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Factors of Diabetic Retinopathy among Type 2 Diabetes Mellitus Patients in Central Java Province, Indonesia

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Abstract

Background: One of the microvascular complications of type 2 diabetes mellitus is diabetic retinopathy. The prevalence of diabetes mellitus in Central Java Province in 2022 increased by 10% to 12.52% in the third quarter of 2023. This prevalence rate has not reached the SDG's target, namely there is no increase in diabetes prevalence by 0%. **Objective**: The purpose of this study is to analyze factors associated with the incidence of diabetic retinopathy in type 2 DM patients at Central Java Provincial Hospital in 2023. **Methods:** This research is quantitative research with a nested case-control study design, using electronic medical record (EMR) data from the Central Java Provincial Hospital in 2023. The variables in this study were gender, age, education level, employment status, marital status, health insurance status, BMI, DM diet, duration of DM, hypertension, other diseases, current blood glucose, and HbA1c. The analysis used was univariate, bivariate, and multivariate analysis (logistic regression). **Results:** The results showed that there was an association between age ≥70 years (p=0.006), DM diet (p<0.0001, OR=20.914), duration of DM (p=0.003, OR=3.010), hypertension (p=0.013, OR=2.619), other diseases including cataracts (p=0.040, OR=9.00), glaucoma (p=0.007), CHD (p=0.040, OR=9.00), and cardiomegaly (p=0.016), current blood glucose (p=0.045, OR=2.478), and HbA1c (p<0.0001, OR=6.152). **Conclusion:** DM diet is the most dominant factor associated with diabetic retinopathy in type 2 DM patients.

INTRODUCTION

Type 2 diabetes mellitus is a chronic disease characterized by hyperglycemia and glucose intolerance due to insufficient insulin production or ineffective insulin use, with a blood glucose level of ≥ 200 mg/dl and fasting blood glucose levels ≥ 126 mg/dl (Petersmann et al., 2019). DM is often referred to as a "silent killer" because many sufferers do not realize it until complications have occurred. The disease can affect almost all systems of the human body, from the skin to the heart, and cause various complications (Hestiana, 2017).

The global SDG's target is that there is no increase in diabetes prevalence by 0% (Kemenkes, 2019). SDG's 3.4 target, which is by 2030, can reduce up to one-third of premature deaths due to non-communicable diseases through pre-

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vention and treatment and improve mental health and well-being (WHO, 2022). The prevalence of diabetes in the world in 2019 was 9.3%, or 463 million people (Saeedi et al., 2019), and increased in 2021 to 10.5%, or 537 million people suffering from diabetes (International Diabetes Federation, 2021b). This phenomenon has not met the global SDG's target, namely that there is no increase in the prevalence of diabetes by 0% (Kemenkes, 2019).

DM is the 6th leading cause of death in the world, which is around 1.3 million people (Handayani et al., 2021). According to data from the International Diabetes Federation (IDF) in 2021, Indonesia ranks fifth with the highest number of diabetics in the world, which is 19.5 million with a prevalence of 10.5%, an increase from 2019, which ranked seventh with a total of 10.7 million (International Diabetes Federation, 2021a).

Based on data from the 2023 Indonesian Health Survey (SKI), the increasing trend of the prevalence of diabetes mellitus in Indonesia diagnosed by doctors in the population aged ≥15 years has increased from 2.0% in 2018 to 2.2% in 2023, so it has not met the global SDG's target (SKI, 2023). The prevalence of diabetes mellitus in Central Java Province in 2022 increased by 10% to 12.52% in the third quarter of 2023. Thus, it has not met the Ministry of Health's target in the Prevention and Control of Non-Communicable Diseases (PNC-NCD) Program, namely that there is no increase in diabetes prevalence by 0% while the gap in increasing diabetes prevalence is 2.52% (Dinas Kesehatan Provinsi Jawa Tengah, 2023).

