



Spatial Analysis and Risk Factors for Diabetes Mellitus Type II in Banbarbaru City

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Abstract

The World Health Organization defines diabetes mellitus as a disease characterized by hyperglycemia and disturbances of carbohydrate, fat and protein metabolism associated with absolute or relative deficiency of insulin action and/or secretion. It is estimated that between 2010 and 2030, developed and developing countries will experience a 20% and 69% increase in the number of adults with diabetes, respectively. This research is a quantitative analytic study with a cross sectional design. Utilizing secondary data at the Health Office of Banjarbaru City as of January-March 2020, in particular the five health centers, namely the South Banjarbaru Health Center, the Sei Besar Health Center, the Sei Ulin Health Center, the Liang Anggang Health Center and the Guntung Manggis Health Center. The sampling method is quota sampling and data analysis using chi square. The result is that there is no relationship between gender (p -value=0.742), marital status (p -value=1), employment status (p -value=0.075), education level (p -value=0.646), smoking (p -value = 0.052), BMI (p -value = 0.451), abdominal circumference (p -value = 0.212), and less fruit and vegetable consumption (p -value = 0.586) on the incidence of diabetes mellitus type II. As for the incidence of diabetes mellitus type II is age (p -value = 0.0001). This study also illustrates the mapping of the distribution of the incidence of Diabetes Mellitus Type II using a color gradation with a scale of 1: 211190, namely in South Banjarbaru District as much as 70.4%, then Liang Anggang District which is 20.4% and North Banjarbaru District 9.2%.

Introduction

Diabetes mellitus Type 2 (DMT2) is a serious public health problem that has a major impact on human life as it affects an individual's functional capacity and quality of life, leading to significant morbidity and premature mortality. Diabetes mellitus is a group of metabolic disorders characterized by chronic hyperglycemic conditions resulting from defects in insulin secretion, insulin action or both (Abdul et al., 2020; Ozougwu et al., 2013). The World Health Organization (WHO) defines diabetes mellitus (DM) as a chronic metabolic disease, a disease characterized by elevated blood glucose levels, which over time causes damage to the heart, blood vessels, eyes, kidneys and nerves (Galicia-Garcia et al., 2020).

It is estimated that between 2010 and

2030, developed and developing countries will experience a 20% and 69% increase in the number of adults with diabetes, respectively. The prevalence of diabetes among those aged 20-79 years could increase to 7.7%, reaching 439 million by 2030 (Al Mansour, 2020). Data from the International Diabetes Federation (IDF) in 2019 stated that DM caused 4.2 million deaths and 463 million people aged between 20-79 years living with DM, this number is likely to increase to 700 million by 2045. Patients with DM have 15 % increased risk of cause of death compared to people without DM (Galicia-Garcia et al., 2020). Diabetes mellitus (DM) is a serious chronic degenerative disease characterized by high blood glucose levels associated with insulin production and/or action. It should be noted that diabetes mellitus

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is a disease that often occurs in the 21st century and it is estimated that by 2030 the number of diabetes mellitus in the world will reach 552 million cases (Muñiz-Ramirez et al., 2021; Nugroho et al., 2020).

Diabetes in Indonesia is considered a major health problem and has been a concern since the early 1980s. Indonesia has a diabetes prevalence rate of 6.2% and is one of the main causes of death. Indonesia is rated as one of the top ten countries in the world by the number of individuals living with diabetes in 2013. Indonesia ranks 7th out of the largest number of diabetes patients worldwide and 3rd out of the top 10 countries with 29.1 million people who have impaired glucose tolerance in 2019 (Kristina et al., 2020; Ligita et al., 2019). The increase in the number of DM patients, mostly DM type 2, is related to several factors. Diabetes mellitus is multifactorial, modifiable risk factors such as body mass index (BMI), physical activity, diet, infection and so on. In addition, non-modifiable risk factors such as age, family history of DM and so on (Majgi et al., 2012).

