Relationship of Leukocyte Numbers and Triglyceride Levels in Type 2 Diabetes Mellitus Patients

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ABSTRACT

Diabetes mellitus is a metabolic disorder characterized by hyperglycemia due to abnormalities in insulin secretion, insulin action or both and is included in the group of non-communicable diseases. In patients with type 2 diabetes mellitus, progressive hyperglycemia occurs resulting in insulin deficiency, where insulin deficiency can damage lipoprotein lipase activity and result in lower HDL levels and higher triglyceride levels. High triglyceride levels in type 2 diabetes mellitus patients result in increased macrophage infiltration into adipose tissue which causes an increase in the number of leukocytes. The aim of this research is to determine the relationship between the number of leukocytes and triglyceride levels in people with type 2 diabetes mellitus. This type of research is a quantitative descriptive laboratory observational approach. The number of samples in this research was 35 samples obtained through techniques*purposive sampling*. Based on the results of the Pearson correlation static test analysis to determine the relationship between the number of leukocytes and triglyceride levels in type 2 diabetes mellitus sufferers, the sig value was 0.035, while for the*Personal Correlation* namely 0.358 so it was concluded that there was a relationship indicating that there was sufficient correlation between the number of leukocytes and triglyceride levels

Keywords: Diabetes Mellitus, Triglycerides, Leukocytes

I. INTRODUCTION

Diabetes mellitus is a long-term chronic metabolic disorder characterized by blood sugar levels exceeding normal limits and is included in the group of non-communicable diseases. Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia due to abnormalities in insulin secretion, insulin action or both. Chronic hyperglycemia in diabetes is associated with long-term damage, dysfunction and damage to various organs, especially the eyes, kidneys, nerves, heart and blood vessels (Indonesian Ministry of Health, 2020).

Diabetes Mellitus (DM) occurs when there is a disturbance in the pancreas which then increases glucose levels, so that there will be a disturbance in carbohydrate metabolism where carbohydrates cannot be a perfect source of energy, in this case fat and protein are the source of energy because the body's cells also cannot. store glucose in the form of glycogen. Diabetes mellitus is divided into four, namely Type 1 diabetes mellitus, Type 2 diabetes mellitus, gastational diabetes mellitus and other specific diabetes mellitus (Sunita & Laksono, 2019).

Type 2 diabetes mellitus (T2DM) is the predominant form of diabetes mellitus, accounting for around 90% of all diabetes mellitus cases. There is a combination of genetic factors (related to impaired insulin secretion, insulin resistance) and environmental factors (obesity, lack of exercise, stress, and the aging process) in type 2 diabetes mellitus (Maratni, 2018).

Based on *International Diabetes Federation* (IDF) found that diabetes in 2019 was 9% in women and 9.65% in men. Diabetes mellitus is estimated to spread as the population increases to 19.9% or 111.2 million people aged 65-79 years. Indonesia is ranked 7th out of 10 countries with the highest number of diabetes mellitus sufferers, namely 10.7 million people (Ministry of Health, 2020). Based on the prevalence of diabetes mellitus in South Sulawesi, it is ranked 17th out of 34 provinces in Indonesia with a number of cases of 1.3% and the highest number of diabetes mellitus sufferers is in Wajo district at 2.19% (Riskesdas, 2018).

In patients with type 2 diabetes mellitus, progressive hyperglycemia occurs resulting in insulin deficiency, where insulin deficiency can damage lipoprotein lipase activity and result in lower HDL levels and higher triglyceride levels. Insulin resistance is related to increased insulin levels in the serum and reduced beta cell mass which causes disruption of the regulation of lipoproteins, as a result of which insulin fails to suppress the liver in producing insulin. *Very Low-Density Lipoprotein* (VLDL) resulting in increased triglyceride levels (Rasyid *et al*, 2018). Triglycerides (TG) are the main form of fat stored by the body. The main function of triglycerides is as an energy source, someone who has diabetes mellitus usually experiences an increase in triglyceride levels (Nizar & Amelia, 2022).

High triglyceride levels in type 2 diabetes mellitus patients increase macrophage infiltration into adipose tissue, this is because adipose tissue is a storage place for food reserves in the form of triglycerides, where if insulin resistance occurs then glucose cannot be used as an energy source, so the body will uses other food reserves as an energy source, namely triglycerides. The breakdown of triglycerides occurs in adipose tissue which continuously causes an increase in free fatty acids (FFA). The increase in free fatty acid levels causes oxidative stress, which then as a result of this oxidative stress triggers systemic inflammation resulting in an inflammatory mechanism, namely the infiltration of macrophages into adipose tissue, which then produces adipokines. Activated adipokines will activate pro-inflammatory cytokines such as Interleukin-6, Tumor Necrosis Factor-α, MCP-1 (Dinutanayo & Akhriani, 2021). The secretion of pro-inflammatory cytokines in hypertriglyceridemia activates inflammatory cells, namely leukocytes, especially monocytes, macrophages and lymphocytes, which causes cytokines produced by macrophages to also change the process of fat metabolism and markers of inflammation in type 2 diabetes mellitus patients (Hasanah, 2016).

