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THE RELATIONSHIP BETWEEN HbA1c LEVELS IN TYPE 2 DIABETES MELLITUS PATIENTS AND CLINICAL MANIFESTATIONS OF DIABETIC MICROANGIOPATHY NEUROPATHY WITH THE INCIDENCE OF ERECTILE DYSFUNCTION

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ABSTRACT

This study aims to analyze the relationship between HbA1c levels and the clinical manifestations of diabetic microangiopathy neuropathy with the incidence of erectile dysfunction in patients with type 2 diabetes mellitus. The objective is to understand the prevalence of the relationship between HbA1c levels, the clinical manifestations of diabetic microangiopathy neuropathy, and the occurrence of erectile dysfunction in patients with type 2 diabetes mellitus. This study used an observational analytical design with a cross-sectional approach. The sample consisted of 61 male patients who underwent examination at RSPAL dr. Ramelan Surabaya from July to September 2024. Data was collected through interviews using the International Index of Erectile Function (IIEF-5) questionnaire, along with secondary data on HbA1c levels and symptoms of diabetic neuropathy. Statistical analysis was performed using the Chi-Square test to identify relationships between the study variables. The results of the study showed a significant relationship between HbA1c levels and the incidence of erectile dysfunction. However, there was no significant relationship between the clinical manifestations of diabetic microangiopathy neuropathy and erectile dysfunction, as indicated by the Chi-Square test. The conclusions of this study are: first, there is a strong relationship between uncontrolled HbA1c levels and the incidence of erectile dysfunction, and second, although the clinical manifestations of diabetic microangiopathy neuropathy are common in patients with type 2 diabetes mellitus, no direct significant relationship was found between the clinical manifestations of diabetic microangiopathy neuropathy and erectile dysfunction.

KEYWORDS HbA1c, Diabetic Neuropathy, Erectile Dysfunction, Type 2 Diabetes Mellitus.

INTRODUCTION

Diabetes mellitus is a serious chronic condition that can occur when blood glucose levels rise because the body cannot produce enough insulin or cannot utilize

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the insulin that is produced optimally. Insulin is a vital hormone produced by the pancreas that facilitates the entry of glucose into the body's cells, where it is converted into energy or stored as energy reserves. Several causes that trigger insulin deficiency, or the body's inability to respond to insulin, will lead to high blood glucose levels (hyperglycemia), which is the main clinical sign of diabetes. (IDF, 2021)

The spread of type 2 diabetes mellitus In 2021, diabetes caused 1.6 million deaths worldwide, with 47% of those deaths occurring in individuals under the age of 70, while the prevalence of diabetes in adults aged 18 years and older reached 14% in 2022, a significant increase from 7% in 1990, and more than half (59%) of those diagnosed with diabetes were not taking medication to control their condition. (WHO, 2019). Specifically in Indonesia itself, this prevalence varies, especially the regions of East Java, Central Java, and West Java are noted as the three provinces with the highest incidence of type 2 diabetes mellitus, also showing a trend of higher prevalence in the middle age group (45-54 years) to the elderly (75 years and over) with a figure reaching 266,648 cases and the number of sufferers is higher in men than women, namely 510,714 cases (Riskesdas, 2018). (Riskesdas, 2018).

Complications of type 2 diabetes mellitus are a serious health concern. Long-term complications include macroangiopathy, microangiopathy and sexual dysfunction in men and women. (Defeudis et al., 2022). Complications of type 2 diabetes mellitus are thought to result from the vascular, neurogenic and metabolic effects of the disease. Peripheral diabetic neuropathy occurs in more than 50% of individuals with diabetes and is the most common cause of neuropathy worldwide (Zakin, Abrams and Simpson, 2019).. Peripheral diabetic neuropathy is generally caused by damage to the peripheral nerves that trigger various pain sensations, such as a burning sensation that comes and goes or is persistent, a feeling of prickling, tingling, numbness, as well as sensations of heat, cold, or itching (Rachmantoko et al., 2019). (Rachmantoko et al., 2021)..

Peripheral diabetic neuropathy may contribute to erectile dysfunction (Defeudis et al., 2022). Erectile dysfunction is referred to as the failure to maintain a sufficient erection and the failure to achieve this state, resulting in unsatisfactory sexual intercourse. (Tridiantari, Saraswati and Udiyono, 2020). where the symptoms of peripheral diabetic neuropathy microangiopathy are responsible for the disruption of sensory impulses from the penis to the reflexogenic erection center and motor impulses to the pelvic floor muscles which causes a reduction in the contractile force of the bulbocavernous and ischiocavernous muscles, therefore there is an outflow of venous blood from the corpus cavernosa. (Defeudis et al., 2022).

HbA1c is a measurement tool that can be used to determine the glucose levels of patients with DM in the last 1-3 months. An HbA1c of 6% is equivalent to a glucose concentration of 126 mg/dl. Every 1% increase in HbA1c level is equivalent to a glucose level of 29 mg/dl. Worsening glycemic levels lead to a corresponding increase in HbA1c levels. Therefore, high HbA1c levels in patients with DM can be an indicator of complications, such as erectile dysfunction. (Widyaningsih and Ahsani, 2021). Hyperglycemia can damage the inner lining of blood vessels (endothelium) and reduce the release of nitric oxide, which is important for dilating blood vessels. Without dilation of blood vessels, blood flow to erectile tissue or corpora cavernosa can be disrupted. As a result, the penis cannot get enough blood for an erection, leading to erectile dysfunction. (Defeudis et al., 2022)