In general, the prevalence of diabetes mellitus in South Kalimantan Province reaches 1.30%. Meanwhile, the prevalence of Diabetes Mellitus based on doctor's diagnosis at all ages according to the district/city of South Kalimantan Province was highest in Banjarmasin City reaching 2.12%, followed by Banjarbaru City which reached 1.65% and Tapin District 1.57%. (Health Research and Development Agency, 2018). Diabetes mellitus is a concern, especially since this disease is one of the diseases with the highest incidence in South Kalimantan. Thus, researchers want to map the distribution of diabetes mellitus cases spatially, considering that research on the distribution of the disease is still minimal in South Kalimantan. Not only that, this study also examines the relationship between several risk factors such as sociodemography, BMI, abdominal circumference, smoking, fruit and vegetable consumption.

Research Methods

This research uses quantitative analytical method with cross sectional design. This study also uses secondary data to see the relationship

between several factors causing the incidence of type 2 diabetes mellitus. The sample of this study was all people with diabetes mellitus who were treated at the community health center who had cases of type II DM in the work area of the Banjarbaru City Health Office. Of the 10 health centers, there are 5 health centers that have complete data, namely South Banjarbaru Health Center, Sungai Besar Health Center, Sungai Ulin Health Center, Liang Anggang Health Center, and Guntung Manggis Health Center.

The formula used to determine the sample size is as follows:

$$n = \frac{N z^2 p q}{d^2 (N - 1) + z^2 p q}$$

Description:

n = sample size

$z^2 = 1,962=3,814$

p = the proportion of a particular case to the usual population in previous studies.

q = 1-p

d = the degree of deviation from the population used, may use 0.05, but 0.02 and 0.01 are prioritized according to WHO recommendations

N = large population, in the productive age of 15-59 years in Banjarbaru City 180,380.

So that,

$$n = \frac{180.380 \times 3,8416 \times 0.0165 \times 0.9835}{0.022 \times 180.379 \times 3,8416 \times 0.0165 \times 0.9835}$$

n = 155.8

n ≈ 156 sample

The sampling technique in this study is quota sampling, where the number of samples is based on the completeness of the data and the suitability of the variables studied in this study. Secondary data collected is non-communicable disease data from January-March 2020. Bivariate data analysis uses a computer data analysis application for the spatial analysis uses Quantum Gis 3.8.3.

Results and Discussion

The results of statistical tests using the chi square test (χ^2) with $\alpha = 0.05$ regarding the relationship between age, gender, marital

status, type of work, education level, smoking, BMI, abdominal circumference and less consumption of fruits and vegetables with the

incidence of Diabetes Mellitus Type II in the working area of the Banjarbaru City Health Office, it can be observed in the following table.

Table 1. Relationship of Respondents Characteristics, Smoking, Fruit and Vegetable Consumption, BMI, and Abdominal Circumference with the incidence of DM Type II

Variable		DM Type 2				p-value
		Yes	%	No	%	
Age Group (Years)	< 45	10	10,2	23	3,4	0,0001
	> 45	88	89,8	35	6,9	
	Total	98	100	58	100	
Gender	Male	36	36,7	19	32,8	0,742
	Female	62	63,3	39	67,2	
	Total	98	100	58	100	
Marital status	Married	89	90,8	52	89,7	1
	Widow/Widower/ Unmarried	9	9,2	6	10,3	
	Total	98	100	58	100	
Type of work	Work	40	40,8	33	56,9	0,075
	Do not work	58	59,2	25	43,1	
	Total	98	100	58	100	
Level of education	Low	49	50	32	55,2	0,646
	High	49	50	26	44,8	
	Total	98	100	58	100	
Smoking	Yes	6	6,1	10	17,2	0,052
	No	92	93,9	48	82,8	
	Total	98	100	58	100	
BMI	Normal	48	49	24	41,4	0,451
	Obesity	50	51	34	58,6	
	Total	98	100	58	100	
Belly Circumference	Normal	36	36,7	28	48,3	0,212
	Risky	62	63,6	30	51,7	
	Total	98	100,3	58	100	
Less Fruit & Vegetable Consumption	Yes	20	20,4	14	24,1	0,586
	No	78	79,6	44	75,9	
	Total	98	100	58	100	