High levels of blood fats such as triglycerides in diabetes mellitus sufferers, apart from increasing the number of leukocytes as a result of systemic inflammation, can also cause reduced elasticity of blood vessels. Excessive fat accumulation in arterial blood vessels can activate inflammatory processes in vascular endothelial tissue, especially in arteries with disrupted non-laminar flow, which causes endothelial dysfunction. As a result, it activates inflammatory processes, migration and cell proliferation. This is related to masovascular complications in diabetes mellitus sufferers. Activated inflammatory cells, especially monocytes, will migrate to the subendothelial layer by binding to endothelial adhesive molecules. Once in the subendothelial layer, these cells undergo differentiation into macrophages. Macrophages will digest oxidized fat which also penetrates the walls of the arteries and then turns into *foam cell* and then forming *fatty streaks*. Activated macrophages release pro-inflammatory cytokines that further activate this process by recruiting more macrophages, T cells and

vascular smooth muscle cells (which synthesize extracellular matrix components) at the site of plaque formation, resulting in an increase in the number of leukocytes in the blood vessels (Pratama*et al* 2017).

II. .METHODS

A. Types of research

The type of research used in this research is a quantitative descriptive laboratory observational approach.

B. Location and Time of Research

1. Research sites

The location of the research was carried out at Labuang Baji Regional Hospital, Makassar.

2. Research time

The research will be carried out in October 2023 until the sample is sufficient.

C. Population and Sample

1. Population

The population in this study is all sufferers of Type 2 Diabetes Mellitus, both inpatients and outpatients at Labuang Baji Regional Hospital, Makassar.

2. Sample

All Type 2 Diabetes Mellitus sufferers who came for a health examination, both inpatient and outpatient and who met the inclusion criteria.

3. Sampling technique

The sampling technique is carried out using techniques*Purposive Sampling*.

4. Sample Size

The samples used in the research were patients with type 2 diabetes mellitus with a total of 35 samples used in accordance with the research inclusion criteria.

D. Research subject criteria

1. Inclusion criteria

a. Type 2 Diabetes Mellitus sufferers

b. The duration of suffering from Diabetes Mellitus is 1-5 years

c. Fasting for 10-12 hours.

d. Do not take antibiotics (Tetracycline, Clindamycin, β-lactams, Glycopeptides)

It is. Willing to be a research subject.

2. Exclusion criteria

a. Incomplete data (identity and disease history).

b. Hemolysis samples.

c. Lipemic samples.

d. Frozen Samples.

A. Works procedure

a. Triglyceride examination

a. Tools and materials

The tools used are*cobas C311 Analyzer* well, torniquet,*centrifuge,* yelow tip and personal protective equipment used, namely laboratory coats, masks and*handscoon.*

The materials used are syringe, serum, tissue,*70% alcohol cotton,*plaster, vacuum tube, urea reagent.

b. Venous blood collection procedure

Prepare the tools and materials that will be used. The patient is asked to straighten the hand/arm, choose the hand that the patient uses most often in carrying out activities. The patient is asked to make a fist and then apply a tourniquet approximately 10 cm above the elbow crease. Rub an alcohol swab on the part of the arm that will be pierced, then let it dry. The vein is punctured with the needle hole facing upwards. When the needle has entered the vein, you will see blood entering the syringe, then pull the plunger and draw enough blood. Place dry cotton at the injection site, then withdraw the needle slowly and press the cotton for a few moments until blood no longer comes out of the patient's hand, then plaster the injection site. Insert the syringe into the vacuum tube so that the blood in the syringe flows into the non-coagulant tube.

c. Serum separation procedure

Let the blood sit until it clots. Centrifuge the blood at 3000 rpm for 15 minutes. Pipette 500 µl of centrifuged serum. Store the serum inside *sample cup.*

d. Inspection

The tools and materials to be used are prepared. Clicked "*work place*" " *test selection*" "*routine*" is entered into the sample disk position number sequence on the sample disk. Sample included*ID* patient. Select the type of test that will be checked, namely triglycerides, then save it. Clicked*start,* Waiting for the results in the form of a print out.

Interpretation of Results

Triglyceride levels   : <150 mg/dL.

b. Leukocyte Count Examination

a. Preparation of tools and materials

The tools used are*Hematology Analyzer*MS-H630, tourniquet and personal protective equipment used are laboratory coats, masks and*handscoon.*

The materials used are, spoit, tissue,*70% alcohol cotton,*plaster, EDTA vacuum tube.

b. Venous blood collection procedure

Prepare the tools and materials that will be used. The patient is asked to straighten the hand/arm, choose the hand that the patient uses most often in carrying out activities. The patient is asked to make a fist and then apply a tourniquet approximately 10 cm above the elbow crease. Rub an alcohol swab on the part of the arm that will be pierced, then let it dry. The vein is punctured with the needle hole facing upwards. When the needle has entered the vein, you will see blood entering the syringe, then pull the plunger and draw enough blood. Place dry cotton at the injection site, then withdraw the needle slowly and press the cotton for a few moments until blood no longer comes out of the patient's hand, then plaster the injection site. Insert the syringe into the vacuum tube so that the blood in the syringe flows into the EDTA vacuum tube.

c. Works procedure

Turn on the hematology analyzer, press the power button. Wait for the tool to work until it is finished and control the tool first, make sure the tool is in the ready position. Homogenize the sample to be examined, then press the "WB" Whole Blood button on the monitor screen. Press the sample ID button by filling in the sample data and press OK. Direct the vacuum tube with the open lid towards the needle on the

tool and press the suction button, leave it for a few moments then the results will appear in the form of a print out.