Men with diabetes mellitus and already have complications such as diabetic microangiopathy neuropathy have a significantly higher risk of erectile dysfunction compared to those without diabetes mellitus, with the prevalence rate of erectile dysfunction in patients with diabetes mellitus reaching 52.5%, which is 3.5-fold higher than that of the population without diabetes mellitus, and the severity of erectile dysfunction in patients with diabetes mellitus is highly dependent on the type and duration of the disease, the type of treatment, and the presence of comorbidities (Defeudis et al., 2022)

It is important to conduct research related to seeing the relationship between uncontrolled blood sugar levels that can be detected by HbA1c examination and also see from the presence or absence of microangiopathy complications of diabetic neuropathy, especially peripheral with the incidence of further complications, namely erectile dysfunction . There is a parallel study from Niken Widyaningsih mentioned that high HbA1c levels in this study were significantly associated with ED (Andersson et al., 2015; Firmansyah & Nugraha, 2024; Widyaningsih & Ahsani, 2021b). Similar research from Mohan (et al) states that men with type 2 diabetes with ED are reported to have higher average HBA1c levels. (Mohan, Mann and Sikri, 2024). Also mentioned from the research of Caitlin (et al) Peripheral neuropathy is a new risk factor for erectile dysfunction. There is a significant independent association between peripheral neuropathy and overall erectile dysfunction (Hicks et al., 2021). Therefore, the researcher conducted a study on the relationship between HbA1c levels and symptoms of diabetic neuropathy microangiopathy with the incidence of erectile dysfunction.

Diabetes mellitus is a metabolic disorder characterized by hyperglycemia due to impaired insulin secretion, insulin action mechanism, or a combination of both (WHO, 2019). Globally, the prevalence of diabetes mellitus reached 9.3% in 2019, with the highest cases in the 65-79 age group (INFODATIN, 2020). Diabetes mellitus is classified into several types, including type 1, type 2, gestational diabetes, and diabetes due to other factors such as pancreatic disease or the use of certain medications (WHO, 2019). Diagnosis of diabetes mellitus involves checking fasting plasma glucose levels, oral glucose tolerance test, and HbA1c, with HbA1c being the most recommended method (ADA, 2022).

Type 2 diabetes mellitus, which accounts for more than 90% of diabetes cases, is often associated with obesity, sedentary lifestyle, and unhealthy diet (IDF, 2021). The main causes involve insulin resistance and decreased pancreatic β-cell function, resulting in chronic hyperglycemia. Risk factors such as genetic predisposition, age, and obesity increase the prevalence of type 2 diabetes, although these risks can be reduced through dietary changes and increased physical activity. Frequent symptoms include polyuria, polydipsia, and polyphagia, as well as severe complications such as ketoacidosis and hyperosmolar coma (WHO, 2020).

Management of type 2 diabetes mellitus involves tight glycemic control through pharmacological therapies such as metformin, insulin, and sulfonylureas, as well as non-pharmacological approaches such as a balanced diet and exercise. Biguanides, such as metformin, work by increasing insulin sensitivity and decreasing glucose production by the liver. Complications of type 2 diabetes mellitus, including cardiovascular disease and erectile dysfunction, require intensive control to reduce mortality risk (Galicia-Garcia et al., 2020; Widyaningsih & Ahsani, 2021).

HbA1c, as an indicator of average blood glucose over the past two to three months, is becoming an important tool in the diagnosis, monitoring, and prevention of diabetes mellitus complications (Guo et al., 2019). HbA1c screening methods include ion-exchange chromatography, immunoassay, and enzyme assay, with High-Performance Liquid Chromatography (HPLC) being the globally recognized standard method (Iqbal et al., 2024). HbA1c control <7% is associated with a reduced risk of microvascular complications such as retinopathy, nephropathy, and peripheral neuropathy by up to 76% (Kaiafa et al., 2021).

The target HbA1c value for diabetes diagnosis is ≥6.5%, while values between 5.7% and 6.4% indicate prediabetes (ADA, 2022). The pre-analytic stability and ease of testing make HbA1c a superior choice, despite its higher cost compared to other methods (Kaiafa et al., 2021). In addition to diagnosis, HbA1c also provides an overview of patient adherence to medication and lifestyle, making it an important tool in long-term strategies for the management of diabetes mellitus (Kaiafa et al., 2021).

Diabetic neuropathy microangiopathy is a chronic complication of type 2 diabetes mellitus involving peripheral sensorimotor and autonomic nerve dysfunction due to damage to the blood capillary walls that nourish the nerves (Labib Bima et al., 2023; Rachmantoko et al., 2021). Risk factors for diabetic neuropathy include metabolic syndrome such as hypertriglyceridemia and hypertension, as well as habits such as long-term alcohol consumption and smoking. The condition often correlates with obesity and advanced age, which affects capillary blood flow and causes pathological changes in nerve fibers (Rachmantoko et al., 2021).

Clinically, diabetic neuropathy is often characterized by symptoms such as tingling, numbness, or burning, especially in the feet or hands, which worsen at night. Initial loss of sensation occurs in the distal parts of the extremities with a glove and stocking pattern, which then extends to other areas of the body (Rachmantoko et al., 2021). The diagnosis of diabetic neuropathy is made through assessment of sensory function, muscle strength, and reflexes, and can be complemented by a nerve biopsy to confirm the condition (Rachmantoko et al., 2021).

Erectile dysfunction, another complication often found in men with diabetes mellitus, is characterized by the inability to achieve or maintain an erection sufficient for satisfactory sexual intercourse (Tridiantari et al., 2020). Risk factors for erectile dysfunction include psychological conditions such as stress and depression, as well as systemic diseases such as diabetes mellitus, hypertension and hyperlipidemia. These diseases often involve decreased production of vasodilator substances such as NO that are essential for erectile function (Mazzilli, 2022; Irwin, 2019).

