, and interpretation of distribution patterns. Univariate analysis was conducted to describe the distribution of age, sex, and number of cases, both statistically and graphically.

RESULTS OF RESEARCH AND DISCUSSION

Mapping of Syphilis Disease in Denpasar City in 2024

Syphilis cases occurred in the Denpasar city regency area, of the 170 samples of syphilis cases, the highest cases were in South Denpasar district, which was 85 cases of Syphilis, 52 cases of West Denpasar District, 22 cases of North Denpasar District, and 11 cases of East Denpasar. The distribution of Pulmonary TB cases is described in table 5.1 as follows:

Table 1. Distribution of Syphilis Cases in Denpasar City in 2024 and Coordinate Points of Patient Locations

District	Syphilis Cases	Coordinate	
		X	And
South Denpasar	85	115.2123xxx	-8.687727xxx
		115.2350xxx	-8.70199xxx
		115.255xxx	-8.702529xxx
		115.2211xxx	-8.68232xxx
		115.2161xxx	-8.692939xxx
		115.21xxx	-8.679914xxx
		115.2242xxx	-8.682893xxx
		115.1896xxx	-8.714501xxx

District	Syphilis Cases	Coordinate	
		X	And
		115.2253xxx	-8.700025xxx
		115.2406xxx	-8.701659xxx
		115.2363xxx	-8.679842xxx
		115.2385xxx	-8.66569xxx
		115.1877xxx	-8.720152xxx
		115.2172xxx	-8.692978xxx
		115.2227xxx	-8.692980xxx
		115.2392xxx	-8.67630xxx
		115.2171xxx	-8.680364xxx
		115.2164xxx	-8.684302xxx
		115.2532xxx	-8.706031xxx
		115.2204xxx	-8.681439xxx
		115.204xxx	-8.701213xxx
		115.2425xxx	-8.687040xxx
		115.242xxx	-8.674839xxx
		115.1925xxx	-8.697368xxx
		115.2063xxx	-8.685118xxx
		115.2237xxx	-8.698662xxx
		115.2565xxx	-8.686916xxx
		115.2271xxx	-8.700299xxx
		115.2378xxx	-8.705043xxx
		115.2430xxx	-8.704838xxx
		115.2393xxx	-8.676213xxx
		115.2537xxx	-8.705466xxx
		115.1878xxx	-8.720131xxx
		115.2434xxx	-8.686628xxx
		115.2286xxx	-8.678704xxx
		115.2543xxx	-8.705289xxx
		115.2543xxx	-8.705289xxx
		115.2545xxx	-8.706335xxx
		115.2183xxx	-8.695705xxx
		115.1919xxx	-8.693973xxx
		115.1927xxx	-8.702440xxx
		115.2229xxx	-8.704342xxx
		115.2529xxx	-8.706962xxx
		115.2242xxx	-8.682956xxx
		115.1925xxx	-8.697315xxx
		115.1929xxx	-8.70299xxx
		115.2392xxx	-8.691909xxx
		115.2133xxx	-8.703488xxx
		115.1908xxx	-8.705718xxx
		115.242xxx	-8.687135xxx
		115.2303xxx	-8.694084xxx
		115.2201xxx	-8.692335xxx
		115.1925xxx	-8.697304xxx
		115.2252xxx	-8.696411xxx
		115.2393xxx	-8.676191xxx
		115.243xxx	-8.704785xxx