Interpretation of Results

Count the number of leukocytes   : 4000-11.000 sel/μL.

H. Data Analysis

Data from research results are processed and presented in the form of tables and narratives and using correlation statistical tests with the decision making requirement that if $p>0.05$ then it is accepted and if $p<0.05$ then it is rejected to find out whether there is a relationship between the number of leukocytes and triglyceride levels in sufferers of type 2 diabetes mellitus. .

III. RESULTS AND DISCUSSION

A. Research result

Based on research conducted at the Labuang Baji Regional Hospital, Makassar in October 2023, by checking the number of leukocytes associated with triglyceride levels in 35 people with type 2 diabetes mellitus, the following results were obtained:

Table 4.1 Characteristics of Research Subjects in Type 2 Diabetes Mellitus Sufferers

Characteristics of Research Subjects		Amount (n)	Percentage(%)
Gender	Man	14	40%
	Woman	21	60%
	Total	35	100%
Age	42-48 Years	12	34%
	49-55 Years	23	66%
	Total	35	100%
Lama DM	≥3	8	23%
	≥4	11	31%
	≥5	16	46%
	Total	35	100%
IMT	Normal body weight: 18.5-22.9	-	-
	Overweight: 23-24,9	11	31%
	Obesity I: 25-29.9	10	29%
	Obesity II: ≥ 30	14	40%
	Total	35	100 %
Blood pressure	Pre-Hypertension : 120-139/80-89	2	6%
	Hypertension I: 140-159/90-99	33	94%
	Hypertension II: ﹥160/﹥100		
	Total	35	100%

Table 4.1 shows that the total number of research subjects was 35 people with type 2 diabetes mellitus. Based on gender, the average was found to be women compared to men, 21 women (60%) and 14 men (40%). Based on the age group 42-48 years as many as 12 people (34%) subjects and aged 49-55 years as many as 23 (66%) subjects, results were obtained based on the duration of suffering from type 2 diabetes mellitus, namely from ≥3 years as many as 8 people (23%) subjects, ≥ 4 years as many as 11 people (31%) subjects and ≥ 5 years as many as 16 people (46%) subjects. Based on the body mass index (BMI) criteria, namely the overweight category, 11 people (31%), 10 people (29%) were obese I subjects and 14 people (40%) were obese II subjects, based on blood pressure, they were in the Pre- hypertension was 2 people (6%) subjects and hypertension level I was 33 people (94%) subjects.

Table 4.2 Results of Examination of Leukocyte Counts with Triglyceride Levels in Type 2 Diabetes Mellitus Patients Based on Gender

Gender (M/M)	Leukocyte count (10^3/μL)				Triglyceride Levels (mg/dl)			
	Normal	Height	Mean	Rate-rate	Normal	Height	Mean	Rate-rate
Woman	7 (20%)	14 (40%)	11.5	10.8	4 (11%)	18 (51%)	163	158.9
Man	9 (26%)	5 (14%)	9	9.3	2 (7%)	11 (31%)	152.5	159.7
Total	35 (100 %)				35 (100%)			

Based on table 4.2, it can be seen that the results of the leukocyte count examination based on gender showed that in women the leukocyte count was normal in 7 people (20%) subjects with an average examination result of 10.8 10^3/μL and mean value 11.5 10^3/μL, while in men the number of leukocytes was normal in 9 people (26%) subjects, the number of leukocytes which was increased in women was 14 people (40%) subjects and there were 5 people (14%) subjects in men with an average of average examination results 9.3 10^3/μL and mean value 9 10^3/μL.

Based on table 4.2, it can be seen from the results of examining Triglyceride levels based on gender. The results obtained in women were normal Triglyceride levels in 4 people (11%) subjects with an average examination result of 158.9 mg/dl and a mean value of 163 mg/dl, while in men - For men, 2 (7%) subjects had normal Triglyceride levels, 18 (51%) subjects had increased Triglyceride levels in women and 11 (31%) men subjects with an average test result of 159.7 mg /dl and the mean value was 152.5 mg/dl.

Table 4.3 Results of Examination of Leukocyte Counts with Triglyceride Levels in Type 2 Diabetes Mellitus Patients Based on Age

Age (Years)	Leukocyte count (10^3/μL)				Triglyceride Levels (mg/dl)			
	Normal	Height	Mean	Rate-rate	Normal	Height	Mean	Rate-rate

	12 (35%)	-	12.24	11.5	3 (9%)	10 (29%)	170	162.4
49-55	4 (12%)	18 (53%)	8.23	8.03	3 (8%)	19 (54%)	150	153.8
Total	35 (100 %)				35 (100%)			

<div align="center">(Source: Primary Data, 2023).</div>

Based on table 4.3, it can be seen that the results of the examination of the number of leukocytes based on age showed that at the age of 42-48 years the number of normal leukocytes was 12 people (35%) subjects, while at the age of 49-55 years the number of normal leukocytes was 4 people (12%) subjects. with an average examination result of 11.5 $10^3/\mu L$ and mean value 12.24 $10^3/\mu L$, the number of leukocytes did not increase at the age of 42-48 years, while at the age of 49-55 years there was an increase in 18 people (53%) subjects with an average examination result of 8.03 $10^3/\mu L$ and mean value 8.23 $10^3/\mu L$.