The pathophysiology of erectile dysfunction includes disorders of the nerves, blood vessels, or a combination of both. Processes that damage neural or vascular pathways, such as spinal cord injury, cardiovascular disease, or chronic diabetes mellitus, can disrupt erectile mechanisms involving blood flow to the corpora cavernosa and smooth muscle relaxation (Bettocchi et al., 2023). Diagnosis of erectile dysfunction involves physical evaluation, assessment of hormone levels, as well as the use of questionnaires such as the International Index of Erectile Function (IIEF-5) to determine severity (Bettocchi et al., 2023).

Treatments for erectile dysfunction include lifestyle changes, the use of phosphodiesterase type 5 inhibitors such as sildenafil and tadalafil, and

nonpharmacological interventions such as vacuum devices and shockwave therapy (Krzastek et al., 2019; Irwin, 2019). In the context of diabetes mellitus, high HbA1c levels indicate poor glucose control, which correlates with an increased risk of erectile dysfunction. Decreasing HbA1c levels may reduce the risk of this complication, emphasizing the importance of strict glycemic management (Widyaningsih & Ahsani, 2021).

This study aims to analyze the relationship between HbA1c levels and clinical manifestations of peripheral diabetic neuropathy microangiopathy with the incidence of erectile dysfunction complications in patients with type 2 diabetes mellitus at RSPAL dr. Ramelan Surabaya during the period July-September 2024. This study also aims to determine the prevalence of erectile dysfunction, its severity, and its relationship with clinical manifestations of peripheral diabetic neuropathy microangiopathy. The results of the study are expected to be useful for researchers to deepen insights into microvascular complications of diabetes mellitus, provide references for other researchers, be additional information for Hang Tuah University medical students, and increase public awareness about the serious impact of type 2 diabetes mellitus, including the risk of erectile dysfunction.

H0 : In patients with type 2 diabetes mellitus, there is no correlation between HbA1c levels and clinical manifestations of diabetic neuropathy microangiopathy and the incidence of microvascular complications of erectile dysfunction.

H1 : In patients with type 2 diabetes mellitus, there is a correlation between HbA1c levels and clinical manifestations of diabetic neuropathy microangiopathy and the incidence of microvascular complications of erectile dysfunction.

RESEARCH METHOD

This study used an analytic observational design with a cross-sectional approach to evaluate the relationship between HbA1c levels and clinical manifestations of diabetic neuropathy microangiopathy as independent variables, and erectile dysfunction as the dependent variable. Quantitative methods were used with primary data in the form of the International Index Erectile Function 5 (IIEF-5) questionnaire and secondary data from medical records that included HbA1c results, age, duration of type 2 diabetes mellitus, and symptoms of diabetic neuropathy. The study sample consisted of 61 male patients with type 2 diabetes mellitus who were selected using consecutive sampling according to the inclusion criteria, namely patients who had complete data from medical records and were willing to participate in the study.

The operational definitions of the study variables included independent variables such as HbA1c levels (categorized as normal, pre-diabetic, and diabetic based on certain restrictions) and microangiopathic symptoms of diabetic neuropathy (expressed as "present" or "absent"). The dependent variable of erectile dysfunction was measured using the IIEF-5 score which was divided into several levels of severity. Data were collected through questionnaire interviews and medical records at Dr. Ramelan General Hospital Surabaya, with data processed using the SPSS application. Analysis was conducted univariately to describe the characteristics of the data and bivariately to analyze the relationship between variables using the Chi-square test with a significance level of $p<0.05$.

The research process included ethical approval, data collection, and data processing through steps such as verification, coding, and tabulating. Univariate

analysis described respondents' characteristics, such as age and duration of type 2 diabetes mellitus, as well as the distribution of study variables. Bivariate analysis was used to evaluate the interaction between HbA1c levels and symptoms of diabetic neuropathy with the incidence of erectile dysfunction, providing greater insight into the factors contributing to this complication.

RESULT AND DISCUSSION

Univariate Analysis

Univariate analysis is a type of statistical analysis that only involves one variable at a time to see the characteristics or distribution of data. This study contains descriptive data analysis including patient characteristics in the form of age, duration of type 2 diabetes mellitus, HbA1c levels, presence or absence of diabetic neuropathy symptoms, and a description of erectile dysfunction complications with various degrees of erectile dysfunction.

HbA1c levels

Based on data from 61 patients with type 2 diabetes mellitus and symptoms of the presence or absence of diabetic neuropathy with or without complications of erectile dysfunction at Dr. Ramelan General Hospital Surabaya in the period July - September 2024 from a total sample of 61 data obtained 6 patients (9.8%) had HbA1c levels < 5.7%, while 13 patients (21.3%) had HbA1c levels of 5.7 - 6.4% and 42 patients (68.9%) had HbA1c levels of ≥ 6,5

Diabetic neuropathy

Based on data from 61 patients with type 2 diabetes mellitus and symptoms of the presence or absence of diabetic neuropathy with or without complications of erectile dysfunction at Dr. Ramelan General Hospital Surabaya in the period July - September 2024 from a total sample of 61, 42 patients (68.9%) had symptoms of Diabetic Neuropathy while 19 patients (31.1%) did not have symptoms of Diabetic Neuropathy.

