TREND AND SPATIAL ANALYSIS OF DIABETES MELLITUS DISEASE 2019-2023 IN YOGYAKARTA CITY

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ABSTRACT

Diabetes is a non-communicable disease that can cause complications. It is characterized by elevated blood sugar levels. This study aimed to map out the trends and characteristics of diabetes mellitus (DM), especially type 2 DM, in Yogyakarta City in 2019-2023. This study employed a quantitative descriptive methodology, utilizing a cross-sectional approach. Data on patients with diabetes mellitus were obtained from the Yogyakarta City Health Office. The population of this study was all data of patients with type 2 DM who visited the health center in Yogyakarta City. Total sampling was used to select research participants. The study was conducted in May-June 2024. Descriptive analysis was processed using SPSS 26, while area mapping used the QGIS application version 3.36.1. The spatial analysis used in this research is spatial descriptive analysis. Based on gender, people with type 2 diabetes mellitus in the city of Yogyakarta in 2019-2023 were female. Type 2 diabetes occurred in people over 45 years of age. Between 2019 and 2023, there was a rise in type 2 diabetes cases. Geographically, Danurejan District had the highest prevalence of type 2 diabetes in 2019 and 2023, whereas Gedong Tengen District had the highest prevalence in 2020–2022. Promotion of a healthy diet, regular exercise, early screening, and diabetes education in Indonesia is necessary.

Keywords: Trends, Spatial Analysis, Diabetes Mellitus

INTRODUCTION

Diabetes is a condition where blood sugar levels exceed normal limits. It is a non-communicable disease that can cause complications (Antar *et al.*, 2023). Diabetes is usually divided into type 1 diabetes, type 2 diabetes, diabetes caused by other factors, and gestational diabetes (American Diabetes Association, 2021).

In 2021, there were 537 million diabetics worldwide. In the event that this illness is poorly treated, the number of individuals with diabetes is predicted to climb to 643 million by 2030 and, if current trends continue, to 783 million by 2045 (IDF Diabetes Atlas, 2021). High blood glucose levels caused by abnormalities in insulin secretion or action, or both, are known as type 2 diabetes. Organs involved in type 2 DM are muscle, brain, and liver (insulin resistance), pancreas (beta cell failure), fat tissue (increased lipolysis), pancreatic alpha cells (hyperglucagonemia), gastrointestinal (incretin definition), and kidney (increased glucose absorption) (Tim Penyusun Buku Pedoman Pengelolaan dan Pencegahan Diabetes Melitus Tipe 2 di Indonesia 2019, 2019). In Indonesia, the prevalence of DM is 2%, DIY is 3.11%, and Yogyakarta City is 4.79%. Yogyakarta City has a higher prevalence of DM than DIY and even Indonesia (Dinas Kesehatan Kota Yogyakarta, 2023).

Geographic analyses by linking health, population and environmental data can be used by researchers to evaluate and quantify relationships between health-related variables and environmental risk factors at different geographic scales (Fletcher-Lartey and Caprarelli, 2016). Geographic analyses can use Geographic Information Systems (GIS), which is a technology that combines geographic aspects with data analysis techniques (Erkamim, Mukhlis and Adiwarman, 2023). There are several reasons why GIS is needed, including: to measure the mapping of access to services for patients and their potential density, to see the mapping interaction between facilities and patients, to help determine the most suitable environment and reduce the impact on the environment, to see the level of disease in an area, to define the

geographical unit of health services, for planning the location and allocation of health service resources to provide maximum health services (Wang, 2020).

Previous research on the mapping of patients with DM disease has been conducted in Yogyakarta City, but the study was only conducted in one village and focused on DM cases with TB complications (Rohman and Catharina, 2019). Therefore, our study aimed to analyze the demographics of people with type 2 diabetes mellitus in Yogyakarta City based on age and gender over the past 5 years and shows a spatial analysis of areas based on prevalence with mapping using Geographic Information Systems. In order to serve as a resource for preventing the incidence of diabetes and its complications in the area, the study's results are anticipated to give an overview of the population with diabetes in the Yogyakarta City area as well as a map of the areas with the highest concentration of cases.

