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THE RELATIONSHIP BETWEEN DURATION OF TYPE 2 DIABETES AND HBA1C WITH THE INCIDENCE OF DIABETIC ULCERS IN DIABETES PATIENTS AT ROEMANI HOSPITAL

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Keywords

Diabetes Mellitus, HbA1C, Diabetic Ulcer

Abstract

Background: Type 2 diabetes mellitus (DM) is a chronic disease that can cause various complications, one of which is diabetic ulcers. Long-term DM and poor glycemic control, as indicated by high HbA1C levels, are thought to contribute to the development of diabetic ulcers. Methods: This study employed an observational analysis approach with a cross-sectional design. The data collection method used total sampling, with 86 samples drawn from the total population. Analysis used the Spearman Rank test with a 95% confidence level and a margin of error of 0.05. Results: The majority of respondents were aged 40–60 years, with a duration of DM ≥5 years (73.3%), HbA1C >6.4% (75.6%), and grade 1 diabetic ulcers (26.7%). Spearman rank analysis results showed a significant relationship between the duration of type 2 DM and the incidence of diabetic ulcers (r = 0.267; p = 0.01) and a significant relationship between HbA1C and the incidence of diabetic ulcers (r = 0.482; p = 0.01). Conclusion: There is a relationship between the duration of type 2 DM and HbA1C with the incidence of diabetic ulcers in type 2 DM patients at Roemani Hospital

1. INTRODUCTION

The International Diabetes Federation (IDF) noted that the number of people with Diabetes Mellitus globally will increase by 2030, reaching 8.6 billion people. Indonesia ranks 5th globally with 19.5 million people suffering from type 2 diabetes. Semarang City ranks 3rd in Central Java with 55,075 cases of diabetes mellitus. Data recorded at one of the hospitals in Semarang, namely Roemani Muhammadiyah Hospital, in 2021, showed that the number of patients with type 2 diabetes mellitus was 367.

Type 2 diabetes mellitus is a condition characterized by hyperinsulinemia, but at the same time, insulin resistance prevents insulin from transporting glucose into the tissues. Insulin resistance occurs when insulin levels remain high, but the receptors are

inactive, resulting in relative insulin deficiency and reduced insulin secretion. This increases blood sugar, which, if uncontrolled, can damage nerves and blood vessels. One way to find out whether type 2 diabetes mellitus is controlled or not is by examining glycated hemoglobin (HbA1C).

HbA1C can provide an overview of blood glucose levels in type 2 diabetes mellitus sufferers over the last 2–3 months. Patients with HbA1C levels >7% are at twice the risk of developing macroangiopathic complications, which can lead to vasculopathy and neuropathy. Vasculopathy in diabetes mellitus disrupts blood flow to peripheral tissues, reducing oxygen and nutrient supply. This condition causes tissue fragility and delays wound healing. Small wounds in people with diabetes are difficult to heal and susceptible to infection, ultimately leading to diabetic ulcers.

Diabetic neuropathy occurs due to nerve damage caused by chronic hyperglycemia, which disrupts blood flow to the nerves and leads to impaired nerve function. This condition causes reduced sensation in the extremities, often leaving injuries unnoticed. It is accompanied by muscle weakness and changes in foot shape, ultimately increasing the risk of diabetic ulcers. The combination of vasculopathy and diabetic neuropathy further worsens the condition by reducing pain sensitivity, making the patient unaware of the wound, susceptible to infection, which eventually develops into a diabetic ulcer.

Diabetic ulcers are still common in patients with type 2 diabetes, especially at Roemani Hospital. Diabetic ulcers are one of the complications associated with the duration of diabetes and HbA1C, according to research conducted by Trisnawati (2023). For that reason, this research was conducted at Roemani Hospital, Semarang.

2. RESEARCH METHOD

The research location is at Roemani Hospital Semarang, Wonodri Street 22, Central Java. Ethical Clearance (EC) processing is at the Health Research Ethics Commission of the Faculty of Nursing and Health Sciences, Muhammadiyah University of Semarang with letter number 178/KE/02/2025. The research was conducted on March 12, 2025. The study in this research will apply an observational analysis approach with a cross-sectional design. The sample data collection method is total sampling with inclusion and exclusion criteria obtained 86 samples from the total population.

3. RESULTS AND DISCUSSION

Table 1. Age and Gender of Respondents

	Jenis Kelamin				
Usia	Laki laki	%	Perempuan	%	Total
40-60 (Dewasa akhir)	32	37,2	23	26,7	55
>60 (Lansia)	10	26,7	21	24,4	31
Total	42	48,8	44	51,2	86

Based on Table 1, the majority of respondents were male (32) aged 40-60 years (37.2%), and the majority were female (23) aged 40-60 years (26.7%). These results align with research conducted by Wahyuni. This age group falls within the early elderly classification, which is the transition period from late adulthood to old age. During this phase, the risk of developing diabetes increases due to a decline in pancreatic function. As a result, the pancreas' response to insulin weakens, resulting in uncontrolled blood sugar levels. Chronic hyperglycemia can trigger atherosclerosis, which results in vasculopathy, disrupting blood flow to the legs and increasing the risk of diabetic foot ulcers.