Complications of Erectile Dysfunction

Table 1. Patient Characteristics Based on Number of Erectile Dysfunction Complications

Erectile Dysfunction	Frequency (n)	Percentage (%)
Available	49	80,3 %
None	12	19,7 %
Total	61	100 %

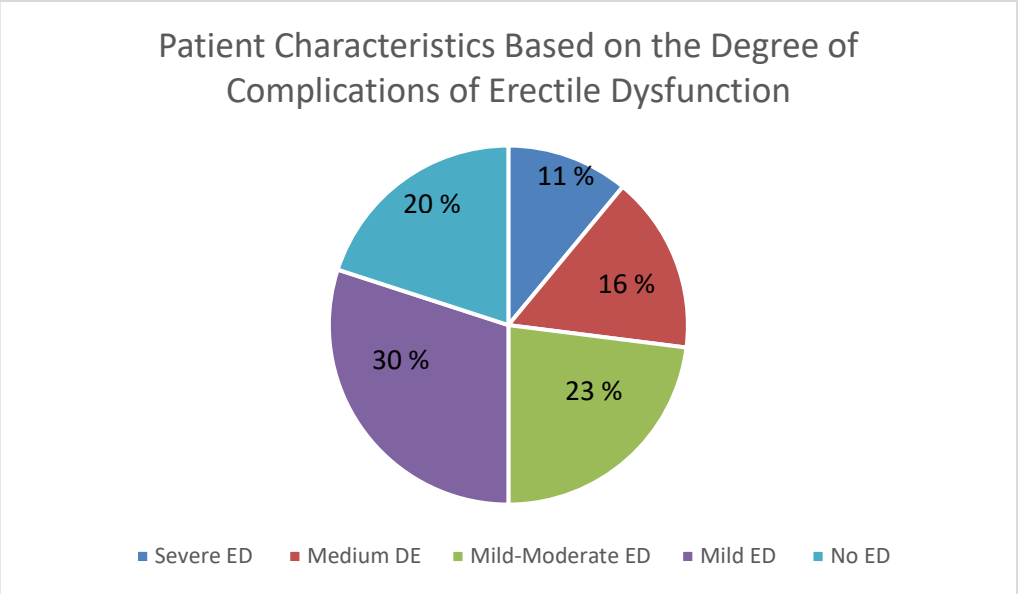

Figure 1. Patient Characteristics Based on Number of Erectile Dysfunction Complications

Based on data from 61 patients with type 2 diabetes mellitus and symptoms of the presence or absence of diabetic neuropathy with or without complications of erectile dysfunction at Dr. Ramelan General Hospital Surabaya in the period July - September 2024 from a total sample of 61 obtained data through the International Index of Erectile Function (IIEF-5) questionnaire to obtain erectile dysfunction complications as many as 49 patients (80.3%) had complications of erectile dysfunction while the remaining 12 patients (19.7%) did not experience erectile dysfunction.

Based on the degree of erectile dysfunction obtained from the International Index of Erectile Function (IIEF-5) questionnaire, 7 patients (11.5%) had severe erectile dysfunction, 10 patients (16.4%) with moderate erectile dysfunction, 14 patients (23%) with mild erectile dysfunction, 18 patients (29.5%) with the highest frequency had mild erectile dysfunction and the remaining 12 patients (19.7%) without erectile dysfunction complications.

Age

Based on data from 61 patients with type 2 diabetes mellitus and symptoms of the presence or absence of diabetic neuropathy with or without complications of erectile dysfunction at Dr. Ramelan General Hospital Surabaya in the period July - September 2024 from a total sample of 61 obtained from the age category < 45 years as many as 7 patients (11.5%), the category 45-59 years as many as 32 patients (52.5%) and for the oldest category, 22 patients (36.1%) were obtained. ≥ 59 years obtained 22 patients (36.1%)

Duration of Type 2 Diabetes Mellitus

Based on data from 61 patients with type 2 diabetes mellitus and symptoms of the presence or absence of diabetic neuropathy with or without complications of erectile dysfunction at Dr. Ramelan General Hospital Surabaya in the period July - September 2024 from a total sample of 61, the largest percentage of 31 patients

(50.8%) were in the category of patients who had type 2 diabetes mellitus in a period of less than 5 years. While the remaining 30 patients (49.2%) had type 2 diabetes mellitus within a period of ≥ 5 years.

Bivariate Analysis

Cross-tabulation between HbA1c levels and Erectile Dysfunction Complications

Table 2. Cross Tabulation Between HbA1c Levels and Complications of Erectile Dysfunction

HbA1c		Erectile Dysfunction	No Dysfunction Erection	Total
< 5,7	n	2	4	6
	%	33,3%	66,7%	100%
5,7-6,4	n	12	1	13
	%	92,3%	7,7%	100%
≥ 6,5	n	35	7	42
	%	83,3%	16,7%	100%
Total	n	49	12	61
	%	80,3%	19,7%	100%

Based on the data obtained shown in table 5.7 and figure 5.8, of the 6 patients who had HbA1c levels <5.7%, 2 patients (33.3%) had complications of erectile dysfunction while the remaining 4 patients (66.7%) did not have complications of erectile dysfunction. Furthermore, a total of 13 patients who had HbA1c values between 5.7% - 6.4% of which around 92.3% had complications of erectile dysfunction and the remaining 7.7% did not experience complications of erectile dysfunction. For the HbA1c group ≥ 6.5 there were a total of 42 patients of which 35 patients (83.3%) had complications of erectile dysfunction and 7 patients (16.7%) did not have complications of erectile dysfunction.

Cross Tabulation Between HbA1c and Degree of Erectile Dysfunction Using IIEF-5

Based on the results of the study, from a total of 61 patients studied, there were 6 patients with HbA1c levels below 5.7%, 13 patients with HbA1c levels between 5.7% to 6.4% and 42 patients with HbA1c levels> 6.5%. In the group of patients with HbA1c levels below 5.7%, the majority of 4 patients or 66.7% did not experience erectile dysfunction.