METHOD

This is a descriptive quantitative study, and the research sample was drawn using the total sampling technique. The total sample was 50176 who were diabetics since 2019-2023. The study was carried out in Yogyakarta City, which covers 32.82 square kilometers, or 1.03% of the total area of Yogyakarta Special Region Province. Yogyakarta City's Badan Pusat Statistik (BPS) provided population data by village to assess the prevalence of type 2 diabetes cases (BPS, 2024).

The number of type 2 diabetes mellitus cases is secondary data obtained from the Yogyakarta City Health Office. The data set is in electronic form, namely all types of diabetes that were examined at the health centers in the Yogyakarta City area in 2019-2023. The code used for diabetes uses ICD-10 (International Statistical Classification of Diseases and Related) where the coding is carried out by the World Health Organization and the code for type 2 DM is E11 (WHO, 2019).

Prevalence classification was measured using the equal count (quantile) mode in QGIS which was used to classify the data into 3 groups: low, medium, and high with almost the same number of features in each

group.

Descriptive data processing was performed using SPSS 26.0 for univariate analysis, while mapping of type 2 diabetes mellitus cases based on prevalence per village used the QGIS application version 3.36.1. The Ahmad Dahlan University Research Ethics Committee has given ethical approval with the number 012404086 for this research.

Table 1 shows the frequency distribution of people with type 2 diabetes based on age and gender. Women suffer from type 2 diabetes more than men. Based on age, most people with DM are aged >45 years.

RESULTS AND DISCUSSION

Table 1. Characteristics of People with Type 2 Diabetes Mellitus in Yogyakarta City 2019-2023.

Year	Sex		Age	
	Male	Female	≤ 45	> 45
	N (%)	N (%)	N (%)	N (%)
2019	3,591 (37.90)	5,883 (62.10)	817 (8.62)	8,657 (91.38)
2020	3,522 (38.75)	5,567 (61.25)	764 (8.40)	8,328 (91.60)
2021	3,942 (39.37)	6,070 (60.63)	911 (9.09)	9,101 (90.91)
2022	3,929 (38.31)	6,326 (61.69)	875 (8.53)	9,380 (91.47)
2023	4,388 (38.67)	6,958 (61.33)	980 (8.64)	10,366 (91.36)

Source: Secondary Data of Yogyakarta City Health Office, 2024

The number of type 2 DM cases tends to increase since 2019-2023 as shown in Figure 1.

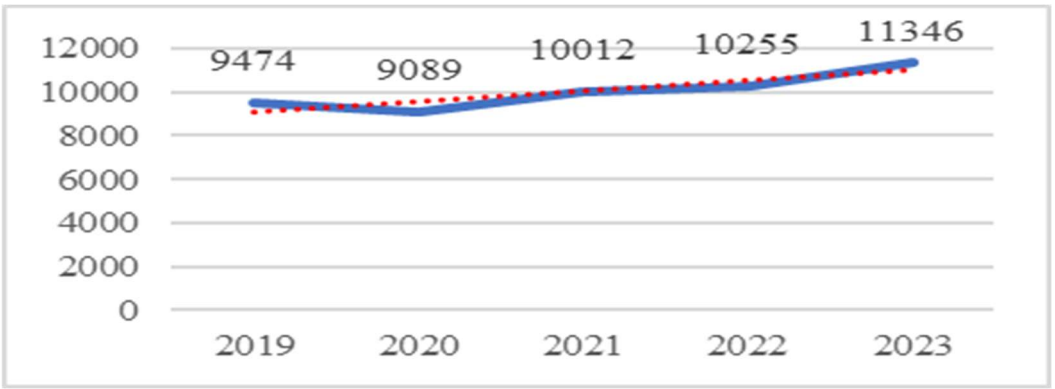

Figure 1. Trend of Type 2 DM Disease in Yogyakarta City 2019-2023

The distribution based on the prevalence of type 2 DM in each sub-district in Yogyakarta City is shown in Table 2. In 2019-2023, Sub-district Danurejan and Gedong Tengen were the sub-district with the highest prevalence of type 2 DM.