Based on table 4.3, it can be seen that the results of examining Triglyceride levels based on age showed that at the age of 42-48 years the Triglyceride levels were normal in 3 people (9%) subjects, while at the age of 49-55 years the Triglyceride levels were normal in 3 people (8%) subjects. with an average examination result of 162.4 mg/dl and a mean value of 170 mg/dl, triglyceride levels increased at the age of 42-48 years as many as 10 subjects (29%), while at the age of 49-55 years there was an increase of 19 people (54%) subjects with an average examination result of 153.8 mg/dl and a mean value of 150 mg/dl.

Table 4.4 Results of Examination of Leukocyte Counts with Triglyceride Levels in Type 2 Diabetes Mellitus Patients Based on the Length of Type 2 Diabetes Mellitus Suffering

Long Suffering from DM (Years)	Leukocyte count ($10^3/\mu L$)				Triglyceride Levels (mg/dl)			
	Normal	Height	Mean	Rate-rate	Normal	Height	Mean	Rate-rate
≥3	8 (23%)	-	6.51	7.13	2 (6%)	6 (17%)	152	154.5
≥4	5 (14%)	6 (17%)	10.38	9.95	2 (6%)	10 (28%)	151	149.1
≥5	3 (9%)	13 (37%)	13.12	12.1		15 (43%)	170	169.8
Total	35 (100 %)				35 (100%)			

<div align="center">(Source: Primary Data, 2023).</div>

Table 4.4 shows the results of the number of leukocytes based on the category of duration of suffering from type 2 diabetes mellitus. The results showed that for a duration of suffering ≥ 3 years, the number of normal leukocytes was 8 people (23%) subjects with an average examination result of 7.13 $10^3/\mu L$ and mean value 6.5 $10^3/\mu L$, while in those with a duration of suffering ≥ 4 years there was an increase in 6 people (17%) and the number of normal leukocytes was 5 people (14%) subjects with an average examination result of 9.5 $10^3/\mu L$ and mean value 10.38 $10^3/\mu L$, as well as for those suffering

from a duration of ≥ 5 years, the number of leukocytes was normal in 3 people (9%) subjects and 13 people (37%) subjects experienced an increase with an average examination result of 12.1 10^3/μL and mean value 13.12 10^3/μL.

Table 4.4 shows the results of total triglyceride levels based on the category of duration of suffering from type 2 diabetes mellitus. The results showed that for duration of suffering ≥ 3 years, triglyceride levels were normal for 2 people (6%) subjects and 6 people (17%) subjects experienced an increase with an average the examination result was 154.5 mg/dl and the mean value was 152 mg/dl, while for those suffering from ≥ 4 years there was an increase in 10 people (28%) and normal triglyceride levels in 2 people (6%) with an average examination result of 149.1 mg /dl and a mean value of 151 mg/dl, as well as those with a long history of suffering ≥ 5 years who experienced an increase in triglyceride levels as many as 15 people (43%) subjects with an average examination result of 169.8 mg/dl and a mean value of 170 mg/dl.

Table 4.5 Results of Leukocyte Count Examination in Type 2 Diabetes Mellitus Patients Based on BMI and Hypertension

Characteristics	Leukocyte Count		Mean	Rate-rate	Number of people	Percent (%)
	Normal	Height				
IMT					35	100%
Excess body weight	10	1	9.33	8.44		
Obesity I	5	5	8.6	9.9		
Obesity II	-	14	12.3	11.63		
Hypertension					35	100%
Pre-Hypertension		2	12.5	12.5		
Hypertension I	16	17	11.2	10.1		

(Source: Primary Data, 2023).

Table 4.5 shows the results of the number of leukocytes based on the BMI and Hypertension categories. Based on the BMI category, the results showed that for overweight, the number of leukocytes was normal for 10 people (28%) subjects and an increase in the number of leukocytes for 1 person (3%) subjects with an average examination result of 8.44. 10^3/μL and mean value 9.33 10^3/μL, while in obesity I there was an increase in 5 people (14%) and the number of normal leukocytes was 5 people (14%) subjects with an average examination result of 9.9 10^3/μL and mean value 8.6 10^3/μL, as well as for obesity II, the number of leukocytes increased by 14 people (40%) subjects with an average examination result of 11.63 10^3/μL and mean value 12.3 10^3/μL.

Table 4.5 shows the results of the number of leukocytes based on the category of hypertension, type 2 diabetes mellitus. Based on the pre-hypertension results, the number of leukocytes increased by 2 people (6%) with an average examination result of 12.5 10^3/μL and mean value 12.5 10^3/μL, while in hypertension I there was an increase in 17 people (48%) subjects and normal triglyceride levels in 16 people (46%) subjects with an average examination result of 10.1 10^3/μL and mean value 11 10^3/μL.

Table 4.6 Results of Examination of Triglyceride Levels in Type 2 Diabetes Mellitus Patients Based on BMI and Hypertension

Characteristics	Triglyceride levels		Mean	Rate-rate	Number of people	Percent (%)
	Normal	Height				
IMT					35	100%
Excess body weight	2	9	150	147		
Obesity I	3	7	159	156		
Obesity II	-	14	170	169		
Hypertension					35	100%
Pre-Hypertension	2		112	112		
Hypertension I	4	29	160	162		

(Source: Primary Data, 2023).