Meanwhile, in the group of patients with HbA1c levels between 5.7-6.4%, the distribution of patients based on the degree of ED was as follows, 1 patient (7.7%%) did not experience ED, there were 0 patients or 0% with mild erectile dysfunction, 2 patients or 15.4% with mild-moderate erectile dysfunction, and there were equal numbers in the category of moderate erectile dysfunction and severe erectile dysfunction, namely 5 patients or 38.5%.

In the group of patients with HbA1c levels between more than 6.5%, the distribution of patients based on the degree of ED is as follows, there is a similar number of patients suffering from erectile dysfunction in mild-moderate degree and erectile dysfunction in moderate degree, namely 8 patients or 19%, then there is also a similar number of patients suffering from erectile dysfunction in mild degree

and patients without erectile dysfunction complications, namely 7 patients or 16.7%. The remaining majority of 12 patients or 28.6% had severe degree of erectile dysfunction.

Cross Tabulation Between Symptoms of Diabetic Neuropathy and Degree of Erectile Dysfunction Using IIEF-5

Based on the results of the study, of the 19 patients without diabetic neuropathy symptoms, 6 patients or 31.6% did not experience ED, 3 patients or 15.8% experienced mild ED, 2 patients or 10.5% experienced mild-moderate ED, 2 patients or 10.5% experienced moderate ED, and 6 patients or 31.6% experienced severe ED. On the other hand, in the group of 42 patients with diabetic neuropathy symptoms, only 6 patients or 14.3% did not experience ED, while 4 patients or 9.5% experienced mild ED, 8 patients or 19% experienced mild-moderate ED, 12 patients or 28.6% experienced moderate ED and 12 patients or 28.6% experienced severe ED.

Cross-tabulation between Diabetic Neuropathy Symptoms and Erectile Dysfunction Complications

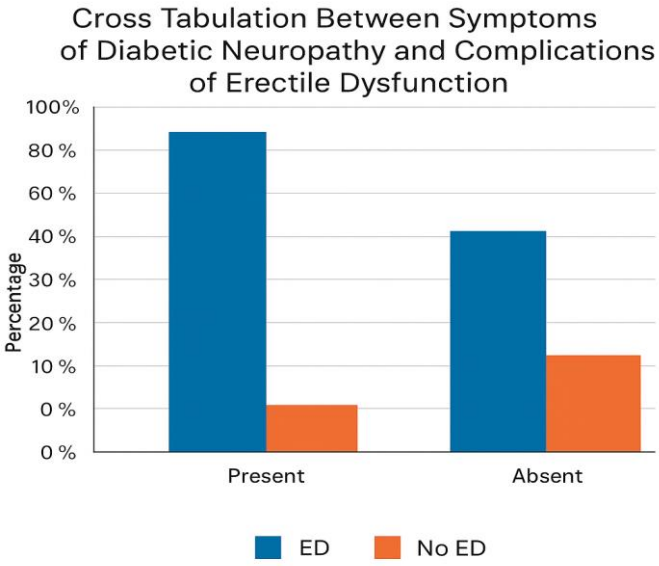

Figure 2. Cross-tabulation between Diabetic Neuropathy Symptoms and Erectile Dysfunction Complications

Based on the data obtained shown in table a total of 42 patients who have symptoms of diabetic neuropathy, 36 patients (85.7%) of them experience complications of erectile dysfunction and the remaining 6 patients (14.3%) do not experience erectile dysfunction. Meanwhile, from a total of 19 patients who did not have symptoms of diabetic neuropathy, 13 patients (68.4%) experienced complications of erectile dysfunction and the remaining 6 patients (31.6%) did not experience complications of erectile dysfunction.

Cross Tabulation Between HbA1c and Age

Table 3. Cross Tabulation Between HbA1c and Age

HbA1c		Age			Total
		< 45	**45-59**	**> 59**	
< 5,7%	n	0	5	1	6
	%	0%	83,3%	16,7%	100%
5,7% - 6,4%	n	0	7	6	13
	%	0%	53,8%	46,2%	100%
≥ 6,5%	n	7	20	15	42
	%	16,7%	47,6%	35,7%	100%
Total	n	7	32	22	61
	%	11,5%	52,5%	36,1%	100%

Based on the data obtained shown in table 3 and figure 2 there are 6 patients who have HbA1c levels < 5.7%, 5 patients (83.3%) are in the age category 45-59 years, followed by 1 patient (16.7%) in the age category > 59 years and no patients under the age of 45 years with HbA1c levels < 5.7%.

The data distribution of 13 patients who had HbA1c levels of 5.7% - 6.4% included the most 7 patients (53.8%) in the age category 45-59 years, 6 patients (46.2%) were in the age category > 59 years and there were no patients under the age of 45 years with HbA1c levels 5.7% - 6.4%.

HbA1c levels with a value of ≥ 6.5% is stated to have the largest number, namely, 42 patients of which 20 patients (47.6%) are in the 45-59 year age category, followed by the second largest number of 15 patients (35.7%) in the over 60 year age category, and 7 patients (16.7%) in the age category. < 45 Years.