Central Java Provincial Hospital is the largest hospital as well as functions as a referral hospital for people in the Central Java Province region who can provide services and treatment for diabetic retinopathy sufferers. The electronic medical record (EMR) data of the Central Java Provincial Hospital has the availability of complete data regarding the variables to be researched. Based on electronic medical record (EMR) data from the Central Java Provincial Hospital, there were 64 diabetic retinopathy patients in 2021, increasing in 2022 to 133 cases. In 2023, cases of diabetic retinopathy will increase to 166 cases (Electronic Medical Records of Central Java Provincial Hospital, 2024). The increase in diabetic retinopathy cases occurs every year, requiring early detection, treatment, and proper management so as not to cause other complications.

Research by Nafia et al. (2021) stated that blood sugar control is related to diabetic retinopathy in type 2 DM patients, while research by Yin et al. (2020) found that there is a relationship between age, gender, hypertension, duration of diabetes, and HbA1c with diabetic retinopathy in type 2 DM patients. Research by Harini et al. (2022) suggested the addition of variables of HbA1c levels and history of hypertension in DM patients, so this study added these variables. The novelty in this study is the addition of other disease variables. Therefore, researchers are interested in conducting this study, which aims to analyze factors associated with the incidence of diabetic retinopathy in type 2 DM patients at Central Java Provincial Hospital in 2023. It is hoped that patients will get early detection examinations, treatment, and proper management so that type 2 DM patients do not experience complications of diabetic retinopathy.

METHOD

This type of research is quantitative research with a nested case-control study research design. This research was carried out at Central Java Provincial Hospital in 2023. The independent variables in this study included gender, age, education level, employment status, marital status, health insurance status, BMI, DM diet, duration of DM, hypertension, other diseases, current blood glucose, and HbA1c. The dependent variable in this study was the incidence of diabetic retinopathy in type 2 DM patients. The case population in this study consists of type 2 diabetes mellitus patients with diabetic retinopathy complications recorded in the electronic medical records (EMR) of Central Java Provincial Hospital in 2023, totaling 166 cases. Meanwhile, the control population in this study consists of type 2 diabetes mellitus patients without any complications recorded in the electronic medical records (EMR) of Central Java Provincial Hospital in 2023, totaling 68 cases (Electronic Medical Records Section of Central Java Provincial Hospital, 2024).

In the control sample, the sampling technique used was total sampling because the control population consisted of 68 individuals, so total sampling was applied. Meanwhile, the case sample was taken using simple random sampling; from 166 cases, 68 cases were selected because this study used a 1:1 ratio, that is cases: controls 68:68. The sample of this study case is a type 2 diabetic mellitus patient who has diabetic retinopathy with inclusion criteria, namely type 2 DM patients with complications in the form of diabetic retinopathy with ICD-10 E11.3 (non-insulin-dependent diabetes mellitus with ophthalmic complications), patients admitted to the Central

Java Provincial Hospital residing in Central Java Province in 2023, electronic medical record data is completely recorded in 2023 including variables of gender, age, education level, employment status, marital status, health insurance status, BMI, DM diet, duration of DM, hypertension, other diseases, current blood glucose, and HbA1c, while the exclusion criteria are the patient who died.

The control sample in this study consists of type 2 diabetes mellitus patients without diabetic retinopathy, with inclusion criteria being type 2 diabetes mellitus patients recorded in the electronic medical records without diabetic retinopathy complications coded as ICD-10 E11.9 (non-insulin-dependent diabetes mellitus without complications), patients treated at the Central Java Provincial Hospital who reside in Central Java Province in 2023, with complete medical record data for the year 2023 including variables of gender, age, education level, employment status, marital status, health insurance status, BMI, DM diet, duration of DM, hypertension, other diseases, current blood glucose, and HbA1c, while the exclusion criteria are the patient who died.

Data analysis in this study includes univariate, bivariate, and multivariate analyses. In this study, univariate analysis is used to determine the frequency distribution and bivariate analysis to determine the associations between independent and dependent variables using the chi-square test and Fisher's exact test as an alternative. Multivariate analysis uses logistic regression to identify which variables are most dominantly associated with the occurrence of diabetic retinopathy in type 2 DM patients and to determine the probability of patients' incidence of diabetic retinopathy. This research protocol has been approved by the Research Ethics Committee of Universitas Negeri Semarang with the number 318/KEPK/FK/KLE/2024.