Description: $\alpha = 0,05$

Source: Banjarbaru City, Health Center Data 2020

Based on table 1, there is no relationship between gender (p-value = 0.742), marital status (p-value = 1), employment status (p-value = 0.075), education level (p-value = 0.646), smoking (p-value = 0.052), BMI (p-value = 0.451), abdominal circumference (p-value = 0.212), and less fruit and vegetable consumption (p-value = 0.586) on the incidence of diabetes mellitus type II as for the incidence of diabetes mellitus type II is age (p-value = 0.0001). Based on a study conducted by Sacerdote et al (2012) compared with the

highest relative education level, the person with the lowest educational position was associated with a 64% increased risk for DM type II in men and a 90% increased risk in women (adjusted HR: 1.64, 95% CI: 1.51–1.80 and 1.90, 95% CI: 1.75–2.07, respectively). Education level and socioeconomic status in general have no direct biological effect on disease; instead the effect is mediated by other risk factors that may be biologically related to the disease (i.e. smoking status, BMI, physical activity). Whereas higher education levels are associated with health in

different ways: individuals with higher levels of education may be more receptive to prevention messages, have a higher ability to change their health behavior and are more likely to use the health care system better so that the risk of DM type II is lower. (Sacerdote et al., 2012).

Research conducted by Akter et al (2017) found that the risk of DM type II was 38% significantly higher for active smokers compared to nonsmokers. The link between smoking and diabetes is biologically plausible. Smoking causes insulin resistance or inadequate compensatory insulin secretion through a variety of underlying effects, including oxidative stress, inflammation, and endothelial dysfunction. Nicotine in cigarettes can also have a direct toxic effect on beta-cell function. In addition, although smoking tends to lose weight, it leads to central adiposity, which has been linked to inflammation and insulin resistance (Akter et al., 2017).

Compared with nonsmokers, ex-smokers were associated with a 19% higher risk of type II diabetes during the first 5 years of smoking cessation, although the risk did not exceed the risk of type II diabetes among current smokers. This is because smoking cessation usually leads to weight gain, concerns have been raised about the possible increased risk of DM type II after smoking cessation. In fact, mechanical studies show a decline in insulin sensitivity and lipid profile after smoking cessation (Akter et al., 2017).

The results of the study by Wu et al (2020) showed that passive smoking increases the prevalence of impaired glucose tolerance in a time-dependent manner, while no similar relationship was observed in impaired fasting glucose and diabetes mellitus type II. The duration of passive smoking 10 years had no effect on carbohydrate and lipid metabolism and the prevalence of prediabetes and diabetes type II. However, if the duration of secondhand smoke exceeds 10 years, it can worsen carbohydrate and lipid metabolism disorders, and is a risk factor for Diabetes Mellitus type II, moreover, there is a time-dependent relationship between the duration of passive smoking and its effect on IFG, IGT, and diabetes type II. (Wu et al., 2020).

Nicotine and tar are the two main

ingredients in tobacco that cause maximum damage to the human body, and these can be harmful components of passive smoke. In addition, the impact of passive smoke on health is related to ventilation, temperature, humidity, depth of breathing, and distance from smokers. After the temperature drops and deposition, some substances in the environment will agglomerate and damage the human body differently compared to active smokers. Nicotine can activate protein kinase $\alpha 2$ AMP-activated adipocytes to enhance adipose tissue lipolysis. Ultimately, nicotine promotes the degradation of insulin receptor-1 (IRS-1) substrate and the loss of insulin-mediated inhibition of lipolysis (Wu et al., 2020).

Based on research conducted by Chizia et al (2017), they do not have formal qualifications that affect the incidence of diabetes, in this case the literacy rate. The literacy rate is directly related to the prevalence of diabetes. Health should be emphasized in education-based policies to ensure that everyone is aware of the components of a healthy lifestyle. Unqualified people may lack the knowledge to make health decisions about the lifestyle to lead. The solution lies not only in policy makers but also in the general public who must adhere to the principles of available knowledge and lead a healthy lifestyle. The school provides information about types of food, diseases and the importance of healthy decision making. However, the acquisition of knowledge is not limited to schools, but is influenced by individual attitudes. It should start in the family and society before and during school and college education (OS. Chizia & D. Bellingham-Young, 2017).