Table 2. Prevalence Rate of People with Type 2 DM in 2019 -2023 in Yogyakarta City Based on Sub District

NO	SUB-DISTRICT	2019	2020	2021	2022	2023
1.	Danurejan	3.21	3.43	3.48	3.75	4.19
2.	Gedongtengen	3.17	3.49	3.99	3.81	3.82
3.	Gondokusuman	1.90	2.02	2.30	2.37	2.60
4.	Gondomanan	2.28	2.71	3.08	3.38	3.72
5.	Jetis	2.54	2.61	2.99	3.38	3.83
6.	Kotagede	2.98	2.73	2.80	2.90	3.30
7.	Kraton	2.00	1.97	2.50	2.62	3.07
8.	Mantrijeron	2.42	2.51	2.44	2.47	2.78
9.	Mergangsan	2.37	2.63	3.00	2.86	3.19
10.	Ngampilan	1.96	2.27	2.66	2.60	3.30
11.	Pakualaman	2.84	3.01	3.09	3.35	3.38
12.	Tegalrejo	2.64	2.59	2.79	2.76	2.97
13.	Umbulharjo	1.37	1.77	1.99	1.95	2.22
14.	Wirobrajan	2.28	2.38	2.51	2.47	2.76

SPATIAL ANALYSIS

Five subdistricts—Danurejan, Gedong Tengen, Kotagede, Pakualaman, and Tegalrejo—have a high prevalence of Type 2 diabetes in 2019 (Figure 2).

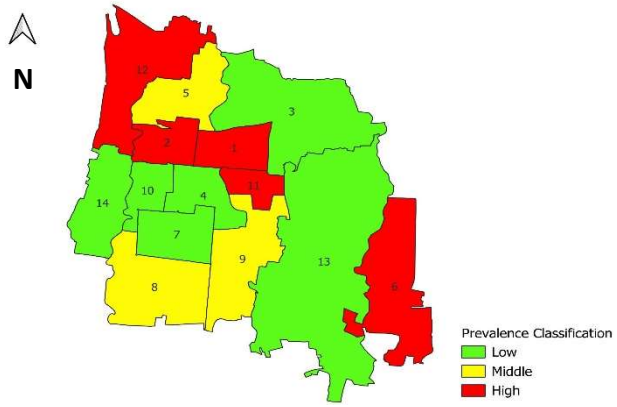

Figure 2. Mapping Based on DM Disease Prevalence in 2019 in Yogyakarta City

Gedong Tengen, Danurejan, Pakualaman, Kotagede, and Gondomanan are

the five districts with the highest rates of Type 2 DM in 2020 (Figure 3).

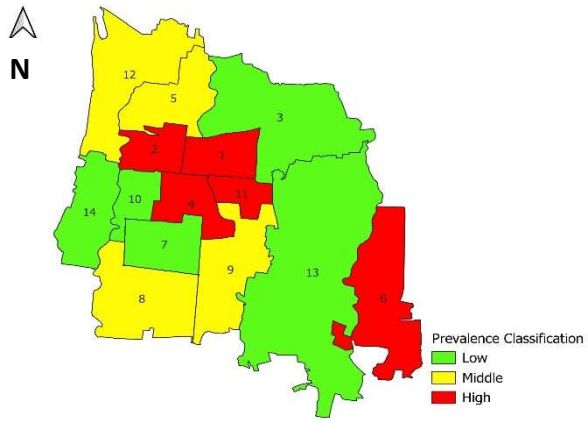

Figure 3. Mapping Based on DM Disease Prevalence in 2020 in Yogyakarta City

Gedong Tengen, Danurejan, Pakualaman, Gondomanan, and Mergangsan are the five sub-districts where Type 2 DM is most prevalent in 2021 (Figure 4).

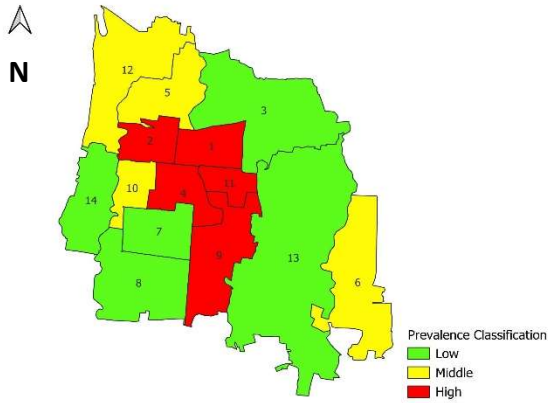

Figure 4. Mapping Based on DM Disease Prevalence in 2021 in Yogyakarta City

Gedong Tengen, Danurejan, Jetis, Gondomanan, and Pakualaman are the five districts with the highest frequency of Type 2 DM in 2022 (Figure 5).

