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Relationship Between HbA1c Levels and Erythrocyte Sedimentation Rate (ESR) in Type II Diabetes Mellitus Patients at Dr. Rasidin Padang Hospital

Demitra Rona[1], Arniat Christiani Telambanua[2] *

[1,2]Applied Bachelor Study Program, Medical Laboratory Technology, Syedza Saintika University

**Applied Bachelor's Study Program, Medical Laboratory Technology*

Syedza Saintika University, Indonesia, christianiarniat@gmail.com

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Abstract

Type II Diabetes Mellitus is a chronic metabolic disorder characterized by increased blood sugar due to decreased insulin secretion by pancreatic beta cells and/or impaired insulin function. The purpose of this study was to determine the relationship between HbA1c levels and the Erythrocyte Sedimentation Rate (ESR) in Type II Diabetes Mellitus patients at Dr. Rasidin Padang Regional General Hospital. This type of research employs quantitative methods and a descriptive design and was conducted in January 2024. The population was all type II diabetes mellitus patients at Dr. Rasidin Padang Regional General Hospital, totaling 55 patients, while the sampling used the total sampling technique. Data were analyzed univariately and bivariately using the Chi-square test. The results of the study showed that 40% had prediabetes HbA1c levels, and 50.9% had abnormal erythrocyte sedimentation rates (ESR). There was a relationship between HbA1c levels and erythrocyte sedimentation rates (ESR) ($p = 0.015$) in type II diabetes mellitus patients at Dr. Rasidin Padang Regional General Hospital. Based on the results, it can be concluded that there is a relationship between HbA1c levels and the erythrocyte sedimentation rate (ESR) in type II diabetes mellitus patients at Dr. Rasidin Padang Regional Hospital. Suggestions: All healthcare workers are expected to provide information about the relationship between HbA1c levels and the erythrocyte sedimentation rate (ESR) in patients with type 2 diabetes mellitus. Health workers should conduct HbA1c examinations more routinely in type II diabetes mellitus patients with tuberculosis

Keywords: Type II Diabetes Mellitus, HbA1c Levels, ESR.

Introduction

Type II diabetes mellitus is a chronic metabolic disorder characterized by elevated blood sugar levels due to decreased insulin secretion by pancreatic beta cells and/or impaired insulin function. Insulin is a hormone that regulates blood sugar balance (Restyana, 2021).

According to Billous & Donelly (2015), the signs and symptoms of type II diabetes mellitus include: Usually a hidden onset of fatigue, thirst, polyuria, and nocturia. No ketoacidosis is found. Usually overweight or obese; often, no recent weight loss is apparent. Frequent infections, such as those in the urine, skin, and chest. Symptoms may be mild and/or ignored by the patient, often indicating other signs of metabolic syndrome, such as hypertension. C-peptide chains can be detected. Common complaints in type II diabetes sufferers include: polyuria, polydipsia, polyphagia, weight loss, weakness, tingling, itching, decreased vision, sores, and vaginal discharge.

According to a 2019 survey conducted by the WHO (World Health Organization), more than 347 million people worldwide suffer from diabetes mellitus. Currently, diabetes mellitus is the seventh leading cause of death globally and is expected to increase by two-thirds between 2008 and 2030. The incidence of diabetes mellitus in Indonesia has reached 9.1 million, placing Indonesia in the top 5 countries with the highest number of diabetes mellitus sufferers after Bangladesh, Bhutan, China, and India. This number is predicted to increase to 21.3 million by 2030. The prevalence of diabetes mellitus in Indonesia, based on diagnoses by healthcare professionals, is 0.7%, while the prevalence of diabetes mellitus is 1.1%. This data indicates that the prevalence of diabetes mellitus diagnosed by healthcare professionals reaches 63.3%, higher than the prevalence of asthma and heart disease (WHO, 2019).

Southeast Asia ranks third with a prevalence of 11.3%. Indonesia ranks 7th among the 10 countries with the highest number of diabetes sufferers, with 10.7 million cases. East Java has the fifth highest number of diabetes sufferers, with a percentage of 2.6% in 2018, rising from 2.1% in 2022. The number of diabetes sufferers in Malang City in 2020 was 21,697 (Ministry of Health of the Republic of Indonesia, 2022).

According to the West Sumatra Provincial Health Profile, the prevalence of diabetes in 2020 was 1.1%, rising to 2.1% in 2021. According to data recorded by the Padang City Health Office, there were 1,200 cases of diabetes in 2020, an increase of 1,290 cases in 2021 (30%) compared to the previous figure (Padang City Health Office, 2021).