Women are the group with the highest number of cases. This is because when women experience menopause, estrogen and progesterone levels decrease, leading to blood sugar disturbances. This disturbance can increase the risk of diabetic ulcers, and women also have higher cholesterol and triglyceride levels than men. Fat in adult women is approximately 20-25% of total body weight, while in adult men, it is 15-20% of total body weight.

Table 2. Characteristics of Duration of Type 2 DM, HbA1C, Diabetic Ulcers

Karakteristik	Frekuensi	Presentase(%)
Lama DM Tipe 2		
1 tahun	3	3,5%
2 tahun	6	7,0%
3 tahun	3	3,5%
4 tahun	9	10,5%
5 tahun	2	2,3%
≥ 5 tahun	63	73,3%
Total	86	100%
HbA1C		
< 5,7	11	12,8%
5,7-6,4	10	11,6%
> 6,4	65	75,6%
Total	86	100%

Derajat Ulkus		
Derajat 0	18	20,9%
Derajat 1	23	26,7%
Derajat 2	11	12,8%
Derajat 3	11	12,8%
Derajat 4	19	22,1%
Derajat 5	4	4,7%
Total	86	100%

Based on Table 2, the majority of respondents, 63 (73.3%), had suffered from type 2 diabetes for ≥ 5 years. This is in line with research conducted by Zhang. This is likely due to fluctuations in blood glucose and diabetic neuropathy. These fluctuations in glucose levels cause metabolic instability and activate abnormal metabolic pathways, such as the polyol pathway, the formation of glycation end products (AGEs), and the activation of protein kinase C (PKC). Furthermore, glucose spikes also cause mitochondrial dysfunction, which triggers increased free radical production. This accumulation of free radicals causes oxidative stress, an imbalance between free radicals and the body's antioxidant system. This oxidative stress causes endothelial dysfunction and accelerates the development of various complications, including diabetic neuropathy. Diabetic neuropathy is a complication of diabetes mellitus that causes decreased or no sensation in the extremities due to fluctuations in blood glucose. Diabetic neuropathy in people with diabetes mellitus can cause loss of sensitivity and increase the risk of diabetic ulcers.

The majority of respondents, with an HbA1C >6.5 (65%) (75.6%), had a HbA1C >6.5. This study aligns with Utomo's findings. High HbA1c levels in type 2 diabetes sufferers can be caused by various factors, one of which is age. Insulin resistance occurs as we age due to changes in body composition. A decrease in muscle mass from 19% to 12% and an increase in fat tissue from 14% to 30% leads to a decrease in the number and sensitivity of insulin receptors. In type 2 diabetes, insulin resistance leads to increased blood glucose levels. This increase in blood glucose also increases the amount of hemoglobin bound to blood glucose, resulting in higher hemoglobin A1C levels.

The majority of respondents, 23 (26.7%), had grade 1 diabetic ulcers. This is in line with research conducted by Raharjo. This is likely because the diabetic ulcer patients in this study were in type C hospitals, so most patients arrived with ulcers that were still in the early or mild stages. In type C hospitals, patients are generally initial

referrals from primary healthcare facilities, so the diabetic ulcers found tend to be less severe.

Table 3. Relationship between Duration of Type 2 DM Suffering and Diabetic Ulcers

Lama DM	Ulkus Diabetik												Total	*P value*
	Derajat 0		Derajat 1		Derajat 2		Derajat 3		Derajat 4		Derajat 5			
	f	%	f	%	f	%	f	%	f	%	f	%		
1 tahun	1	33,3	2	66,7	0	0,0	0	0,0	0	0,0	0	0,0	3	0,01
2 tahun	2	33,3	2	33,3	1	16,7	1	0,0	0	0,0	0	0,0	6	
3 tahun	0	0,0	3	100	0	0,0	0	0,0	0	0,0	0	0,0	3	
4 tahun	2	22,2	4	44,4	2	22,2	1	11,1	0	0,0	0	0,0	9	
5 tahun	0	0,0	0	0,0	0	0,0	1	50,0	0	0,0	1	50,0	2	
>5 tahun	13	20,6	12	19,0	8	12,7	9	14,3	18	28,6	3	4,8	63	
Total	18	20,9	23	26,7	11	12,8	12	14,0	18	20,9	4	4,7	86	

The results of the Spearman Rank correlation test on the relationship between the duration of type 2 diabetes mellitus and the incidence of diabetic ulcers obtained an r_count value of 0.267 with a p-value of 0.01. Because the p-value <0.05, the test decision is H0 rejected, so it is concluded that there is a relationship between the duration of type 2 diabetes mellitus and the incidence of diabetic ulcers at Roemani Hospital, Semarang. These results are in line with research conducted by Trisnawati which found a significant relationship between the longer duration of diabetes mellitus and diabetes mellitus with ulcers at Depok Regional General Hospital. The longer a person suffers from diabetes mellitus, the more prolonged hyperglycemia they experience and the greater their risk of developing chronic hyperglycemia. Persistent hyperglycemia leads to hyperglycemia, a condition where cells are flooded with glucose. Chronic hyperglycemia alters the biochemical homeostasis of these cells, potentially

leading to changes in the underlying pathways that lead to the development of chronic complications of diabetes mellitus.