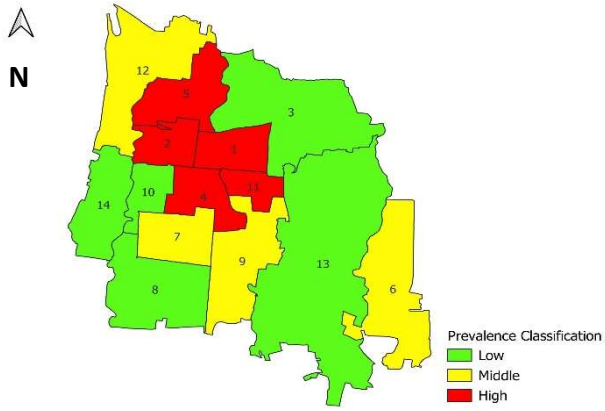

Figure 5. Mapping Based on DM Disease Prevalence in 2022 in Yogyakarta City

Danurejan, Jetis, Gedong Tengen, Gondomanan, and Pakualaman are the five sub-districts where Type 2 DM is most prevalent in 2023 (Figure 6).

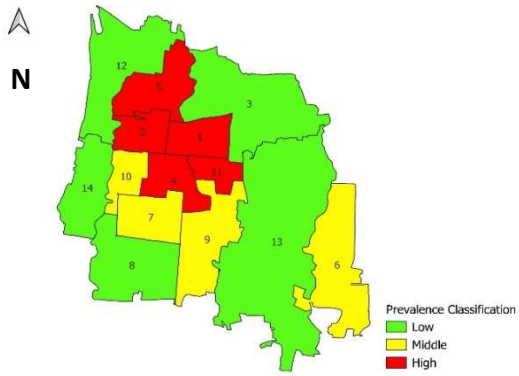

Figure 6. Mapping Based on DM Disease Prevalence in 2023 in Yogyakarta City

DISCUSSION

The majority of Yogyakarta City's type 2 diabetes patients in 2019–2023 were female, according to the data in Table 1. After adjusting for age, ethnicity, occupation, household income, and obesity, women have a five times higher risk of acquiring type 2 diabetes than males (2023), according to study results by Barcia et al (García, Montaño and Figueroa, 2023). Women made up 56% of the population overall, according to Ghassab et al. (2023). A basic logistic regression model's results indicate that the incidence of type 2 diabetes is significantly correlated with age, high blood pressure, abdominal obesity, cholesterol, high blood pressure, and triglycerides in both men and women (Ghassab-Abdollahi *et al.*, 2023). The prevalence is higher in women (15.5%) than in men (11.8%).

Due to the enormous hormonal changes that women undergo during their life, they are more likely to develop type 2 diabetes. Insulin resistance may rise as a result of these hormonal shifts. Insulin resistance during pregnancy is influenced by a wide range of factors, including obesity, placental hormones, bad food, inactivity, and genetic and epigenetic contributions (Kampmann *et al.*, 2019). The most frequent pregnancy complication, gestational diabetes mellitus, is linked to type 2 diabetes risk as well as ethnic characteristics. Type 2 diabetes is twice as likely to strike pregnant

women who develop the disease 24.4% of 765 women with a history of gestational diabetes went on to develop type 2 diabetes as a result of their gestational diabetes (Bower *et al.*, 2019). In young women, the rate of type 2 diabetes is higher, while men have a higher prevalence in middle age (Huebschmann *et al.*, 2019). Hormonal changes in women at menopause are also followed by the risk of diabetes mellitus (Cappola *et al.*, 2023; Karvonen-Gutierrez, Park and Kim, 2016).

The incidence of diabetes is influenced by unchangeable characteristics such as age, gender, and length of type 2 diabetes mellitus (Zahrotunnisa Arizky and Kurniasari, 2023). The results of the study in Table 1 consistently from 2019 to 2023 show that the most common people with type 2 diabetes are those aged more than 45 years. Numerous physiological and pathological mechanisms cause the body's tissues and organs to deteriorate with age.