Research conducted by Wang et al (2016) adjusted maximum relative risk for diabetes type 2 for the highest and lowest intakes of 0.91 for total fruits, 0.75 for blueberries, 0.87 for green leafy vegetables, 0.72 for yellow vegetables, 0.82 for cruciferous vegetables and 0.9 These results suggest that a higher intake of fruit, especially berries, and green leafy vegetables, yellow vegetables, cruciferous vegetables or their fiber is associated with a lower risk of diabetes type 2. (Wang et al., 2016). Fruits and vegetables are rich sources of fiber, flavonoids, and anti-oxidant compounds (carotenoids, vitamins C

and E), folate, and potassium, which may explain the protective effect of fruits and vegetables in diabetes type 2. Dietary fiber is associated with insulin sensitivity, and increased ability to delay carbohydrate absorption and secrete insulin adequately to overcome insulin resistance, resulting in lower postprandial blood glucose and insulin levels. High intake of dietary fiber can increase feelings of fullness and reduce intake of energy-dense foods, resulting in a reduced risk of being overweight/obese, which is a well-established risk factor for diabetes type 2 (Wang et al., 2016).

Based on research by Aravinda (2019) and Mansour (2020) showing obesity is the main risk factor for DM type II where the proportion of DM Type II Patients who are obese or overweight is eight times higher than non-obese/not overweight patients. The proposed mechanism linking the two is increased adipokine/cytokine production, which can lead to insulin resistance and decreased adiponectin levels, ectopic fat deposition, mitochondrial dysfunction which not only decreases insulin sensitivity but also affects cell function β (Al Mansour, 2020; Aravinda, 2019). It was also stated that obesity was found to be a common risk factor for diabetes mellitus (Han et al., 2020).

However, this study did not show an association between BMI and the incidence of DM Type II. This is in line with other studies which state that there is no significant relationship between obesity and an increase in blood sugar levels at any time. Research conducted by Rahayu et al. found no relationship between obesity status and blood sugar levels. This is because most respondents are obedient in taking drugs so that blood sugar levels can be controlled properly (Rahayu et al., 2018; Sasmita, 2017). Body Mass Index is theoretically correlated with blood glucose levels. However, this is not always the case. A previous study at King Faisal University did not show a significant correlation between blood sugar levels and Body Mass Index. Another study by Karimah revealed that someone who is overweight will not always have high blood glucose levels too, many factors affect a person's high blood glucose levels including food intake and hormones. Carbohydrate intake is the most

influential factor on fasting blood sugar levels. The differences that occur in the results of this study with the results of previous studies are the influencing factors such as genes, food, exercise (Awadh et al., 2018; Karimah, 2018).

Regardless of genetics, obesity is rooted primarily in improper diet or physical activity, but in the current study we observed that even in patients who have an active or strenuous lifestyle, the prevalence of obesity is comparable to that of the sedentary group. This may imply that the transition of nutrition, to high saturated fat, sugar, and processed foods as well as transportation facilities and increased stress, especially in urban populations may play an important role (Aravinda, 2019). BMI and belly circumference served as parameters for estimating general or abdominal fat mass, respectively. It is assumed that abdominal fat mass is very important in the development of not only diabetes type 2, but also other chronic diseases, including cardiovascular disease and some forms of cancer. Based on a study by Feller et al (2010) The association between belly circumference and risk of diabetes type 2 was more marked at low BMI than at higher BMI. An increase in belly circumference by a gender-specific standard deviation (9.9 cm for men and 11.2 for women) was associated with a 2.21-fold increased risk of diabetes in men and a 2.31-fold increased risk for women. In individuals with low BMI, belly circumference is a more precise measure of visceral fat, as these individuals have mostly less subcutaneous fat which can affect belly circumference. However, it is the visceral fat that on the other hand greatly increases the risk of diabetes. On the other hand, the biochemistry of subcutaneous fat differs from that of visceral fat (e1-e10) and there is even evidence that subcutaneous fat produces substances that may have a beneficial effect on glucose metabolism. Therefore, it is likely that the amount of subcutaneous fat that causes the negative interaction (Feller et al., 2010).

