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RESEARCH

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Characteristics and Lifestyle Related to Blood Sugar Levels in Type 2 Diabetes Mellitus Patients

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Abstract

Type 2 diabetes mellitus has been a prominent public health issue today. Globally, an estimated 462 million people are affected by type 2 diabetes, equivalent to 6.28% of the world's population. Globally, an estimated 462 million people are affected by type 2 diabetes, equivalent to 6.28% of the world's population. In Asia, especially Indonesia, the number of cases is expected to increase to 21.3 by 2030 in Indonesia. Type 2 diabetes is determined by blood sugar level, which is affected by many factors including patients' characteristics and lifestyle habits such as physical activity and diet. The purpose of this research is to find the association between age, sex, education level, employment status, duration of disease, obesity, hypertension, diet, and physical activity with the blood glucose level of type 2 diabetic patients. This research used a cross-sectional study design. The population is type 2 diabetes mellitus patients. The population is type 2 diabetes mellitus patients who are spread over three areas of the city of Makassar, at the city center, suburban health center and coastal health center, total sample size of 273 patients. The research was conducted by sampling for 2 months via interview. The research instruments used were IPAQ and FFQ. The data analysis technique used is univariate and bivariate analysis, using chi-square. The results of this study indicate that there is a correlation between the variables. Lifestyle was found to be most associated with blood sugar level. Findings of the research found an association between duration ($p=0.003$), obesity ($p=0.000$), hypertension ($p=0.048$), diet ($p=0.000$), and physical activity ($p=0.000$) with blood sugar levels. Meanwhile, age ($p=0.461$), gender ($p=0.431$), education level ($p=0.357$), working status ($p=0.522$), were found not associated with blood sugar levels in patients with type 2 diabetes. The conclusion is that duration, obesity, hypertension, diet, and physical activity were found associated with blood glucose level in type 2 diabetic patients. Patients with type 2 diabetes are expected to maintain blood sugar level by implementing a healthy lifestyle. This includes regular physical activity and a balanced diet.

Keywords: Diabetes Mellitus, Blood Sugar Level, Life Style, Characteristics.

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1. INTRODUCTION

Diabetes Mellitus (DM) is a chronic disease affecting millions of people globally. World Health Organization (WHO) reported since 1980, the number of adults living with DM increased four times to 422 million people in 2021 (Veridiana & Nurjana, 2019). International Diabetes Federation (IDF) reported approximately 463 million adult suffers from diabetes which makes up 9,3% population of the world (International Diabetes Federation, 2019), (International Diabetes Federation, 2020). Within the same year, 4,2 million adults died from diabetes and its complications. Indonesia ranks seventh in countries with the highest cases of DM in the world, with 10.7 million patients (40 patients per 100.000 population) and 73,7% undiagnosed cases. There is an increase in DM prevalence according to blood sugar tests from 6,9% in 2013 to 8,5% in 2018 . Highest prevalence is in DKI Jakarta, followed by East Kalimantan, and Special Region of Yogyakarta (Kementerian Kesehatan Republik Indonesia, 2018), (World Health Organization, 2020). Estimates that the number of people with type 2 DM in Indonesia will increase significantly to 21.3 million people (70 patients per 10,000 population) by 2030 (World Health Organization, 2020) (Khan, 2020).

In South Sulawesi, proportion of DM still placed second for non-communicable disease after heart and blood vessel disease (15,79%) (Adri et al., 2020). Prevalence of DM increased from 1.6 % in 2017 to 1,7% in 2022 (Kementerian Kesehatan Republik Indonesia, 2018). Makassar is one of the areas of South Sulawesi with the highest number of DM patients, with the number of DM cases served as many as 18.305 (12,1 per 1000 population), and the number of DM disease targets of 79.608 (52,7 per 1000 population) (Dinas Kesehatan Kota Makassar, 2021).

Diabetes Mellitus (DM) is caused by a lack of insulin production by the pancreas. Insulin, a hormone produced by the pancreas, controls the glucose level in the blood by regulating its production and storage. Lack of insulin in the body can result in an increase in the concentration of glucose in the blood (hyperglycemia) (Tella et al., 2021). Blood sugar level is the amount of blood plasma glucose content used to establish the diagnosis of Diabetes Mellitus (Chaudhary & Tyagi, 2018). Diabetes mellitus has risk factors that are divided into two, namely modifiable factors and non-modifiable factors. Risk factors that cannot be modified are race, ethnicity, age, gender, family history of diabetes mellitus, history of giving birth to a baby >4,000 grams, and a history of Low Birth Weight (Isnaini & Ratnasari, 2018).