Cross-tabulation between HbA1c and Duration of Type 2 Diabetes Mellitus

Table 4. Cross-tabulation between HbA1c levels and duration of diabetes mellitus type 2

HbA1c		< 5 Years	> 5 Years	Total
< 5,7	n	4	2	6
	%	66,7%	33,3%	100%
5,7-6,4	n	6	7	13
	%	46,2%	53,8%	100%
≥ 6,5	n	21	21	42
	%	50%	50%	100%
Total	n	31	30	61
	%	50,8%	49,2%	100%

Based on the data obtained shown in table 4 and figure 3, a total of 6 patients who have HbA1c levels <5.7%, 4 patients (66.7%) are stated to have had type 2 diabetes mellitus for less than 5 years and 2 patients (33.3%) have type 2 diabetes mellitus for more than 5 years.

Data distribution of 13 patients who have HbA1c levels of 5.7% - 6.4% of which the most as many as 7 patients (53.8%) have had type 2 diabetes mellitus lasting more than 5 years and 6 patients (46.2%) have had type 2 diabetes mellitus for less than 5 years.

There were 42 patients with HbA1c levels ≥ 6.5 where the number of patients who have type 2 diabetes mellitus for less than 5 years and more than 5 years is equal to 21 patients.

Cross Tabulation Between Diabetic Neuropathy Symptoms and Age

Table 5. Cross-tabulation between Diabetic Neuropathy Symptoms and Age

Symptoms of Diabetic Neuropathy		Age			Total
		< 45	45-59	> 59	
Available	n	5	23	14	42
	%	11,9%	54,8%	33,3%	100%
No	n	2	9	8	19
There is	%	10,5%	47,4%	42,1%	100%
Total	n	7	32	22	61
	%	11,5%	52,5%	36,1%	100%

Based on the data obtained shown in table 5, out of a total of 42 patients who have symptoms of diabetic neuropathy, 23 patients (54.8%) are in the age category of 45-59 years, followed by the second highest position of 14 patients (33.3%) aged more than 59 years and with the lowest patient distribution of 5 patients (11.9%) in the age range of less than 45 years. Whereas from a total of 19 patients who did not have symptoms of diabetic neuropathy, 9 patients (47.4%) were in the age range of 45-59 years, followed by 8 patients (42.1%) in the age category of more than 59 years and 2 patients (10.5%) were in the category of patients less than 45 years old.

Cross-tabulation between Diabetic Neuropathy Symptoms and Duration of Type 2 Diabetes Mellitus

Table 6. Cross-tabulation between Diabetic Neuropathy Symptoms and Duration of Type 2 Diabetes Mellitus

Symptoms of Diabetic Neuropathy		< 5 Years	> 5 Years	Total
Available	n	22	20	42
	%	52,4%	47,6%	100%
None	n	9	10	19
	%	47,4%	52,6%	100%
Total	n	31	30	61
	%	50,8%	49,2%	100%

Based on the data obtained shown in table 56, it states that of the 42 patients who have symptoms of diabetic neuropathy, 22 patients (52.4%) have had type 2 diabetes mellitus for less than 5 years and 20 patients (47.6%) have had type 2 diabetes mellitus for more than 5 years. Meanwhile, a total of 19 patients who did not have symptoms of diabetic neuropathy found 10 people (52.6%) had had type 2 diabetes mellitus for more than 5 years and 9 patients (47.4%) had type 2 diabetes mellitus for less than 5 years.

Cross Tabulation Between Complications of Erectile Dysfunction and Age

Table 7. Cross-tabulation between Erectile Dysfunction Complications and Age

Erectile Dysfunction		Age			Total
		< 45	45-59	> 59	
There is	n	2	26	21	49
	%	4,1%	53,1%	42,9%	100%

Erectile Dysfunction		Age			Total
		< 45	45-59	> 59	
No Available	n	5	6	1	12
	%	41,7%	50%	8,3%	100%
Total	n	7	32	22	61
	%	11,5%	52,5%	36,1%	100%

Based on the data obtained shown in table 7, of the total 49 patients who had erectile dysfunction complications, 26 patients (53.1%) were in the age range of 45-59 years, followed by 21 patients (42.9%) in the age range of more than 59 years and with the lowest number of patients of 2 patients (4.1%) aged less than 45 years. Whereas from a total of 12 patients who did not experience erectile dysfunction complications, 6 patients (50%) were in the age range of 45-59 years, followed by 5 patients (41.7%) who were less than 45 years old and there was only 1 patient (8.3%) who was more than 59 years old who did not experience erectile dysfunction complications.

Cross-tabulation between Erectile Dysfunction Complications and Duration of Type 2 Diabetes Mellitus

Table 8. Cross tabulation between complications of erectile dysfunction and duration of diabetes mellitus type 2

Complications of Erectile Dysfunction		< 5 Years	> 5 Years	Total
Available	n	23	26	49
	%	46,9%	53,1%	100%
None	n	8	4	12
	%	66,7%	33,3%	100%
Total	n	31	30	61
	%	50,8%	49,2%	100%

Based on the data obtained shown in table 58, it states that of the 49 patients who have the highest erectile dysfunction complications, 26 patients (53.1%) have had type 2 diabetes mellitus for more than 5 years and 23 patients (46.9%) have had type 2 diabetes mellitus for less than 5 years. Whereas from a total of 12 patients who did not have erectile dysfunction complications, 8 patients (66.7%) had type 2 diabetes mellitus for less than 5 years and 4 patients (33.3%) had type 2 diabetes mellitus for more than 5 years.