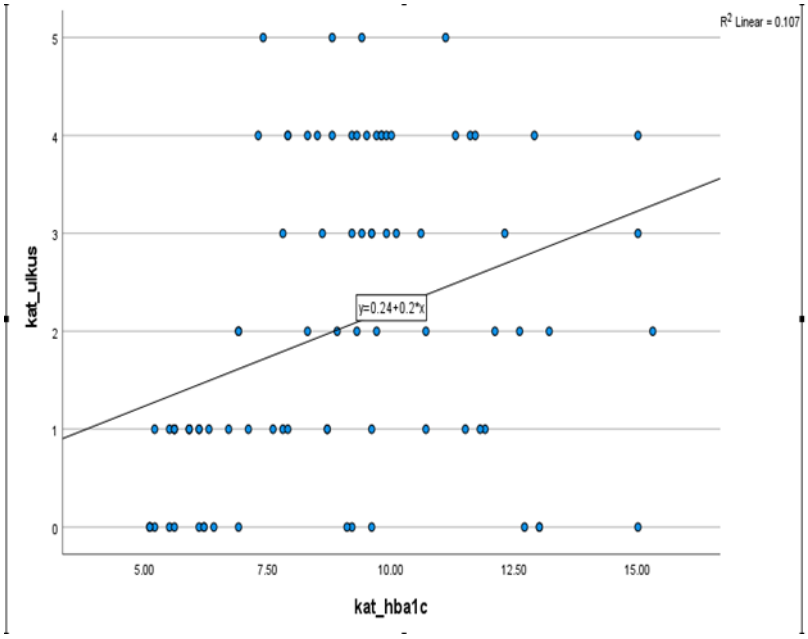

Figure 1. Relationship between HbA1C and Diabetic Ulcers

Figure 1 shows the relationship between HbA1c (kat_hba1c) on the X-axis and the degree of diabetic ulcer (kat_ulkus) on the Y-axis. The resulting linear regression equation is y = 0.24 + 0.2x, meaning that every 1-point increase in HbA1c is associated with an increase in ulcer severity of approximately 0.2%. These results indicate that the higher the HbA1c level, the more severe the ulcer severity experienced by patients with diabetes mellitus.

The Spearman Rank correlation test for the relationship between HbA1c and the incidence of diabetic ulcers obtained an r_count of 0.482 with a p-value of 0.01. Because the p-value <0.05, the test decision is H0 is rejected, thus concluding that there is a relationship between HbA1c and the incidence of diabetic ulcers at Roemani Hospital, Semarang. These results are in line with research conducted by Sitompul which found a significant relationship between HbA1C levels and the degree of diabetic ulcers.

One way to control diabetes mellitus is by checking HbA1C levels. HbA1C levels are considered the gold standard for assessing blood glucose levels because they increase proportionally over the past 8–10 weeks, as HbA1C is contained in erythrocytes, which live for 100–120 days. Therefore, if the HbA1C level is poor or increasing, it reflects poor glucose metabolism control over the past 3–4 months. Higher HbA1C levels indicate a higher risk of complications, and vice versa.

The European Association for the Study of Diabetes and the International Diabetes Federation stated that from 600 participants, PP (Postprandial) glucose monitoring and HbA1c examination showed a close relationship between blood glucose and HbA1c. The data presented showed that an HbA1c level of 6% is equivalent to an average blood glucose concentration of 126 mg/dL. A 1% increase in HbA1c correlates with an increase in glucose levels of approximately 30 mg/dL, while a 2% decrease in HbA1c levels has been clinically proven to reduce the risk of diabetes complications, including diabetic ulcers, by 50–70%.

4. CONCLUSION

1. The majority of respondents have suffered from type 2 diabetes for ≥ 5 years
2. The majority of respondents experienced HbA1C > 6,4
3. The majority of respondents experienced grade 1 diabetic ulcers
4. There is a significant relationship between the length of time suffering from type 2 DM and the incidence of diabetic ulcers at Roemani Hospital, Semarang.
5. There is a significant relationship between HbA1C and the incidence of diabetic ulcers at Roemani Hospital, Semarang.

Suggestions

Considering the limitations of the non-normal data distribution in this study, further research should increase the sample size and consider collecting data from several hospitals to obtain more representative results and more optimal statistical analysis.

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