One of the main causes of resistance to insulin is these age-related alterations in adipose tissue (Zhao and Yue, 2024). In Australia, almost 1 in 5 Australians (19%) aged 80-84 years live with diabetes and is almost 30 times higher than those aged under 40 years (0.7%) (Australian Institute of Health and Welfare, 2024). In line with the research of (Yan *et al.*, 2023) that the prevalence of diabetes and prediabetes is higher in the elderly compared to the middle-aged group.

Based on Figure 1, the number of type 2 DM cases in 2020 had decreased by 4.24% from 2019 as a result of the COVID-19 pandemic that first appeared in Indonesia in 2020. The COVID-19 pandemic disrupted clinical care for type 2 diabetes which led to a decrease in primary healthcare visits (Hooker *et al.*, 2022). During the COVID-19 pandemic there are restrictions on community activities (lockdown), which increases stress and results in weight gain (Ruissen et al., 2021). Physical activity and exercise are beneficial, safe and effective activities for diabetes management, and can be widely used during the COVID-19 outbreak. Physical activity/exercise is recommended during and after the COVID-19 outbreak, to improve diabetes management, as well as to prevent an increase in the global burden of

COVID-19, diabetes and other non-communicable diseases. (Marçal et al., 2020).

In mapping areas based on sub-district (Figure 1-5), from 2019-2023 there were 2 sub-districts with the highest prevalence. Danurejan sub-district has a prevalence of type 2 DM cases of 3.21 per 100 population in 2019 and 4.19 per 100 population in 2023. The highest prevalence of type 2 DM in 2020-2022 was in Kemantren Gedong Tengen. The Danurejan and Gedong Tengen areas are located in the middle of the city center which allows residents to access a variety of ready-to-eat foods that contain high levels of sugar, foods with refined carbohydrates, fast food, and sugary drinks at affordable prices. This can cause people to have less access to healthy food, which can affect the occurrence of DM. The Danurejan area is located in the center of the city which has more access to health facilities, so more cases of diabetes are detected.

The neighborhood environment significantly influences the development of diabetes risk factors, morbidity and mortality throughout a person's life. The social, economic and physical environment of a neighborhood influences individual and community health risks (Mujahid *et al.*, 2023). Diabetes is an increasing health problem in low- and middle-income countries (Zhou *et al.*, 2016). Environmental conditions also affect the incidence of type 2 DM. People who live in a green environment have a lower risk of type 2 diabetes (Astell-Burt, Feng and Kolt, 2014). The prevalence of diabetes mellitus cases in urban communities is higher than rural communities due to lifestyle factors (Zhao *et al.*, 2023).

Yogyakarta City is an area that has many open spaces and sports facilities that allow its citizens to do physical activity as an effort to prevent type 2 DM. Modernization and the development of technology make the residents of Yogyakarta City do not do much physical activity or better known as sedentary lifestyle, namely non-active physical activities such as playing mobile phones, lying down, surfing social media, watching television, and playing video games (on behalf of SBRN Terminology Consensus Project Participants *et al.*,

2017). All sub-districts in the city of Yogyakarta have health facilities that are evenly distributed. However, some residents lack access to health care facilities due to economic problems. In general, in the period 2017-2021 the poverty line in Yogyakarta City has increased (BPS Kota Yogyakarta, 2022). On average, the cost of health care for people with diabetes is 2.3 times more expensive than people without diabetes (American Diabetes Association, 2018).

CONCLUSION

The results above show that women are the most people with type 2 diabetes mellitus in the Yogyakarta City area in 2019-2023. Based on age, most are over 45 years old. The disease trend of type 2 DM cases has increased from 2019-2023. Based on region, the highest prevalence of type 2 DM in 2019 and 2023 was in Danurejan sub-district and in 2020-2022 was in Gedong Tengen sub-district.

The shortcomings of this study are the limitations of the variables studied because it uses secondary data. There is a lack of data on factors that influence the incidence of diabetes mellitus such as smoking habits, lifestyle, comorbidities, health-seeking behavior, and physical activity. Future research is expected to integrate primary data collection, examine rural-urban disparities, or conduct longitudinal studies to track individual cases over time.

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