District	Syphilis Cases	Coordinate	
		X	And
		115.2426xxx	-8.687050xxx
		115.2163xxx	-8.684207xxx
		115.2078xxx	-8.7102xxx
		115.2293xxx	-8.70266xxx
		115.247xxx	-8.680947xxx
		115.2536xxx	-8.705466xxx
		115.2177xxx	-8.685095xxx
		115.1913xxx	-8.698217xxx
		115.2228xxx	-8.704395xxx
		115.2340xxx	-8.683691xxx
		115.1945xxx	-8.692759xxx
		115.2430xxx	-8.704806xxx
		115.2064xxx	-8.685065xxx
		115.2554xxx	-8.679766xxx
		115.2257xxx	-8.7009xxx
		115.2256xxx	-8.7010xxx
		115.2444xxx	-8.704503xxx
		115.2304xxx	-8.694105xxx
		115.2189xxx	-8.697457xxx
		115.2331xxx	-8.707543xxx
		115.2407xxx	-8.704355xxx
		115.2551xxx	-8.671593xxx
		115.2338xxx	-8.686616xxx
		115.2573xxx	-8.704863xxx
		115.2293xxx	-8.702597xxx
		115.2551xxx	-8.678046xxx
		115.229xxx	-8.70589xxx
		115.2250xxx	-8.71120xxx
		115.2163xxx	-8.684302xxx
West Denpasar	52	115.2223xxx	-8.680162xxx
		115.1990xxx	-8.655643xxx
		115.2261xxx	-8.685863xxx
		115.1970xxx	-8.66236xxx
		115.1773xxx	-8.684609xxx
		115.1774xxx	-8.684535xxx
		115.1872xxx	-8.62405xxx
		115.1858xxx	-8.67452xxx
		115.1986xxx	-8.678455xxx
		115.2043xxx	-8.65902xxx
		115.1966xxx	-8.682032xxx
		115.2182xxx	-8.659625xxx
		115.1860xxx	-8.627246xxx
		115.1890xxx	-8.644753xxx
		115.2040xxx	-8.682493xxx
		115. 1992xxx	-8.684831xxx
		115.2165xxx	-8. Ref: 659775xxx
		115.1842xxx	-8.679808xxx
		115.1853xxx	-8.67860xxx

District	Syphilis Cases	Coordinate	
		X	And
		115.1874xxx	-8.62613xxx
		115.196xxx	-8.682106xxx
		115.2146xxx	-8.66336xxx
		115.1878xxx	-8.684039xxx
		115.2223xxx	-8.680236xxx
		115.1986xxx	-8.679455xxx
		115.1840xxx	-8.700883xxx
		115.1949xxx	-8.66282xxx
		115.2182xxx	-8.659731xxx
		115.2286xxx	-8.685466xxx
		115.1693xxx	-8.683266xxx
		115.1723xxx	-8.682936xxx
		115.1810xxx	-8.684902xxx
		115.2280xxx	-8.690334xxx
		115.2087xxx	-8.677519xxx
		115.1998xxx	-8.675453xxx
		115.2044xxx	-8.659059xxx
		115.1891xxx	-8.64476xxx
		115.1835xxx	-8.631665xxx
		115.1965xxx	-8.659475xxx
		115.230xxx	-8.68253xxx
		115.2276xxx	-8.684217xxx
		115.1877xxx	-8.684124xxx
		115.1837xxx	-8.700904xxx
		115.2022xxx	-8.682805xxx
		115.213xxx	-8.664060xxx
		115.1996xxx	-8.677973xxx
		115.172xxx	-8.682926xxx
		115.1897xxx	-8.652103xxx
		115.1903xxx	-8.681490xxx
		115.1857xxx	-8.674651xxx
		115.182xxx	-8.654770xxx
		115.1949xxx	-8.662726xxx
North Denpasar	22	115.2161xxx	-8.639778xxx
		115.2134xxx	-8.649107xxx
		115.2020xxx	-8.617736xxx
		115.2178xxx	-8.648914xxx
		115.2185xxx	-8.637946xxx
		115.2328xxx	-8.636937xxx
		115.2263xxx	-8.637007xxx
		115.1951xxx	-8.634676xxx
		115.2247xxx	-8.641345xxx
		115.2135xxx	-8.649096xxx
		115.2181xxx	-8.645996xxx
		115.2263xxx	-8.636996xxx
		115.2144xxx	-8.648812xxx
		115.2136xxx	-8.649054xxx
		115.2137xxx	-8.636946xxx

District	Syphilis Cases	Coordinate	
		X	And
		115.2122xxx	-8.642033xxx
		115.2284xxx	-8.616437xxx
		115.1915xxx	-8.628884xxx
		115.2262xxx	-8.637007xxx
		115.2208xxx	-8.624232xxx
		115.2136xxx	-8.6490xxx
		115.2204xxx	-8.636484xxx
East Denpasar	11	115.2632xxx	-8.660902xxx
		115.2604xxx	-8.655085xxx
		115.2495xxx	-8.660306xxx
		115.2595xxx	-8.662711xxx
		115.2308xxx	-8.635451xxx
		115.2296xxx	-8.648714xxx
		115.2492xxx	-8.665834xxx
		115.2300xxx	8.650080xxx
		115.2297xxx	-8.652898xxx
		115.227xxx	-8.663255xxx
		115.2240xxx	-8.658523xxx

Based on data on the distribution of syphilis cases in Denpasar City, namely South Denpasar District 85 cases, West Denpasar District 52 cases, North Denpasar District 22 cases and East Denpasar District 11 cases. The number of cases in Southwest Sumba Regency in 2024 will be 250 cases that occurred in 11 sub-districts.