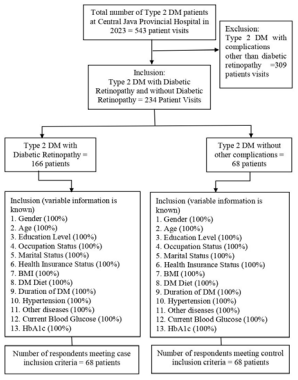

Figure 1. The flow of Data Collection from Sample Data of EMR Central Java Provincial Hospital, 2023 with Nested Case-Control Design
Source: Electronic Medical Records of Central Java Provincial Hospital, 2023

RESULT AND DISCUSION

The results of the univariate analysis in Table 1 included 136 patients as the sample for this study. The characteristics of respondents regarding socio-demographic factors show that the majority of patients are female (63.2%) rather than male (36.8%). 12.5% were ≥ 70 years old, 38.2% had low education, 61.8% were employed, 86.8% of patients were married, 8.1% were divorced, and 5.1% were unmarried. 73.5% of patients with JKN Non-PBI. In the health and behavioral characteristics of the patients, 14.9% had obesity, 40.4% of the patients did not follow the DM diet, 55.9% had DM ≥ 5 years, 62.5% had hypertension, 75.7% had current blood glucose ≥200 mg/dL, and 66.9% had HbA1c ≥6.5%. Based on other diseases, 5.1% of patients had cataracts, 4.4% had glaucoma, 1.5% had diabetic nephropathy, 14.0% had CKD (chronic kidney disease), 0.7% had kidney failure, 18.4% had azotemia, 5.1% had CHD (coronary heart disease), 3.7% had cardiomegaly, 2.9% had stroke, 5.9% had urinary tract infections, and 3.7% had bronchopneumonia.

Table 1. Univariate Analysis of Factors Diabetic Retinopathy among T2DM Patients in Central Java Province

Variables	Total (n)	Percentage (%)
Gender		
Female	86	63.2
Male	50	36.8
Age		
≥ 70 years	17	12.5
60-69 years	33	24.3
50-59 years	56	41.2
< 50 years	30	22.0
Education Level		
Low (SD-SMP)	52	38.2
High (SMA-PT)	84	61.8
Occupation Status		
Employment	84	61.8
Unemployment	52	38.2
Marital Status		
Married	118	86.8
divorce	11	8.1
Unmarried	7	5.1
Health Insurance Status		
JKN non PBI	100	73.5

Variables	Total (n)	Percentage (%)
JKN PBI	36	26.5
Body Mass Index (BMI)		
≥ 28 (Obesity)	20	14.9
24,0—27,9 (Overweight)	40	29.9
18,5-23,9 (Normalweight)	63	47.0
< 18,5 (Underweight)	11	8.2
DM Diet		
No	55	40.4
Yes	81	59.6
Duration of DM		
≥ 5 years	76	55.9
< 5 years	60	44.1
Hypertension		
Yes	85	62.5
No	51	37.5
Other Diseases		
Cataracts	7	5.1
Glaucoma	6	4.4
Diabetic nephropathy	2	1.5
CKD (Chronic Kidney Disease)	19	14.0
Kidney failure	1	0.7
Azotemia	25	18.4
CHD (Coronary Heart Disease)	7	5.1
Cardiomegali	5	3.7
Stroke	4	2.9
UTI (Urinary Tract Infection)	8	5.9
Bronchopenumonia	5	3.7
None	47	34.6
Current Blood Glucose		
≥200 mg/dL	103	75.7
<200 mg/dL	33	24.3
HbA1c		
≥6,5%	91	66.9
<6,5%	45	33.1
Diabetic Retinopathy		
T2DM with diabetic retinopathy	68	50.0
T2DM without diabetic retinopathy	68	50.0

Source: Electronic Medical Records of Central Java Provincial Hospital, 2023

In the bivariate analysis of the 13 variables in Table 2, it is found that 7 variables have an association with risk factors of diabetic retinopathy at Central Java Provincial Hospital in 2023 (p-value <0.05). The associated variables were age ≥70 years (p=0.006), DM diet (p<0.0001, OR=20.914), duration of DM (p=0.003, OR=3.010), hypertension (p=0.013, OR=2.619), other diseases including cataracts (p=0.040, OR=9.00), glaucoma (p=0.007), coronary heart disease (p=0.040, OR=9.00), and cardiomegaly (p=0.016), current blood glucose (p=0.045, OR=2.478), and HbA1c (p<0.0001, OR=6.152). In contrast, the following independent variables were not associated with diabetic retinopathy in patients with type 2 diabetes: body mass index, gender, education level, work status, marital status, and health insurance status.