One laboratory test to support diabetes mellitus is the erythrocyte sedimentation rate (ESR) or BSR (Erythrocyte Sedimentation Rate). This test determines the rate at which red blood cells settle in unclotted blood (blood containing an anticoagulant) in a vertical tube over one hour. The faster the red blood cells settle, the higher the erythrocyte sedimentation rate. Red blood cells will settle to the bottom of the tube, while plasma will float on the surface. This rate of red blood cell sedimentation is called the ESR.

HbA1c is a stable glucose molecule bound to the N-terminal group of the HbA chain, forming a post-translational modification that combines with a free amino group on the N-terminal valine residue of the hemoglobin β chain. The resulting Schiff base is unstable and, through an irreversible rearrangement, forms a stable ketoamine. Glycation can occur on specific lysine residues of the α and β chains of hemoglobin, resulting in measurable total glycohemoglobin, or total glycated hemoglobin, known as HbA1c. Hemoglobin glycation is not catalyzed by enzymes, but rather through a chemical reaction resulting from exposure to circulating glucose in red blood cells. The rate of HbA1c synthesis is a function of the concentration of glucose bound to red blood

cells during exposure. HbA1c concentration depends on blood glucose concentration and red blood cell age; several studies have shown a relationship between HbA1c concentration and average blood glucose levels (Sri Rahayu, 2021).

HbA1c can also be used to monitor the effects of diet, exercise, and drug therapy. This is in line with findings from the American Diabetes Association (ADA, 2019) that each decrease in HbA1c reduces the incidence of diabetes mellitus-related deaths by 21%. The diagnostic criteria for diabetes based on HbA1c is 6.5%, while the recommended therapeutic goal is less than 7%. Poor HbA1c levels reflect poor patient compliance with diabetes therapy, which can include dietary adjustments, physical exercise, and medication.

Research conducted by Nita Ermawati (2022) on 25 diabetes mellitus patients treated at Daha Husada Hospital in Kediri City showed a strong correlation between HbA1c levels and erythrocyte sedimentation rate.

Method

This type of research is quantitative research with descriptive methods and observational design. Retrospective research is research conducted with the main goal of creating an objective picture or description of a condition by looking back (Notoatmodjo 20018). In this study, the researcher observed or described the results of research on the relationship between HbA1c levels and the Erythrocyte Sedimentation Rate (ESR) in patients with Type II Diabetes Mellitus at Dr. Rasidin Padang Regional Hospital. The population in this study was 55 Type II Diabetes Mellitus sufferers, data collected over the last 3 months from the Dr. Rasidin Padang Regional Hospital polyclinic, and diagnosed by a doctor. The sample in this study was calculated using the total sampling technique, namely, the total population was sampled based on certain criteria.

For the HbA1c Rapid Quantitative Test examination, the sandwich immunodetection

method is used. To examine the erythrocyte sedimentation rate, use the Westergren method. Then, Univariate And Bivariate Variable Analysis Was Performed After Data Processing.

Results

Frequency Distribution of Patient Characteristics

Table1
Distribution of Patient Characteristics

Patient Characteristics	f (%)	%
Gender		
Male	34	61.8
Female	21	38.2
Age		
40-50 Years	4	7.3
51-60 Years	27	49.1
>61 Year	24	43.6
Amount	**55**	**100**

Based on Table 1, it can be seen that of the 55 patients, 34 patients (61.8%) were mostly male, and 27 patients (49.1%) were aged 51-60 years in type II diabetes mellitus patients at Dr. Rasidin Padang Regional Hospital.

Univariate Analysis

Frequency Distribution of HbA1c Levels in Type II Diabetes Mellitus Patients at Dr. Rasidin Padang Regional Hospital

Table 2 Frequency Distribution of HbA1c Levels in Type II Diabetes Mellitus Patients at Dr. Rasidin Padang Regional Hospital

HbA1c Levels	f (%)	%
Diabetes	20	36.4
Prediabetes	22	40.0
Normal	13	23.6
Amount	55	100

Based on Table 2, it can be seen that of the 55 patients, 22 patients (40%) had prediabetes HbA1c levels in type II diabetes mellitus patients at Dr. Rasidin Padang Regional Hospital.

Frequency Distribution of Erythrocyte Sedimentation Rate (ESR) in Type II Diabetes Mellitus Patients at Dr. Rasidin Padang Regional Hospital

Table 3 Frequency Distribution of Erythrocyte Sedimentation Rate (ESR) in Type II Diabetes Mellitus Patients at Dr. Rasidin Padang Regional Hospital

Erythrocyte Sedimentation Rate (ESR)	f	%
Abnormal	28	50.9
Normal	27	49.1
Amount	55	100

Based on Table 3, it can be seen that of the 55 patients, 28 patients (50.9%) had an abnormal erythrocyte sedimentation rate (ESR) in type II diabetes mellitus patients at Dr. Rasidin Padang Regional Hospital.