Classification of the Spread of Spilis Cases in Denpasar City

From the distribution of syphilis cases in Denpasar City in 2024, it is classified into several classes. To find the Classification of the distance (Range) of the class, the class interval formula (Kingma formula) is used with the following calculations:

$$K = \frac{X_t - X_r}{i} = \frac{85 - 11}{3} = \frac{74}{3} = 25 \text{ kasus}$$

From the results of the calculation of the classification above, a table of disease distribution was obtained which was classified into 3 categories, namely high, medium to low classification, where this classification was obtained from a spatial map using the ArcView geographic information system. Therefore, each class has a range of 25 cases. The classification of syphilis cases:

Table 2. Classification of Syphilis Cases in Denpasar City in 2024

No	District	Syphilis Cases	Classification
1	South Denpasar	85	Tall
2	West Denpasar	52	Keep
3	North Denpasar	22	Low
4	East Denpasar	11	Low

Discussion

Classification of Syphilis Cases in Denpasar City in 2024 Based on Age and Gender

Syphilis is a sexually transmitted infection that can affect individuals of different ages and genders. Research shows that the risk factors for the occurrence of syphilis are strongly influenced by age, where young age groups, especially adolescents and adults, have a higher prevalence. This is due to risky sexual behaviors, lack of knowledge about sexual health, and limited access to health services. According to research by Sari et al. (2021), individuals aged 15-24 years have a higher risk of being infected with syphilis compared to older age groups.

In addition to age, gender also plays an important role in determining the risk of developing syphilis. The data shows that men, especially those who have sex with men (MSM), have higher infection rates than women. Research by Pratiwi et al. (2022) revealed that social and cultural factors, such as stigma towards sexual health and gender norms, can influence risky behaviors among men. This shows the need for a more gender-sensitive approach in syphilis prevention and treatment programs. The classification of syphilis cases is obtained in table 5.3 below.

Table 3. Classification of syphilis cases by age and gender

Syphilis Cases					
	District				
	South Denpasar	**West Denpasar**	**North Denpasar**	**East Denpasar**	
Age					Total
12-25 Th	27	13	13	4	57
26-45 Th	56	39	8	7	110
46 Th+	2		1		3
Total	85	52	22	11	170
Gender					
Male - Male	62	45	21	8	136
Woman	23	7	1	3	34
Total	85	52	22	11	170

Based on table 5.2, it can be concluded that the number of Syphilis cases tends to occur in the adult age group (26–45 years), as well as with the adolescent (12–25 years) and elderly (46+ years) groups**.** This indicates that syphilis is still quite high in the age group and productive, namely adolescent and adulthood, in addition to that it can be concluded according to table 5.2 that men are more predominantly affected by syphilis, which is as many as 136 cases compared to women who have a rate of syphilis cases of 34 cases.

CONCLUSION

Based on the research, syphilis cases in Denpasar City in 2024 were recorded at 170 cases with high classification in South Denpasar (85 cases), medium in West Denpasar (52 cases), and low in North Denpasar (22 cases) and East Denpasar (11 cases). The highest prevalence occurred in the productive age group (26–45 years), followed by adolescents (12–25 years) and the elderly (46+ years), with risk factors related to unsafe sexual activity and

lack of reproductive health education. Based on gender, more cases occurred in men (136 cases) than women (34 cases), influenced by risky sexual behavior and stigma that makes women reluctant to seek medical examination. Therefore, it is recommended that the Health Office utilize Geographic Information System (GIS) technology for targeted mapping and case management, as well as strengthen syphilis education programs focused on vulnerable groups, especially men of productive age and adolescents, through education, early detection, and increased access to health services.

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