Based on the age variable, the age group ≥70 years has a p-value of 0.006 (p<0.05), indicating a significant association between the age group ≥70 years and the occurrence of diabetic retinopathy in type 2 DM patients. The OR (odds ratio) value for this age group is 0.132, indicating that this age group acts as a protective factor. In this study, the number of diabetic retinopathy patients in the age group ≥70 years is relatively small. This occurs because diabetic retinopathy is one of the more serious microvascular complications, patients with type 2 DM with diabetic retinopathy have a reduced life expectancy than those without retinopathy, and patients who are older than 70 years may have already died. The life expectancy of type 2 DM patients diagnosed at the age of ≥70 years is lower, ranging from approximately 4.3 to 9.6 years (Kianmehr et al., 2022). In the age groups of 50-59 years and 60-69 years, the proportion of patients showed only slight differences, whether with diabetic retinopathy or without diabetic retinopathy, so no significant association was found between these age groups and the occurrence of diabetic retinopathy (p = 0.119 and p = 0.087). In line with the research by B. Li et al. (2024), age has a p-value

Table 2. Bivariate Analysis of Factors Diabetic Retinopathy among T2DM Patients in Central Java Province

Variables	Diabetic Retinopathy				p-value	OR	(Cl 95%)
	T2DM with diabetic retinopathy		T2DM without diabetic retinopathy				
	N	%	N	%			
Gender							
Female	39	57.4	47	69.1	0.213	0.601	0.297-1.215
Male	29	42.6	21	30.9			
Age							
≥ 70 years	4	5.9	13	19.1	0.006*	0.132	0.034-0.517
60-69 years	15	22.0	18	26.5	0.087	0.357	0.126-1.009
50-59 years	28	41.2	28	41.2	0.119	0.429	0.167-1.097
< 50 years	21	30.9	9	13.2	Reff		
Education Level							
Low (SD-SMP)	27	39.7	25	36.8	0.860	1.133	0.567-2.263
High (SMA-PT)	41	60.3	43	63.2			
Occupation Status							
Employment	44	64.7	40	58.8	0.597	1.283	0.642-2.567
Unemployment	24	35.3	28	41.2			
Marital Status							
Married	61	89.7	57	83.8	0.273	2.675	0.499-14.342
divorce	5	7.4	6	8.8	0.637	2.083	0.275-15.772
Unmarried	2	2.9	5	7.4	Reff		
Health Insurance Status							
JKN non PBI	51	75.0	49	72.1	0.846	1.163	0.542-2.494
JKN PBI	17	25.0	19	27.9			
Body Mass Index (BMI)							
≥ 28 (Obesity)	11	16.2	9	13.2	0.943	1.184	0.431-3.251
24,0—27,9 (Overweight)	19	27.9	21	30.9	0.902	0.876	0.397-1.937
<18,5 (Underweight)	6	8.8	7	10.3	0.578	0.554	0.147-2.081
18,5-23,9 (Normalweight)	32	47.1	31	45.6	Reff		
DM Diet							
No	48	70.6	7	10.3	<0.0001**	20.914	8.169-53.548
Yes	20	29.4	61	89.7			
Duration of DM							
≥ 5 years	47	69.1	29	42.6	0.003*	3.010	1.489-6.085
< 5 years	21	30.9	39	57.4			
Hypertension							
Yes	50	73.5	35	51.5	0.013*	2.619	1.277-5.373
No	18	26.5	33	48.5			