Table 4.6 shows the results of triglyceride levels based on the BMI and Hypertension categories. Based on the BMI category, the results for overweight were normal triglyceride levels in 2 people (6%) subjects and increased triglyceride levels in 9 people (26%) subjects with an average examination result of 147 mg/dl and a mean value of 150 mg/dl, while in obesity I there was an increase in 7 people (20%) and normal triglyceride levels in 3 people (8%) subjects with an average examination result of 156 mg/dl and a mean value of 159 mg/dl, as well as for obesity II, triglyceride levels increased in 14 people (40%) subjects with an average examination result of 169 mg/dl and a mean value of 170 mg/dl.

Table 4.6 shows the results of total triglyceride levels based on the category of hypertension, type 2 diabetes mellitus. The results obtained based on pre-hypertension were normal triglyceride levels in 2 people (6%) with an average examination result of 112 mg/dl and a mean value of 112 mg/dl, while for hypertension I there was an increase in 29 people (83%) subjects and normal triglyceride levels in 4 people (11%) subjects with an average examination result of 162 mg/dl and a mean value of 160 mg/dl.

Table 4.7 Distribution Results of Examination of Leukocyte Counts and Triglyceride Levels in Type 2 Diabetes Mellitus Patients at Labuang Baji Hospital, Makassar City

Characteristics	Leukocyte count (10^3/μL)				Triglyceride Levels (mg/dl)			
	Amount	Percentage (%)	Mean	Rate-rate	Normal	Height	Mean	Rate-rate
Increased	19	54%	12.5	12.1	29	83%	165	164.6

Normal	16	46%	7.3	7.4	6	17%	142.5	133.2
Decrease	-	-						
Total	35 (100 %)				35 (100%)			

(Source: Primary Data, 2023).

Based on table 4.7, the results of examining Triglyceride levels in type 2 diabetes mellitus sufferers showed that 35 respondents experienced an increase in Triglyceride levels, 29 people (83%) subjects with an average examination result of 164.6 mg/dl and a mean value of 165 mg/dl, while there were 6 people (17%) of the subjects had normal triglyceride levels with an average examination result of 133.2 mg/dl and a mean value of 142.5 mg/dl.

Based on table 4.7, the results of the examination of the number of leukocytes in type 2 diabetes mellitus sufferers in 35 respondents experienced an increase in the number of leukocytes by 16 people (54%) with an average examination result of 12.1 $10^3/\mu L$ and mean value 12.5 $10^3/\mu L$, while 16 people (17%) subjects had a normal leukocyte count with an average examination result of 7.4 $10^3/\mu L$ and mean value 7.3 $10^3/\mu L$.

Table 4.8 Analysis of the Relationship between Leukocyte Counts and Triglyceride Levels in Type 2 Diabetes Mellitus Patients Using the Pearson Correlation Test

Variable	N (Number)	R	*Personal Correlation (p)*
Leukocyte Count Triglyceride levels	35 (100%)	0.035	0.358

(Source: Primary Data, 2023).

Table 4.8 shows the relationship between the number of leukocytes and triglyceride levels in type 2 diabetes mellitus sufferers, it was found to have a sig value of 0.035, while the *Personal Correlation* namely 0.358.

Based on the table above, if the sig value is smaller than <0.05 then there is a relationship, conversely if the sig value is greater than >0.05 then there is no relationship. As for value *Person Correlation* if it is at 0.00-0.25 it can be said to have a very weak correlation, then if it is at a value of 0.26-0.50 it can be said to have a sufficient correlation, then if it is at a value of 0.51-0.75 it has a strong correlation, if it is at a value of 0.76-0.99 it has a very strong correlation and if it is at a value of 1.00 it has a perfect correlation, so it can be concluded that the results of the correlation test between the number of leukocytes and triglyceride levels in type 2 diabetes mellitus sufferers have a sig value of 0.035 There is a relationship between the number of leukocytes and triglyceride levels, and for value *Personal Correlation* namely 0.358 can be said to have sufficient correlation.

B. Discussion

Based on research carried out at Labuang Baji Hospital, Makassar City in October 2023, an examination was carried out to determine the relationship between the number of leukocytes and triglyceride levels in sufferers of type 2 diabetes mellitus as many as 35 research subjects using the technique*Purposive sampling* using the Cobas C311 method*Enzymatic colorimetry test* for checking triglyceride levels and using tools*Hematology analyzer* MS-H630 metode *flocytometri* to check the leukocyte count.

Table 4.1 shows the characteristics of research subjects based on gender. Female subjects were more likely to suffer from type 2 diabetes mellitus. Gender is one of the factors related to the occurrence of diabetes mellitus. This occurs because female respondents are more interested in carrying out examinations so that the data obtained is also mostly women, but this is in line with Bantas' research*et al* (2012) stated that women suffer from type 2 diabetes mellitus with metabolic syndrome more often than men and also in the female gender category, this is one of the factors causing metabolic syndrome which is characterized by an excessive increase in blood glucose levels caused by physical activity and Unhealthy lifestyle, as well as hormonal factors, cause women to be 2 times more likely to develop diabetes mellitus than men (Bantas*et al*, 2012).

Characteristics of research subjects based on age, the highest incidence of type 2 diabetes mellitus in respondents aged 49-55 years is because at this age many people tend to carry out controlled health checks because they have entered an age that is susceptible to disease, both type 2 diabetes mellitus and other diseases. This is in line with the theory that people over the age of >45 years usually experience changes in body composition that cause loss of muscle mass, so that a decrease in the basal metabolic rate of this variable contributes to the development of diabetes mellitus. According to Dabla (2010) who states that metabolic syndrome sufferers are more likely to suffer from those aged >45 years. Age is a risk factor for type 2 diabetes mellitus, where the older you get, the higher the risk of diabetes mellitus with metabolic syndrome (Dabla, 2010).