Hypothesis Testing

Chi-Square Test of the Relationship between HbA1c and Erectile Dysfunction

Table 9. Chi-Square Test 1

Chi-Square Test			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.806[a]	2	.007
Likelihood Ratio	7.954	2	.019
Linear-by-Linear Association	3.877	1	.049

N of Valid Cases	61

This test analyzes the relationship between HbA1c levels and the incidence of erectile dysfunction using the Chi-Square correlation analysis test. Based on the output table, it is known that the value of Asymp. Sig. (2-sided) on the Pearson Chi-Square test is 0.007. Where the criteria are known as follows:

1. If the significance α > (0.05), then H_0 accepted and H_1 rejected.
2. If the significance α < (0.05), then H_0 rejected and H_1 accepted.

Therefore, based on the above criteria, it can be concluded that H_0 rejected and H_1 accepted because the value α obtained is 0.007 where this is < (0.05). Thus it can be seen that there is a relationship between HbA1c levels and complications of erectile dysfunction in male patients diagnosed with type 2 diabetes mellitus at RSPAL dr. Ramelan Surabaya.

Chi-Square Test for the Relationship of Diabetic Neuropathy to Erectile Dysfunction

Table 10. Chi-Square Test 2

Chi-Square Tests					
	Value	**df**	**Asymptotic Significance (2-sided)**	**Exact Sig. (2-sided)**	**Exact Sig. (1-sided)**
Pearson Chi-Square	2.476[a]	1	.116		
Continuity Correction[b]	1.502	1	.220		
Likelihood Ratio	2.343	1	.126		
Fisher's Exact Test				.165	.112
Linear-by-Linear Association		1			
N of Valid Cases	61				

This test analyzes the relationship between the symptoms of Diabetic Neuropathy and the incidence of erectile dysfunction using the Chi-Square correlation analysis test. Based on the output table, it is known that the value of Asymp. Sig. (2-sided) on the Pearson Chi- Square test is 0.116 where the following criteria are known:

1. If the significance α > (0.05), then H_0 accepted and H_1 rejected.
2. If the significance α < (0.05), then H_0 rejected and H_1 accepted.

Therefore, based on the above criteria, it can be concluded that H_0 accepted and H_1 rejected because the value α obtained by .116 where this > (0.05). Thus it can be seen that there is no relationship between the symptoms of Diabetic Neuropathy and the complications of erectile dysfunction in male patients diagnosed with type 2 diabetes mellitus at RSPAL dr. Ramelan Surabaya.

Discussion

Characteristic Analysis

In a study of the age characteristics of patients with type 2 diabetes mellitus, it was found that of 61 patients, most were in the age range of 45-59 years, namely 32 people or 52.5% of the total number of patients, 36.1% or 22 other patients, were over the age of 59 years and there were 7 patients or 11.5% under the age of 45 years. These results are in line with research conducted by Gurinder Mohan, Gurbir Singh Mann, and Tejinder Sikri, 2024, who found that of 65 patients with erectile dysfunction diagnosed with type 2 diabetes mellitus, most were aged 30 to 40 years, with an average age of 39 years. (Mohan, Mann and Sikri, 2024).

Similar results were found in another study conducted in 2019 by Balasingam Nisahan, Thirunavukarasu Kumanan, Nadarajah Rajeshkannan, Thampipillai Peranantharajah, and Mahalingam Aravinthan, involving 326 men with type 2 diabetes. Almost 98.8% of the patients had complications of erectile dysfunction. Most of the patients were between 49 to 56 years old (Nisahan et al., 2019). However, these findings differ from research conducted by Nanda Suryani Sagala and Mei Adelina Harahap, 2021 at the Padang Sidimpuan City Regional General Hospital in 2020. Of the 31 patients with type 2 diabetes mellitus who experienced erectile dysfunction, 18 patients or 58.1% were in the age group of 56 to 65 years, known as the elderly. There are 13 other patients or 41.9% in the age group 46 to 55 years, known as middle age. (Sagala et al., 2021)

In a study of the characteristics of the duration of having type 2 diabetes mellitus in patients with type 2 diabetes mellitus who have complications of erectile dysfunction, it was found that of 61 patients, most had type 2 diabetes mellitus for less than 5 years as many as 31 patients or 50.8% and as many as 30 patients or 49.2% who had suffered for more than 5 years. These results are in line with research conducted by Nanda Suryani Sagala and Mei Adelina Harahap, 2021 at the Padang Sidimpuan City Regional General Hospital in 2020 found that of the 31 patients diagnosed with type 2 diabetes mellitus with complications of erectile dysfunction most suffered from type 2 diabetes mellitus in the range of 1-3 years with a total of 16 patients or 51.6%. (Sagala et al., 2021)

Another study conducted in 2019 by Balasingam Nisahan, Thirunavukarasu Kumanan, Nadarajah Rajeshkannan, Thampipillai Peranantharajah, and Mahalingam Aravinthan stated that the majority of patients as many as 56% of patients from a total of 326 male patients who were questioned stated that they had suffered from diabetes mellitus for more than 5 years and 23.6% of patients for more than 10 years. (Nisahan et al., 2019)

In studies on erectile dysfunction (ED) degree characteristics in patients with type 2 diabetes mellitus vary, with most patients showing symptoms of erectile dysfunction that range from mild to severe. The International Index of Erectile Function (IIEF-5) questionnaire, which evaluates erectile dysfunction based on a specific scale, was used to categorize this erectile dysfunction. Of the 61 patients studied, 80.3% experienced mild to severe ED in 49 patients (80.3%). Of the total patients with ED, 7 patients or 11.5% had severe ED, 10 patients or 16.4% had moderate ED, 14 patients or 23% had mild-moderate ED, and 18 patients or 29.5% had mild ED, while 12 patients or 19.7% had no ED.