Variables	Diabetic Retinopathy				p-value	OR	(Cl 95%)
	T2DM with diabetic retinopathy		T2DM without diabetic retinopathy				
	N	%	N	%			
Other Diseases							
Cataracts	6	8.8	1	1.5	0.040*	9.000	0.998-81.177
Glaucoma	6	8.8	0	0	0.007*	-	-
Diabetic nephropathy	0	0	2	2.9	0.517	-	-
Chronic Kidney Disease	7	10.3	12	17.7	1.000	0.875	0.289-2.646
Kidney failure	1	1.5	0	0	0.413	-	-
Azotemia	13	19.1	12	17.6	0.473	1.625	0.607-4.354
Coronary Heart Disease	6	8.8	1	1.5	0.040*	9.000	0.998-81.177
Cardiomegali	5	7.4	0	0	0.016*	-	-
Stroke	1	1.5	3	4.4	1.000	0.50	0.048-5.193
UTI (Urinary Tract Infection)	2	2.9	6	8.8	0.695	0.50	0.091-2.758
Bronchopenumonia	3	4.4	2	2.9	0.638	2.250	0.341-14.834
None	18	26.5	29	42.7	Reff		
Current Blood Glucose							
≥200 mg/dL	57	83.8	46	67.6	0.045*	2.478	1.090-5.635
<200 mg/dL	11	16.2	22	32.4			
HbA1c							
≥6,5%	58	85.3	33	48.5	<0.0001**	6.152	2.702-14.002
<6,5%	10	14.7	35	51.5			

Source: Electronic Medical Records of Central Java Provincial Hospital, 2023
** = p-value < 0,001
* = p-value < 0,05

of 0.48, meaning there is no association between age and diabetic retinopathy in type 2 DM patients (B. Li et al., 2024).

Based on the bivariate result, the variable DM diet has a p-value of <0.0001 (p<0.05), indicating that the incidence of diabetic retinopathy in type 2 DM patients at the Central Java Provincial Hospital in 2023 is significantly associated with the DM diet. The OR (odds ratio) value is 20,914, meaning that patients who do not follow a DM diet are 20,914 times more likely to develop diabetic retinopathy compared to patients who follow a good DM diet. The results of this research are consistent with the results published by Cho et al. (2018), which found a significant association between dietary adherence and blood glucose level control, shown by their p-value of <0.0001 (p<0.05) (Cho et al., 2018). Adherence to the DM diet and a healthy lifestyle is especially important for people with type 2 diabetes, especially in combination with glucose-lowering drug therapy. DM diet recommendations, especially in terms of sufficient vegetable consumption. Vegetables can lower the risk of cardiovascular disease and microvascular problems in diabetics because they are high in fiber and antioxidants (Cho et al., 2018). Patients who adhere to the diet tend to have better glycemic control, which can prevent chronic complications and reduce the risk of long-term complications (Matsushita et al., 2021).

The variable duration of DM has a p-value of 0.003 (p<0.05) according to the bivariate result, indicating a significant association between the incidence of diabetic retinopathy in type 2 DM patients at the Central Java Provincial Hos-

pital in 2023 and the duration of DM. The OR (odds ratio) value is 3,010, meaning that patients who experience DM ≥5 years are at risk of developing diabetic retinopathy by 3,010 times compared to patients who experience DM <5 years. The results of this research are consistent with those of Pedersen et al. (2023), which found an association between the incidence of diabetic retinopathy and the duration of diabetes mellitus, with a p-value of <0.001 (p<0.05). Furthermore, the findings of this study are consistent with those of a study by B. Li et al. (2024) and a study by Qi et al. (2022), both of which found a significant association between the incidence of diabetic retinopathy in type 2 DM patients and the duration of DM (p-value <0.001). Prolonged hyperglycemia triggers the formation of many free radicals, such as advanced glycation end (AGE) products, sorbitol, and reactive oxygen species induced by excess blood glucose in the body of diabetics. These free radicals will cause circulatory disorders, hypoxia, and retinal inflammation (Dewi et al., 2019). Longer duration of diabetes is associated with poorer glycemic control (Li et al., 2024). Increased glucose levels in the endothelial cells of the retinal arteries lead to endothelial dysfunction and oxidative stress, which contribute to the complications of diabetic retinopathy (Mersha et al., 2022).