Characteristics of research subjects based on the length of time they have suffered from diabetes mellitus, there are more research subjects with a duration of 4-5 years, this is because respondents who have suffered from type 2 diabetes mellitus for a long time will experience many complaints of other health problems so that they go to the hospital more often because they have to always carry out regular health checks, in accordance with the theory according to Hariani, Jalil & Putra (2018) that the longer a person suffers from type 2 diabetes mellitus, the greater the risk of health problems that will reduce the ability of pancreatic beta cells to produce sufficient insulin to meet the body's needs, Apart from that, the health of the body's organs will get worse over time due to uncontrolled blood glucose levels (Hariani, Jalil & Putra, 2018).

Characteristics of research subjects based on body mass index (BMI) there were more research subjects who were obese or had a body mass index (BMI) of $\geq 30 kg/m^2$, this can happen because the respondents used in this study do not maintain a healthy lifestyle so they easily experience obesity and type 2 diabetes mellitus. According to Saputra, one of the factors causing someone to experience type 2 diabetes mellitus is obesity so that more people will be found. diabetes and obesity. An increase in body mass index can cause high free fat deposits which ultimately triggers fat oxidation thereby inhibiting the use of glucose in muscles. Excessive fat deposits in the body of obese sufferers can result in insulin resistance which affects blood sugar levels which causes diabetes mellitus 2 (Saputra*et al*, 2020).

Characteristics of research subjects based on blood pressure, there were more research subjects who experienced increased blood pressure, this was because the research subjects had a history of hypertension caused by genetics or an unhealthy lifestyle. In accordance with the theory that hypertension in diabetes mellitus sufferers occurs due to increased sodium and water absorption, it is suspected that hypertension in diabetes mellitus sufferers causes intravascular volume expansion accompanied by hyperinsulin. In addition, hyperinsulinemia increases the activity of Na-K ATPase channels, which increases intracellular sodium and calcium levels and causes increased vascular smooth muscle contraction and endothelial dysfunction both of which play an important role in the development of hypertension (Rohman, 2007).

From table 4.2, it shows the results of examining the number of leukocytes and triglyceride levels in type 2 diabetes mellitus sufferers based on gender. The results show that women experienced more increases in the number of leukocytes by 14 respondents. This is because female respondents pay more attention to health checks than male respondents, so the data Most of the people obtained were women. This research is in line with research conducted by Dewi (2022) based on research conducted in Baluk Village, Negara District, that the number of respondents who had high leukocyte levels was 11 women (32.35%), while the number of high leukocyte levels was in men. -2 men (5.88%) where the dominant increase in the number of leukocytes occurred in women. An increase in the number of leukocytes can occur due to an increase in glucose levels which causes disruption of the phagocytic function of leukocyte cells, resulting in the body being susceptible to infection which can also stimulate an increase in the number of leukocytes (Dewi, 2022).

The results of examining triglyceride levels based on gender showed that 18 respondents had an increase in triglyceride levels in women. The increase in triglyceride levels in female respondents was because most of them had entered the pre-menopausal period so it was easy for triglyceride levels to increase. This is adjusted to the theory that women are susceptible to experiencing The increase in triglyceride levels is a result of the presence of the estrogen hormone, which should play a role in maintaining blood lipid levels and will suppress lipoproteins in women who are still actively menstruating. Meanwhile, in women entering the menopause period, there will be a decrease in the synthesis of the hormone estrogen so that blood triglyceride levels will increase. This research is in line with research by Niswah (2020) where women over 45-55 years old who experience irregular menstruation have entered the pre-menopausal period where pre-menopause is the transition period to menopause, so that it corresponds to the age of the respondents in this study, namely 42-55 years (Niswah , 2020).

From table 4.3, it shows the results of examining the number of leukocytes and triglyceride levels in type 2 diabetes mellitus sufferers based on age. The results showed that the number of leukocytes and triglyceride levels increased at the age of 49-55 years, as many as 18 respondents in the number of leukocytes, while there were 19 respondents in the level of triglycerides, p. This is because many of the research subjects used have entered old age, where we know that as we get older, organ systems in the body will experience a decline in function, thus affecting health both in the immune system and in fat metabolism. According to Meysela (2020), based on the average age of diabetes mellitus, which is ≥ 45 years, it can also affect the immune system in old age so that it experiences a decline in function which will make the body susceptible to infection and inflammation so that it can increase the number of leukocytes (Meysela, 2020). Apart from that, this research is in line with Zanhetta's research *et al* (2020) from 150 respondents, it was found that there was a close relationship between age and triglyceride levels, which shows that as age increases, triglyceride levels increase,

where the body's ability to metabolize fat will decrease due to changes in the secretion of the hormone adiponectin which affects the work of fat metabolism. so it is easy to increase triglyceride levels (Zanhetta *et al*2020).