Another study conducted by Ahmet Ariman et al. stated that most patients suffered from erectile dysfunction at a mild-moderate degree where as many as 46 patients or 38.3%, followed by 28 patients or 23.3% of mild degrees, then 26

patients or 21.7% with mild degrees, 20 patients or 16.7% of severe degrees. (Arıman et al., 2021)

Relationship between HbA1c and Erectile Dysfunction

This study used primary data, namely the international index of erection - 5 questionnaire and secondary data in the form of medical records on patients with type 2 diabetes mellitus who had HbA1c examination results accompanied or without diabetic neuropathy at the diabetes clinic of Dr. Ramelan Surabaya in July-September 2024. A total of 61 samples of type 2 diabetes mellitus patients who met the inclusion and exclusion criteria were obtained.

All data were entered into SPSS and data were analyzed to find the relationship with the Chi-Square correlation test. From the test results, it was found that there was a significant relationship between HbA1c levels of patients with type 2 diabetes mellitus and the incidence of erectile dysfunction at Dr. Ramelan General Hospital Surabaya. With the results of the p value in the Chi-Square test of 0.007 which means that H_0 rejected and H_1 accepted because the value α obtained is 0.007 where this is < (0.05).

Erectile dysfunction in patients with type 2 diabetes mellitus is often caused by damage to blood vessels and nerves due to chronic hyperglycemia. High HbA1c levels accelerate the process of atherosclerosis in small blood vessels, including those leading to penile tissue. Chronic hyperglycemia also causes oxidative stress and the production of advanced glycation end products (AGEs) that damage the vascular endothelium and impair nerve function. As a result, patients experience impaired blood flow and nerve function in the genital area, which contributes to the occurrence of erectile dysfunction. (Prawitasari, 2019).

This study showed that the degree of erectile dysfunction was more severe in patients with higher HbA1c levels. In the group of patients with HbA1c> 6.5%, as many as 35 patients or 83.3% experienced ED with varying degrees ranging from mild to severe, while in the group with HbA1c levels between 5.7-6.4%, as many as 12 patients experienced erectile dysfunction with more degrees of ED ranging from moderate to severe and for HbA1c levels < 5.7% dominated by 4 patients or 66.7% without complications of erectile dysfunction. This indicates that poor glycemic control increases the risk and severity of ED in patients with type 2 diabetes mellitus.

The results of this study can be strengthened by the research of Gurinder Mohan (et al) stated that patients with higher Hba1c levels with levels greater than 6.5% had severe erectile dysfunction with a lower average IIEF-5 score compared to those who had relatively better glycemic control. (Mohan, Mann and Sikri, 2024)..

Relationship between Diabetic Neuropathy Symptoms and Erectile Dysfunction

Based on the data obtained from this study, there is no significant correlation between peripheral diabetic neuropathy symptoms and erectile dysfunction complications in type 2 diabetes patients at Dr. Ramelan General Hospital Surabaya. The results of hypothesis testing using Chi-Square correlation analysis showed that there was no statistically significant relationship between symptoms of diabetic neuropathy and erectile dysfunction in the patients studied where the significance

value was 0.116. Thus, H_0 accepted and H_1 rejected which means that there is no significant statistical relationship.

Diabetic neuropathy is a condition that includes impaired peripheral sensorimotor and autonomic nerve function in patients with diabetes. This condition is usually asymptomatic, but in some cases pain appears called diabetic neuropathic pain. For this study, it is more specific to peripheral diabetic neuropathy where the symptoms of peripheral diabetic neuropathy pain vary, including a burning sensation either persistent or intermittent, stabbing, tingling, numbness, and feelings of heat, cold, or itching. Typically, these symptoms begin to develop from distal areas, such as the feet, and then spread towards the proximal parts of the body. (Rachmantoko et al., 2021).. However, in this study, although a large number of patients showed the presence of diabetic neuropathy, 42 patients or 68.9% of the total 61 patients, most of those who experienced erectile dysfunction were not directly related to the presence of diabetic neuropathy symptoms.

There are several factors that may cause the absence of a significant association between diabetic neuropathy and erectile dysfunction in this study. Erectile dysfunction in diabetic patients is not only affected by neuropathy but also by other factors such as HbA1c levels that are higher than the normal limit, age and duration of diabetes mellitus as mentioned in the study of Gurinder Mohan, Gurbir Singh Mann, and Tejinder Sikri, 2024. (Mohan, Mann and Sikri, 2024). Other factors include low testosterone levels, neurogenic and iatrogenic factors (related to medical or surgical treatment). In addition, psychological components are also involved, thus complicating the clinical picture and worsening quality of life (Defeudis et al., 2022; Fisken, 2010; Khan & Rahman, 2022)

CONCLUSION

This study concludes that there is a significant association between HbA1c levels and the incidence of erectile dysfunction (ED) in patients with type 2 diabetes mellitus, whereas no significant relationship was found between the clinical manifestations of diabetic neuropathy microangiopathy and ED. The findings reveal that 80.3% of diabetic patients experienced erectile dysfunction, with the majority categorized as mild cases. Furthermore, among patients who exhibited symptoms of diabetic neuropathy, 85.7% also had complications of erectile dysfunction. These findings highlight the critical role of glycemic control in the development of ED in diabetic patients.

For future research, it is recommended to increase the sample size and use primary data sources to enhance the statistical strength and representativeness of the study. A longitudinal approach could also provide valuable insights into how changes in HbA1c levels influence the progression of both neuropathy and erectile dysfunction over time. Additionally, future studies should consider incorporating a broader range of potential contributing factors to erectile dysfunction, including other organic diseases, hormonal imbalances, psychological conditions, medication side effects, and relationship dynamics, to provide a more comprehensive understanding of this complication in diabetic patients.

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