This research was conducted at Public Health Centre in Makassar. Report by Health Office Department of Makassar showed that three Public Health Centre has highest case of DM of 46 public health facility in Makassar (Dinas Kesehatan Kota Makassar, 2021). Based on the risk factors of type 2 diabetes previously mentioned, researcher concluded that characteristics of patients and daily habit plays a significant role in affecting blood sugar level, therefore this research aims to find the association between age, sex, education level, employment status, duration of disease, obesity, hypertension, diet, and physical activity with the blood glucose level of type 2 diabetes mellitus patients.

2. RESEARCH METHOD

The type of research used is observational analytics with a cross-sectional research design. This research was conducted in three Community Health Centers and was carried out for 2 months starting from early January to early March 2023. The population in this study were all Type 2 DM sufferers in the three working areas of the Makassar City Health Center with a total sample of 273 using a simple random sampling technique. Instruments used for this research are questionnaires adapted from *International Physical Activity Questionnaire 2005*) and *Food Frequency Questionnaire* (FFQ). Primary data was collected through interview via phone call, while the secondary data were collected from patients' medical record. The data analysis were univariate analysis and bivariate analysis using chi-square test. This research has

received ethical approval and its ethical number is 15655/UN4.14.1/TP.01.02/2022.

3. RESULTS AND DISCUSSION

Table 1. Distribution of Respondents based on Research Variables of Type 2 Diabetic Mellitus Patients Public Health Centre in Makassar.

Research Variables	Frequency (n)	Percentage (%)
Age		
Non-productive (>65 years)	132	48,4
Productive (15-65 years)	141	51,6
Sex		
Male	105	38,5
Female	168	61,5
Education Level		
Low (<High School)	210	76,9
High (\geq High School)	63	23,1
Employment Status		
Employed	198	72,5
Unemployed	75	27,5
Duration		
Short Duration (0-5 years)	114	41,8
Moderate Duration (6-10 years)	159	58,2
Blood Sugar Level		
Normal (<200 mg/dl)	138	50,5
High (\geq 200 mg/dl)	135	49,5
Obesity		
Obese (\geq 27 kg/m ²)	33	12,1
Normal (18,5-24,9 kg/m ²)	201	73,6
Overweight (25-27 kg/m ²)	39	14,3
Hypertension		
Hypertension	195	71,4
Non-hypertension	78	28,6
Diet		
Good	165	60,4
Poor	108	39,6
Physical Activity		
Low/moderate Physical Activity	141	51,6
High Physical Activity	132	48,4
Total	273	100

Table 1 showed the distribution of respondents based on the research variables of Type 2 DM patients. Total of 273 respondents were interviewed during the research. In this study, more than half of the respondents belong to productive age group with 141 people (51,6%) and 132 people (48,4%) belong to non-productive age group. The average age of the respondents is 64,8 years with median of 64 years. There are 168 female respondents (61,5%) and only 105 male respondents (38,5%). Most respondents received low education level with 210 people (76,9%) and 63 respondents (23,1%) received high education level. Majority of respondents are employed as much as 198 people (72,5%), while 75 respondents (27,5%) are unemployed.

Based on the duration, in average the respondents have suffered from Type 2 DM for 6 years with median of 7 years, with 159 people (58,2%) in moderate duration and 114 people (41,8%) in short duration. More respondents have normal blood sugar level with 138 people (50,5%) than those with high blood sugar level as many as 135 people (49,5%), with the average of 195 mg/dl and median of 200 mg/dll. Most of respondents have normal weight as many as 201 people (73,6%), while 39 people (14,3%) are overweight and 33 people (12,1%) are obese, average of Body Mass Index (BMI) of the respondents is 23,2 kg/m² while the median is 22,8 kg/m². Most of the respondents as many as 195 people (71,4%) also suffers from hypertension while 1088 people (28,6%) does not. Based on diet, more respondents as many as 165 people (60,4%) have good diet, while 108 people (39,6%) have poor diet. More respondents are doing low/moderate physical activity with 141 people (51,6%), while 132 people (48,4%) are doing high physical activity.

Table 1. Bivariate Analysis of Independent Variables with Blood Sugar Level of Type 2 Diabetic Patients at Public Health Center Makassar.