Based on the results of the study, it was found that nineteen (15.6%) respondents under the age of 40 years and 103 (44.6%) of those who were at least 40 years old suffered from diabetes mellitus ($p < 0.001$). A total of 56 (34.2%) and 66 (34.9%) of men and women had this disease

respectively. Diabetes mellitus rates for both business and private individuals, government employees, housewives, and students were 38.5%, 32%, 10.3%, and 31.9%, respectively. Five (10.4%) of single, 99 (36.3%) married, and 18 (56.3%) divorced or widowed respondents had diabetes mellitus type 2 ($p < 0.001$). Diseases in the low, medium, and high-income groups consisted of 42.4%, 29.0%, and 26.1%. Regular physical activity, smoking tobacco, consuming fatty foods, high LDL, and high blood pressure were not statistically significant factors in diabetic patients. On the other hand, seven (13.2%) of normal or underweight respondents had diabetes mellitus type 2 compared with 115 (42.3%) who were overweight or obese patients ($p < 0.001$).

Triglyceride levels were found to be influential, as many as 76 (32.5%) patients with desired or borderline TG had diabetes mellitus. Triglyceride levels were found to be influential, as many as 76 (32.5%) patients with desired or borderline TG had diabetes mellitus type 2, compared with 46 (43.4%) patients with high triglyceride levels ($p < 0.004$). 113 (35.9%) patients with desired total cholesterol levels and nine (23.7%) patients with high levels had diabetes mellitus Type II ($p < 0.016$). A total of 101 (37.3%) patients with low/mean HDL and 21 (25.6%) patients with HDL had DM. Triglyceride levels were found to be influential, as many as 76 (32.5%) patients with desired or borderline TG had type 2 diabetes mellitus, compared with 46 (43.4%) patients with high triglyceride levels ($p < 0.004$). 113 (35.9%) patients with desired total cholesterol levels and nine (23.7%) patients with high levels had Type II diabetes mellitus ($p < 0.016$). A total of 101 (37.3%) patients with low/mean HDL and 21 (25.6%) patients with HDL had DM Type II (p , compared with 46 (43.4%) patients with high triglyceride levels ($p < 0.004$). 113 (35.9%) patients with desired total cholesterol levels and nine (23.7%) patients with high levels had diabetes mellitus Type II ($p < 0.016$). A total of 101 (37.3%) patients with low/mean HDL and 21 (25.6%) patients with HDL had DM Type II ($p < 0.012$).

There is a significant relationship between DM Type II and age. Patients aged forty years or older were more likely to have this

disease compared to younger age groups ($p < 0.001$). DM Type II showed a significant relationship with occupation ($p < 0.001$). The prevalence of DM Type II (38.5%) among businesses or the private sector is higher than that of government employees (32%), students (31.9%), and housewives (31.9%). It was also found that the prevalence of DM Type II was higher in married and divorced or widowed respondents compared to single respondents ($p < 0.001$). Then the results of the study also showed that more DM Type II patients were tobacco smokers than nonsmokers, but the relationship was not significant. Furthermore, it was found a significant relationship between obesity and DM Type II.

Lack of physical activity is one of the risk factors for diabetes mellitus reported in this study; However, the relationship between physical activity and diabetes was not significant ($p > 0.05$). Tiwari et al. reported similar findings that those who engaged in light activity had diabetes mellitus and the difference was not significant. Shah et al., Ahmad et al., and Mohan et al. found that less physical activity was significantly associated with diabetes mellitus and subjects who did moderate to light physical activity had diabetes mellitus compared to those who did strenuous physical activity (Patil & Gothankar, 2019). The work of housewives shows a higher prevalence of diabetes mellitus than other occupations. This may be because housewives tend to be less active outdoors along with a less active traditional lifestyle which may be responsible for the higher prevalence of diabetes mellitus in them. The highest prevalence is housewives (9.9%) followed by unemployed and retirees (9.6%).