According to the hypertension variable, the incidence of diabetic retinopathy in type 2 DM patients at the Central Java Provincial Hospital in 2023 is significantly associated with hypertension, with a p-value of 0.013 (p<0.05). The OR (odds ratio) value is 2.619, meaning that patients suffering from hypertension are at risk of developing diabetic retinopathy by 2.619 times compared to non-hypertensive patients. The results of this research are consistent with those of a study by Ashoor et al. (2023), which found a significant association between the incidence of diabetic retinopathy in patients with type 2 diabetes and hypertension, with a value of p<0.0001 (p<0.05). This study additionally backs that of Abuhay et al. (2024), who found a p-value of 0.005 (p<0.05) and OR = 3.01 for the association between the incidence of diabetic retinopathy in type 2 DM patients and hypertension. Type 2 DM patients with hypertension have a lower ability to regulate retinal blood flow, leading to endothelial damage and increased VEGF expression. VEGF increases vascular permeability and ischemic neovascularization in diabetic retinopathy as well as stimulates ICAM-1, which causes leukocyte binding to the endothelium and contributes to retinal blood barrier damage, thrombosis, and capillary occlusion (Dewi et al., 2019).

Based on the variables of other diseases, cataracts have a p-value of 0.040 (p<0.05), meaning that there is an association between cataracts and the incidence of diabetic retinopathy in type 2 DM patients. The OR (odds ratio) value is 9.00, meaning that patients suffering from cataracts are 9 times more likely to experience diabetic retinopathy than patients without cataracts. According to research by Yao et al. (2021), cataracts have a value of p<0.001 (p<0.05), which is consistent with the findings of this study. Patients with DM older than 10 years, especially those with a thin retina (tessellated retina) or cataracts, are at high risk of developing diabetic retinopathy. The risk of diabetic retinopathy increases 1.29 times each year of having diabetes, and in cataract patients, the risk of non-proliferative retinopathy is 1.48–4.11 times higher (Yao et al., 2021).

Based on the variables of other diseases, the incidence of diabetic retinopathy in patients with type 2 diabetes is associated with glaucoma, as indicated by the p-value of 0.007 (p<0.05) for glaucoma. The function of VEGF (vascular endothelial growth factor) connects glaucoma to diabetic retinopathy (RD). Glaucoma is associated with diabetic retinopathy (RD) through the role of VEGF (vascular endothelial growth factor), which is produced by various retinal cells. There is diabetic retinopathy, especially proliferative diabetic retinopathy (PDR); hyperglycemia and hypoxia increase the production of VEGF, triggering neovascularization and the formation of abnormal blood vessels. High VEGF levels are found in aqueous humor in neovascular glaucoma (NVG) patients and are elevated in vitreous PDR, stimulating angiogenesis and inflammation (Tang et al., 2023).

Based on the variables of other diseases, coronary heart disease (CHD) has a p-value of 0.040 (p<0.05) and OR=9.00, meaning that there is an association between coronary heart disease (CHD) and the incidence of diabetic retinopathy in type 2 DM patients. The results of this research are consistent with those of a study by Sun et al. (2022) that there is a significant association between coronary heart disease (CHD) and the incidence of diabetic retinopathy in type 2 DM patients, p=0.0002 (p<0.05) and OR 1.136. Diabetic retinopathy and coronary heart disease (CHD) have similar risk factors, such as hyperglycemia, hyperlipidemia, and hypertension (Yang et al., 2020).

Based on the variables of other diseases, cardiomegaly has a p-value of 0.016 (p<0.05), meaning that there is an association between

cardiomegaly and the incidence of diabetic retinopathy in type 2 DM patients. Long-lasting cardiomegaly can lead to diabetic cardiomyopathy, which is impaired heart function even though the main blood vessels appear normal. Diabetic cardiomyopathy is similar to microvascular damage in diabetic retinopathy, including thickening of capillary membranes and impaired endothelial function. In type 2 diabetes mellitus, hyperglycemia also causes inflammation, the development of new blood vessels, and cardiac fibrosis as a result of microvascular injury (Chung et al., 2017).