Independent Variables	Blood Sugar Level				Total		<i>p-value</i>
	Normal		High		n	%	
	n	%	n	%			
Age							
Productive	66	46,8	75	53,2	141	100	0,461
Non-productive	72	53,3	60	46,7	132	100	
Sex							
Male	57	55,8	45	44,2	102	100	0,432
Female	81	47,3	90	52,7	171	100	
Education Level							
Low	114	54,2	96	45,8	210	100	0,357
High	24	38,1	39	61,9	63	100	
Employment Status							
Employed	96	48,4	102	51,6	198	100	0,522
Unemployed	42	56	33	44	75	100	
Duration							
Short Duration	60	52,6	54	47,4	114	100	0,003
Moderate Duration	78	49	81	51	159	100	
Obesity							
Obese	3	9,1	30	90,9	33	100	0,000
Normal	126	62,6	75	37,4	201	100	
Overweight	9	23	30	77	39	100	
Hypertension							
Hypertension	96	49,3	99	50,7	195	100	0,048
Non-hypertension	42	53,8	36	46,2	78	100	
Diet							
Good	114	69	51	31	165	100	0,000
Not Good	24	22	84	78	108	100	
Physical Activity							
Low/moderate Physical Activity	6	4,3	135	95,7	141	100	0,000
High Physical Activity	132	100	0	0	132	100	

Table 2 showed the independent variable of blood sugar level of type 2 diabetic patients. The results of bivariate analysis using chi-square showed the value of $p=0,461$ ($p>0,05$),

indicating there are no significant association between age and blood glucose level of type 2 diabetic patients in Public Health Centre at Makassar. This indication also applies to sex variable with the value of $p=0,432$ ($p>0,05$) analysed using chi-square test. The result of chi-square analysis for education level showed the value of $p=0,357$ ($p>0,05$), indicating no relation between education level and blood sugar level within this population. For employment status, the analysis result using chi-square showed the value of $p=0,522$ ($p>0,05$), showing no association between employment status and blood sugar level in type 2 diabetic patients in the Public Health Centre Makassar. In terms of duration of disease, the chi-square test showed the value of $p=0,003$ ($p<0,05$), indicating duration of disease is associated with blood glucose level in type 2 diabetic patients of the Public Health Centre Makassar. Obesity was statistically analysed using chi-square test showing the value of $p=0,000$ ($p<0,05$), which showed a the Public Health Centre Makassar. Hypertension was statistically analysed using chi-square test showed the value of $p=0,0048$ ($p<0,05$), indicating is significant association between hypertension and blood sugar level in type 2 diabetic patients of Public Health Makassar. Diet was statistically analysed using chi-square test showed the value of $p=0,000$ ($p<0,05$), showing a significant relation between diet and blood sugar level in type 2 diabetic patients of the Public Health Makassar. Physical activity was statistically analysed using fisher's exact test showed the value of $p=0,000$ ($p<0,05$), indicating physical activity is associated with blood glucose level in type 2 diabetic patients of the Public Health Makassar.

It is found that there is no significant difference of blood sugar level between productive age and non-productive age. Both age groups have the same chance of having higher blood sugar level. The result of statistical bivariate analysis showed that age was not associated with blood glucose level in type 2 diabetic patients at the Public Health Centre Makassar ($p=0,461$). However this findings are not in line with study conducted by Latifah, which found higher level of blood sugar level in non-productive age groups compared to their counterparts (Latifah, 2020). Increase in age lead to lower physiology, secretion, and insulin resistance so the ability to control hyperglycemia in body is not optimal (Chaudhary & Tyagi, 2018).

Female patients are more likely to have higher blood glucose level compared to male. The result of statistical bivariate analysis showed that there was no association between sex and blood sugar level in type 2 diabetic patients at the Public Health Centre Makassar ($p=0,432$). Study by Mauvais-jarvis & Orleans argued that blood sugar level tend to be higher in female because the premenstrual syndrome and other hormonal process plays a role in this factor, increasing the risk of increased blood sugar level for this gender (Mauvais-jarvis & Orleans, 2018). A similar study also conducted by Milita et al., (2021) found that blood sugar in the female gender was higher (55.4%) compared to the male gender. Other study suggests gender does not affect blood sugar level, as it varies depending on habits and lifestyles of type 2 diabetic patients (Boku, 2019). Contradicting study by (Komariah & Rahayu, 2020), however, found that female tend to have normal blood sugar level than male

Majority of patients completed high level of education. The result of statistical bivariate analysis showed education level is not associated with blood glucose level in type 2 diabetic patients in the Public Health Centre Makassar ($p=0,357$). This finding is affected by other external factor. Patients may know how to control their blood sugar levels from medical examinations and pamphlets, but they also do not want to control their blood sugar levels. Other findings by Pahlawati & Nugroho found association between education level and blood glucose level (Pahlawati & Nugroho, 2019).

Employed patients have higher blood glucose level compared to their counterpart. The result of statistical bivariate analysis showed no association between employment status and

blood glucose level in type 2 diabetic patients in the Public Health Centre Makassar ($p=0,522$). This finding is in line with research by Zahroh, Ningtyas & Sawitri showing that patients with less work load tend to have higher blood sugar level compared to those with heavy work load, this is because of higher chances of obesity from less of physical activity often done while working (Zahroh et al., 2018). Other study by Arania et al found contradicting result, however association found in this research was weak since blood sugar level can be suppressed if the person is working with a high level of physical activity (Arania et al., 2021).