A study says, women are more likely to experience DM than men for reasons of hormonal and metabolic factors. Women who have excess fat in the trunk, especially if it is in the abdomen, are more likely to develop DM, this is because fat in the abdominal organs is easier to process for energy. The results of previous studies regarding the effect of obesity on the incidence of DM in women of childbearing age showed that there was an influence of obesity on the incidence of DM in women of childbearing age with a p

value of 0.009 (<0.05). The results of previous studies regarding the effect of obesity on the incidence of DM in women of childbearing age showed that women of childbearing age had a

3.09-fold risk of obesity compared to women of childbearing age whose BMI was normal (Ardiani et al., 2018; Isnaini & Ratnasari, 2018).

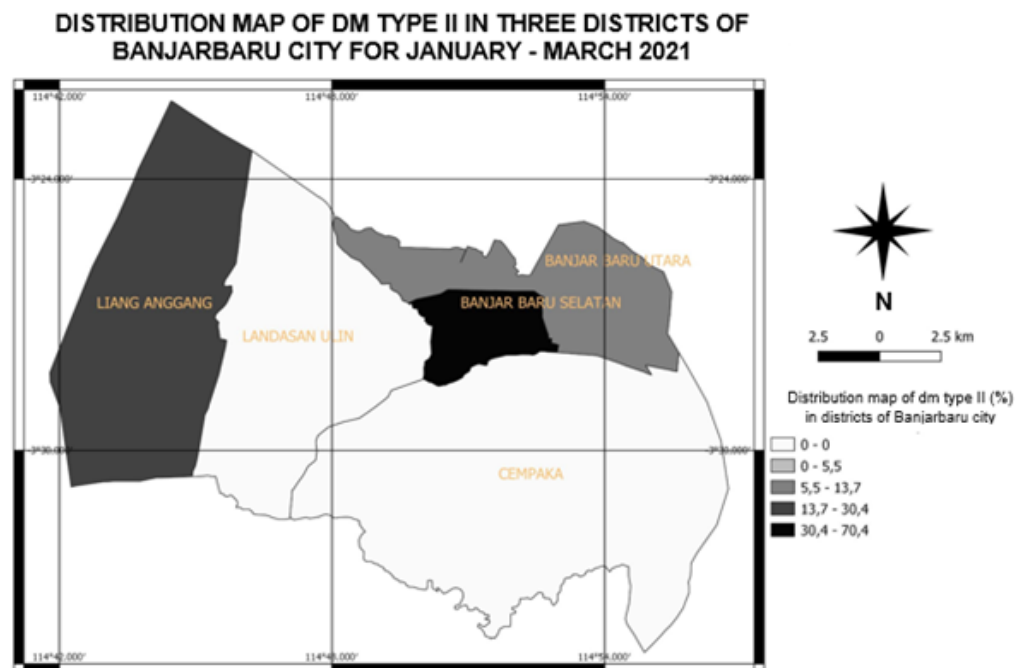


Figure 1. Distribution Map of DM Type II in Three Districts of Banjarbaru City

Based on the map above with a scale of 1: 211190 with color gradient technique, the distribution of the incidence of Diabetes Mellitus Type II in South Banjarbaru District is 70.4%, then Liang Anggang District is 20.4% and North Banjarbaru District is 9.2%.

Conclusion

There is no relationship between gender, marital status, employment status, education level, smoking, BMI, abdominal circumference, and lack of fruit and vegetable consumption on the incidence of diabetes mellitus type II. As for the incidence of diabetes mellitus type II is age. This study also illustrates the mapping of the distribution of the incidence of Diabetes Mellitus type II with a color gradation with a scale of 1: 211190, namely in South Banjarbaru District where there is a need for further intervention in the community regarding lifestyle and consumption patterns of vegetables and fruit. Thus, it is hoped that the community can make more efforts to maintain health by preventing the incidence of diabetes mellitus type II.

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