Bivariate Analysis

The Relationship between HbA1c Levels and Erythrocyte Sedimentation Rate (ESR) in Type II Diabetes Mellitus Patients at Dr. Rasidin Padang Regional Hospital

Table 4 Relationship between HbA1c Levels and Erythrocyte Sedimentation Rate (ESR) in Type II Diabetes Mellitus Patients at Dr. Rasidin Padang Regional Hospital

HbA1c Levels	Erythrocyte Sedimentation Rate (ESR)						P- Value
	Abnormal		Normal		Amount		
	f	%	f	%	f	%	
Diabetes	14	70.0	6	30.0	20	100	**0,015**
Prediabetes	6	27.3	16	72.7	22	100	
Normal	8	61.5	5	38.5	13	100	
Amount	28	50.9	27	49.1	55	100	

Table 4 shows that patients with abnormal erythrocyte sedimentation rates (ESR) were more common in patients with diabetes (14 patients (70%), compared to patients with prediabetes (6 patients (27.3%) with HbA1c levels) and patients with normal HbA1c levels (8 patients (61.5%) in type II diabetes mellitus patients at Dr. Rasidin Padang Regional Hospital.

Based on the Chi-square test results, a p-value of 0.015 ($p<0.05$) was obtained. It can be concluded that there is a relationship between HbA1c levels and erythrocyte sedimentation rates (ESR) in type II diabetes mellitus patients at Dr. Rasidin Padang Regional Hospital.

Discussion

Univariate Analysis

Frequency Distribution of HbA1c Levels in Type II Diabetes Mellitus Patients at Dr. Rasidin Padang Regional Hospital

Based on the research results, it can be seen that of the 55 patients, 22 (40%) had prediabetic HbA1c levels in patients with type II diabetes mellitus at Dr. Rasidin Padang Regional Hospital.

These results align with research conducted by Aminah (2022) entitled "The Relationship Between HbA1c Levels and Erythrocyte Sedimentation Rate (ESR) in Type II Diabetes Mellitus Patients at Jombang Regional Hospital." The results showed that many patients had diabetic HbA1c levels, at 65.8% at Jombang Regional Hospital.

Hemoglobin A1c is a stable glucose bound to the N-terminal group of the HbA0 chain, forming a post-translational modification where the glucose combines with the free amino group on the N-terminal valine residue of the hemoglobin β chain. The resulting Schiff base is unstable and, through an irreversible rearrangement, forms a stable ketoamine. Glycation can occur on specific lysine residues of the α and β chains of hemoglobin, resulting in measurable total glycohemoglobin, or total glycated hemoglobin, known as HbA1c. Hemoglobin glycation is not catalyzed by enzymes, but rather through a chemical reaction resulting from exposure to circulating glucose in the bloodstream in erythrocytes. The rate of HbA1c synthesis is a function of the concentration of glucose bound to erythrocytes during exposure. HbA1c concentration depends on blood glucose concentration and erythrocyte age; several studies have shown a relationship between HbA1c concentration and average blood glucose levels (Rahayu, 2017).

The researchers assumed that the results showed that many patients had prediabetes HbA1c levels, a metabolic disease characterized by hyperglycemia that occurs due to abnormalities in insulin secretion, insulin action, or both. Diabetes mellitus (DM) is a major public health problem, as its prevalence increases year after year. If left untreated, diabetes can lead to poor blood sugar control, leading to hyperglycemia, or elevated blood sugar levels above normal. Type II diabetes is a group of diabetes characterized by insulin resistance and relative insulin deficiency. Symptoms of type II diabetes often go unnoticed for a long time and are only detected when

complications develop.

Distribution of Erythrocyte Sedimentation Rate (ESR) Frequency in Type II Diabetes Mellitus Patients at Dr. Rasidin Padang Regional

Based on the research results, it can be seen that out of 55 patients, 28 (50.9%) had an abnormal erythrocyte sedimentation rate (ESR) in type II diabetes mellitus patients at Dr. Rasidin Padang Regional Hospital.

These results are supported by a study conducted by Stevani (2019) entitled "The Relationship between HbA1c Levels and Erythrocyte Sedimentation Rate (ESR) in Type II Diabetes Mellitus Patients at Labuang Baji Regional Hospital, Makassar City." The results showed that many patients had an abnormal erythrocyte sedimentation rate (ESR), namely 69.7% of patients with type II diabetes mellitus at Labuang Baji Regional Hospital, Makassar City.