From table 4.4, it shows the results of examining the number of leukocytes and triglyceride levels in type 2 diabetes mellitus sufferers based on the length of time they have suffered from type 2 diabetes mellitus. The results show that for the number of leukocytes and triglyceride levels there was an increase in the duration of suffering ≥ 5 years by 13 respondents in the number of leukocytes and by 15 respondents' triglyceride levels, this could happen because the research subjects had experienced several complications such as hypertension and were still minimal in implementing a healthy lifestyle so they easily experienced an increase in the number of leukocytes and triglyceride levels. This research is in line with Handayati's research*et al* (2020) there is a significant relationship between glucose levels and the number of leukocytes, namely that there is an increase in the number of leukocytes in type 2 diabetes mellitus sufferers with a duration of 5 years. An increase in the number of leukocytes can occur as a result of an increase in glucose levels which causes blood cells to not be able to move freely, especially erythrocyte cells which causes many tissues to experience a lack of oxygen and causes oxidative stress which then causes inflammation resulting in an increase in the number of leukocytes (Handayati*et al*, 2020). Meanwhile, the increase in triglyceride levels is in line with research conducted by Mar*et al* (2023) stated that in people with type 2 diabetes mellitus there can be changes in fat metabolism due to decreased insulin, namely increased tissue lipolysis and decreased effectiveness of lipoprotein lipase in the blood, so that triglyceride levels in the blood increase. The function of lipoprotein lipase is to hydrolyze triglycerides, so that if this hormone is not inhibited there will be an increase in triglyceride levels in the blood (Mar*et al*, 2023).

From table 4.5, it shows the results of examining the number of leukocytes in type 2 diabetes mellitus sufferers based on BMI and hypertension. It was found that there was an increase in BMI with an average of 20 respondents in the obesity II category and 19 respondents in the hypertension category, this was due to the research subjects used in the study. This time, more people were obese and had a history of hypertension, making it easier for respondents to experience an increase in their leukocyte count. This research is in line with research conducted by Humaira*et al*(2020) that a person who is excessively obese can cause death in adipocyte cells, where the dead adipocytes then attract macrophages to the adipose tissue to eliminate the dead adipocytes. Macrophages together with adipocytes will produce various types of adipocytokines which trigger a series of chronic inflammatory processes resulting in an increase in the number of leukocytes (Humaira*et al*, *2020*).

The hypertension category is in line with research conducted by Fauzan*et al* (2020) cross-sectional study in humans, it was found that the prevalence of hypertension was high along with increasing CRP levels and leukocyte counts. This can occur as a result of the resulting inflammatory response causing the entry of effector T cells into perivascular fat which will cause macrophage infiltration as a result of signaling from T cells. Cytokines and other inflammatory mediators released by these cells will work with the final result of the event. This event is ongoing hypertension (Fauzan*et al*, 2020).

From table 4.6, it shows the results of examining triglyceride levels in type 2 diabetes mellitus sufferers based on BMI and hypertension. The results showed that triglyceride levels increased in 14 people based on BMI and 29 respondents based on hypertension. This research is in line with the theory according to Niswah (2020) that insulin resistance in obese sufferers inhibits lipogenesis thereby

reducing glucose uptake in adipose tissue and activating the sensitive hormone lipase which will increase triglyceride lipolysis in adipose tissue. This situation will create Excessive free fatty acids in the blood will then be converted back into triglycerides and become part of *very low dencity lipoprotein* (VLDL) in the liver. *Very low dencity lipoprotein* (VLDL) produced in conditions of insulin resistance is rich in triglycerides, resulting in an increase in triglyceride levels (Niswah, 2020). Meanwhile, based on the hypertension category, it is in line with Zanhetta's research *et al* (2020) which states that generally high blood pressure will indicate increased levels of triglycerides and blood lipids. An increase in triglyceride levels causes an increase in blood viscosity which has an impact on disrupting blood flow in the blood vessels so that the heart works harder to pump blood, the effect of which is an increase in blood pressure (Zanhetta *et al*, 2020).

From table 4.7, it shows the results of the distribution of leukocyte counts and triglyceride levels in type 2 diabetes mellitus sufferers. It was found that there was an increase in the number of leukocytes, namely 19 respondents and 16 respondents with normal leukocyte counts. This could have happened because of the research subjects used in In this research, a person suffering from type 2 diabetes mellitus experiences hyperglycemia, which can slowly damage organ systems in the body, if they have suffered from type 2 diabetes mellitus for a long time and enter old age, this can facilitate the occurrence of complications in type 2 diabetes mellitus sufferers, so that it can trigger activation of the immune system resulting in an increase in the number of leukocytes. Meanwhile, research subjects with normal leukocyte counts were due to the respondent's young age and recent history of suffering from type 2 diabetes mellitus, so the leukocyte count was normal. This research is in line with Moradi's research *et al* (2012) the relationship between age and the long duration of diabetes greatly influences the number of leukocytes. It can be said that higher leukocyte counts occur more frequently at older ages and the period of experiencing diabetes is longer (Moradi *et al* 2012), and in research conducted by Haroen *et al* (2016) from 54 samples whose triglyceride levels were examined, 41 samples had normal leukocyte counts. The number of leukocytes is normal because in this study samples were taken from type 2 diabetes mellitus patients who were not accompanied by complications. Samples from type 2 diabetes mellitus patients without complications will give blood test results within normal limits. There were 15 patients who experienced leukocytosis and no patients experienced leukopenia. The number of leukocytes is influenced by age, deviation from the basal state and others.