Patients suffering with type 2 diabetes for moderate duration (6-10 years) tend to have higher blood glucose level. The result of statistical bivariate analysis showed is relation between duration of disease and blood sugar level in type 2 diabetic patients in Public Health Centre Makassar ($p=0,003$). This finding is in line with study conducted by Rahayu, Sataswati & Setyawan, which argues that blood sugar level will be controlled as long as therapy is done accordingly and healthy lifestyle is implemented regardless of how long one has suffered from diabetes (Rahayu et al., 2018). Previous study by Hariani et al showed that duration of disease is related to blood sugar level. This is due to the control of blood glucose is worsened as the duration of disease increase, this is due to a decrease in the ability of insulin secretion by pancreatic beta cells due to a long workload as compensation for an increase in glucose levels in blood (Hariani et al., 2020).

Patients with obesity have higher blood sugar level compared to those in normal weight and overweight. The result of statistical bivariate analysis showed significant association between obesity and blood sugar level in type 2 diabetic patients in the Public Health Centre Makassar ($p=0,000$). Another study conducted (Ardiani et al., 2021) showed that obesity has a significant influence on the incidence of diabetes mellitus. Previous research conducted by Masruroh showed significant relation between obesity and blood glucose level. This is due to insulin resistance, reducing the supply of glucose to the cells and stimulating pancreatic cells to produce and excrete excess insulin. The presence of high insulin levels can generally control blood sugar levels for several months. However, this can decrease productivity because the cells in the pancreas are too heavy to function. Finally, insulin production slows down and then stops. As a result, glucose accumulates in the blood and becomes high (Masruroh, 2018).

Most of patients with hypertension have higher level of blood glucose level. The results of statistical bivariate analysis showed that there was association between hypertension and blood sugar level of people with type 2 diabetes mellitus at the Public Health Centre Makassar ($p=0,0488$), previous study by Putra shown similar findings of significant relation between hypertension and blood sugar level. Based on this study, the relationship between hypertension and blood sugar levels is very complex, hypertension can reduce the sensitivity of cells to insulin (insulin resistant) which causes disturbances in blood sugar levels (Putra, 2018). Other studies have found that there is a relationship between hypertension and blood sugar levels (Choi et al., 2023).

Higher blood sugar level was found more prominent in patients with poor dietary habit. The results of statistical bivariate analysis showed a significant association between diet and blood glucose level in type 2 diabetic patients in the Public Health Centre Makassar ($p=0,000$). Previous study by Rahmawati, Wahyuningsih & Yalastyarini shown the two variables are associated, blood glucose level often affected by diet (Rahmawati, Wahyuningsih & Yalastyarini, 2018). Diet is an important determinant of obesity and insulin resistance. Excessive energy intake will increase insulin resistance even if there has not been a significant weight gain hence increase the risk of high blood sugar levels (Pratiwi et al., 2021). Food consumption based on the amount, type, and time of eating influences high blood sugar levels in a person (Komariah & Rahayu, 2020).

Patients with low/moderate physical activity were found with high blood sugar level compared to their counterpart. The results of statistical bivariate analysis showed a significant

association between physical activity and blood glucose level in type 2 diabetic patients in the Public Health Centre Makassar ($p=0,000$). This finding is in line with study by Sari & Purnama, which shown patients with less or no physical activity has higher blood glucose level and less controlled insulin sensitivity (Sari & Purnama, 2019). Individuals with light activity or rarely do sports result in food substances that enter the body being accumulated into fat and sugar. Regular physical activity or exercise is associated with an increase in the speed of recovery of muscle glucose. When doing physical activity or exercising, muscles take glucose from the blood to increase blood glucose control (Tella et al., 2021). Other study by Azitha, Aprilia, & Ilhami found contradicting findings, shown that patients with low physical activity have normal blood sugar level, this is due to majority of patients are elders hence unable to do high physical activity (Azitha et al., 2018). Therefore, quality of life has a relationship with diabetes mellitus (Zhang et al., 2023). The main limitations of our study include reliance on secondary secondary data, which in turn is affected by measurement accuracy, changes in case definitions. The sample in this study is also still quite small. Future research can expand the scope of the sample.

4. CONCLUSION

There was an association found between obesity, diet, and physical activity with blood sugar levels duration, hypertension. Meanwhile, age, gender, education level, working status, were factors that did not associated with blood sugar levels in patients with type 2 diabetes. It is recommended for people with Type 2 DM to always apply healthy lifestyle behaviors, especially maintaining a diet according to the recommendations for the type, amount, and time of eating as well as doing physical activity regularly so that blood sugar levels in the body are always controlled and prevent complications of diabetes mellitus.

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