Erythrocyte Sedimentation Rate is the sedimentation rate of erythrocytes from a blood sample examined in a specific instrument, expressed in mm/hour (Kiswari, 2016). The first phase is also called the aggregation phase because during this phase, erythrocytes begin to aggregate, resulting in very slow sedimentation. In the second phase, erythrocyte sedimentation occurs rapidly. After aggregation (adhering to one another), the ratio of volume to surface area decreases, resulting in faster sedimentation. Rouleaux formation (stacking) also occurs during this phase. In the third phase, the erythrocyte sedimentation rate begins to decrease as the erythrocyte sedimentation rate solidifies (Kiswari, 2016).

Researchers believe that many studies have shown that the patient's erythrocyte sedimentation rate (ESR) is abnormal because prolonged hyperglycemia due to poor glycemic control causes toxic effects on cells (glucose toxicity). This effect ultimately leads to the formation of reactive oxygen species (ROS) and increased production of free fatty acids (FFA) in the liver. The increased ROS and FFA in patients with type 2 diabetes disrupt the thyroid hormone deiodinase process, which can lead to thyroid dysfunction. A high ESR is caused by chronic and acute infections and acute inflammation in the body, fibrinogen globulin, and many other triggers. A high ESR provides a nonspecific response to tissue damage and is an indicator of disease.

Bivariate Analysis

The Relationship between HbA1c Levels and Erythrocyte Sedimentation Rate (ESR) in Type II Diabetes Mellitus Patients at Dr. Rasidin Padang Regional Hospital

The normality Based on the research results, it can be seen that patients with abnormal erythrocyte sedimentation rates (ESR) were more common in patients with diabetes (14 patients (70%), compared to patients with prediabetes (6 patients (27.3%) and patients with normal HbA1c levels (8 patients (61.5%) of type II diabetes mellitus patients at Dr. Rasidin Padang Regional Hospital). Based on the results of the Chi-square test, a p-value of 0.015 ($p<0.05$) was obtained, thus it can be concluded that there is a relationship between HbA1c levels and erythrocyte sedimentation rates (ESR) in patients with type II diabetes mellitus at Dr. Rasidin Padang Regional Hospital.

These research results are supported by research conducted by Adlanta (2022) entitled "The Relationship between HbA1c Levels and Erythrocyte Sedimentation Rates (ESR) at Dr. Pirngadi Medan Regional Hospital." The research results showed a correlation between HbA1c levels and the erythrocyte sedimentation rate (ESR) with a p-value of 0.012 ($p<0.05$) at Dr. Pirngadi Regional General Hospital, Medan.

Erythrocyte sedimentation rate (ESR) is the rate at which erythrocytes settle from a blood sample tested in a specific instrument, expressed in mm/hour (Kiswari, 2016). The first phase, also called the aggregation phase, occurs because during this phase, erythrocytes begin to aggregate, resulting in very slow sedimentation. In the second phase, erythrocyte sedimentation occurs rapidly because after aggregation (adhering to one another), the ratio between their volume and surface area decreases, resulting in faster sedimentation. Rouleaux formation (stacking) also occurs during this phase. In the third phase, the erythrocyte sedimentation rate begins to decrease as the erythrocyte sedimentation rate (ESR) solidifies (Kiswari, 2016).

The researchers hypothesize that the results indicate a relationship between HbA1c levels and the erythrocyte sedimentation rate (ESR) in type II diabetes mellitus patients. This is due to the chronic disease, characterized by hyperglycemia and triggering chronic inflammation. There is an increase in the number of neutrophils in patients with diabetes mellitus experiencing inflammation. In acute inflammation, neutrophils are activated first due to their higher concentration in the blood compared to

mononuclear cells. The transition from neutrophil to lymphocyte activation is also accompanied by apoptosis and phagocytosis of neutrophils, as excessively high neutrophil counts are toxic to surrounding tissues and induce inflammation. The erythrocyte sedimentation rate (ESR) in type II diabetes mellitus (DM) patients is influenced by many factors, the most important of which is chronic inflammation in body tissues, resulting in high blood glucose levels because the body cannot adequately release or utilize insulin. Insulin is a hormone produced by the pancreas that facilitates or controls blood glucose levels by regulating its production and storage. Therefore, inflammation in the body results in a high erythrocyte sedimentation rate (ESR).

Conclusion

Based on the results of data processing and analysis, the following conclusions can be drawn:

1. 40% of patients with type II diabetes mellitus at Dr. Rasidin Padang Regional General Hospital had prediabetic HbA1c levels.
2. 50.9% of patients with type II diabetes mellitus at Dr. Rasidin Padang Regional General Hospital had abnormal erythrocyte sedimentation rates (ESR).
3. There is a relationship between HbA1c levels and erythrocyte sedimentation rates (ESR) in patients with type II diabetes mellitus at Dr. Rasidin Padang Regional General Hospital.

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