The results of examinations for triglyceride levels in type 2 diabetes mellitus sufferers showed that 29 respondents had increased triglyceride levels and 6 respondents had normal triglyceride levels. In this research subject, many of them are obese accompanied by diabetes mellitus, where we know that someone who is obese is prone to increasing triglyceride levels due to the accumulation of fat in their body, so that this is also influenced by the condition of diabetes mellitus experienced by the research subjects, making it easier for triglyceride levels to increase while in research subjects who had normal triglyceride levels because the six respondents had a BMI $\leq$ 24.9, where the weight of the six respondents was not yet in the obesity category, causing normal triglyceride levels. This research is in line with research conducted by Nizar & Amelia, (2022) research results showed that 71.9% of diabetes mellitus sufferers with high triglyceride levels had a BMI > 27 (Obesity). The BMI value influences the increase in triglyceride levels in type 2 diabetes mellitus sufferers because excessive fat deposits in the body of sufferers who are overweight or obese can result in an increase in the amount of free fatty acids resulting in an increase in triglyceride levels (Nizar & Amelia, 2022).

Based on the results of statistical tests using the test *pearson correlations* To see the relationship between the number of leukocytes and triglyceride levels in type 2 diabetes mellitus sufferers, the results

showed that these two variables had a significant relationship, namely based on table 4.8 showing the relationship between the number of leukocytes and triglyceride levels in type 2 diabetes mellitus sufferers, it was found to have a sig value of 0.035 no exceeds 0.05 so it can be said to have a relationship, while for the value *Personal Correlation* namely 0.358 so it can be said to have a sufficient correlation relationship. This research is in line with research conducted by Sawant *et al*, (2021) cross-sectional data from NHANES shows the cholesterol relationship *high-density lipoprotein* Lower (HDL) and higher triglycerides with higher leukocyte count with correlation *p* = <0.001 so a 10 mg/dL increase in triglycerides over one year is also associated with a 0.09×103/μL increase in leukocyte count over the same period. In accordance with the reference for high triglyceride levels in patients with type 2 diabetes mellitus, there is an increase in macrophage infiltration into adipose tissue, this is because adipose tissue is a storage place for food reserves in the form of triglycerides, where if insulin resistance occurs then glucose cannot be used as an energy source. So the body will use other food reserves as an energy source, namely triglycerides. The breakdown of triglycerides occurs in adipose tissue which continuously causes an increase in free fatty acids. Increased levels of free fatty acids cause oxidative stress, which then as a result of oxidative stress triggers systemic inflammation. So an inflammatory mechanism occurs, namely infiltration of macrophages into adipose tissue, which then produces adipokines. Activated adipokines will activate pro-inflammatory cytokines such as Interleukin-6, Tumor Necrosis Factor-α, MCP-1 (Dinutanayo & Akhriani, 2021). The secretion of pro-inflammatory cytokines in hypertriglyceridemia activates inflammatory cells, namely leukocytes, especially monocytes, macrophages and lymphocytes, which causes cytokines produced by macrophages to also change the process of fat metabolism and markers of inflammation in type 2 diabetes mellitus patients (Hasanah, 2016).

High levels of blood fats such as triglycerides in diabetes mellitus sufferers, apart from increasing the number of leukocytes as a result of systemic inflammation, can also cause reduced elasticity of blood vessels. Excessive fat accumulation in arterial blood vessels can activate inflammatory processes in vascular endothelial tissue, especially in arteries with disrupted non-laminar flow, which causes endothelial dysfunction. As a result, it activates inflammatory processes, migration and cell proliferation. This is related to masovascular complications in diabetes mellitus sufferers. Activated inflammatory cells, especially monocytes, will migrate to the subendothelial layer by binding to endothelial adhesive molecules. Once in the subendothelial layer, these cells undergo differentiation into macrophages. Macrophages will digest oxidized fat which also penetrates the walls of the arteries and then turns into *foam cell* and then forming *fatty streaks*. Activated macrophages release pro-inflammatory cytokines that further activate this process by recruiting more macrophages, T cells and vascular smooth muscle cells (which synthesize extracellular matrix components) at the site of plaque formation, resulting in an increase in the number of leukocytes in the blood vessels (Pratama *et al* 2017). This causes an increase in the number of leukocytes in diabetes mellitus patients, which is mediated by increased triglyceride levels as a result of insulin resistance in diabetes mellitus sufferers, which will cause complications in type 2 diabetes mellitus sufferers in the form of cardiovascular disease, stroke, or damage to the nervous system.

By Because That, important for public general for realize necessity guard health body with apply by life Healthy regularly regular, like apply by eat Which Healthy, specifically nutrition balanced, low calories, height fiber, and height antioxidant, as well as do activity physique Which balanced, like combine activity physique light (stretching) Of between activity sit down, exercising regularly regular, like exercise 3-5 time per week so that you can maintain your body's health, as well as carrying out regular health checks to know your body's condition and be able to deal with health problems

appropriately if you already know the disease you are suffering from, as well as knowing the importance of education about the dangers of metabolic diseases, one of which is type 2 diabetes mellitus, namely being more selective in maintain a healthy lifestyle to avoid type 2 diabetes mellitus.

IV. CONCLUSION

From the results of this study it can be concluded that of the 35 subjects, there is a relationship between the number of leukocytes and triglyceride levels in type 2 diabetes mellitus patients with a sig value of 0.035 while for the *Personal Correlation* namely 0.358 which indicates that there is sufficient correlation between the number of leukocytes and triglyceride levels.

V. REFERENCES

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