The current blood glucose variable with a p-value obtained was 0.045 (p<0.05), meaning that there was an association between current blood glucose and the incidence of diabetic retinopathy in type 2 DM patients at the Central Java Provincial Hospital in 2023. The OR (odds ratio) value is 2,478, meaning that patients who have blood glucose ≥200 mg/dL are 2,478 times more likely to develop diabetic retinopathy compared to patients who have blood glucose <200 mg/

Table 3. Analysis Results of Logistic Regression Multivariate

Variables	B	Wald	p-value	OR	(95% CI)	
					Lower	Upper
DM Diet						
No	4.451	27.713	<0.0001	85.734	16.346	449.665
Yes						
Duration of DM						
≥ 5 years	1.188	4.452	0.035	3.282	1.088	9.897
< 5 years						
Hypertension						
Yes	2.777	10.874	0.001	16.071	3.085	83.725
No						
HbA1c						
≥6,5%	2.196	10.958	0.001	8.985	2.449	32.966
<6,5%						
Constant	-5.703	24.320	<0.0001	0.003		

Source: Electronic Medical Records of Central Java Provincial Hospital, 2023

Table 4. Results of Probability Calculation of Diabetic Retinopathy in Several Scenarios

Patients	Variables				Probability of Diabetic Retinopathy
	DM diet	Duration of DM	Hypertension	HBA1c	
Patient 1	No	≥ 5 years	Yes	≥6,5%	99,2%
Patient 2	No	< 5 years	Yes	≥6,5%	97,6%
Patient 3	No	≥ 5 years	Yes	<6,5%	93,7%
Patient 4	No	≥ 5 years	No	≥6,5%	89,3%
Patient 5	No	< 5 years	Yes	<6,5%	82,1%
Patient 6	No	< 5 years	No	≥6,5%	71,9%
Patient 7	Yes	≥ 5 years	Yes	≥6,5%	61,2%
Patient 8	No	≥ 5 years	No	<6,5%	48,4%
Patient 9	Yes	< 5 years	Yes	≥6,5%	32,5%
Patient 10	No	< 5 years	No	<6,5%	22,2%
Patient 11	Yes	≥ 5 years	Yes	<6,5%	14,9%
Patient 12	Yes	≥ 5 years	No	≥6,5%	8,9%
Patient 13	Yes	< 5 years	Yes	<6,5%	5%
Patient 14	Yes	< 5 years	No	≥6,5%	2.9%

Source: Electronic Medical Records of Central Java Provincial Hospital, 2023

dL. According to studies conducted by Akrofi et al. (2021), there is an association between blood glucose levels and the incidence of diabetic retinopathy, it is proven that the values of p<0.0001 (p<0.05) and OR 2.65 (Akrofi et al., 2021). Diabetic retinopathy is caused by chronic hyperglycemia that affects the endothelium of blood vessels. The incidence of diabetic retinopathy can be reduced to roughly 30% with controlled blood sugar levels (Utami et al., 2017). Patients with poor blood glucose control have a 3.28-fold higher chance of developing diabetic retinopathy than those with adequate control (Mersha et al., 2022).

The HbA1c variable has a p-value of <0.0001 (p<0.05), meaning that there is a significant association between HbA1c and the incidence of diabetic retinopathy in type 2 DM patients at Central Java Provincial Hospital in 2023. The OR (odds ratio) value is 6,152, meaning that patients who have an HbA1c of ≥6.5% are at risk of developing diabetic retinopathy by 6,152 times compared to patients with an HbA1c of <6.5%. The results of this research are consistent with the research conducted by Hou et al. (2023), who obtained a p-value of <0.0001 and an OR of 2.72. In addition, research by Shi et al. (2022) obtained a p-value of <0.0001 and an OR of 7.13. The average blood glucose level over the previous three months is represented by the HbA1c, which is the gold standard in diabetes management. Good HbA1c control can protect vision and reduce the risk of photocoagulation therapy, as well as prevent or slow the progression of diabetic retinopathy in type 2 diabetic patients (Rahmawati et al., 2023). A decrease in HbA1c from 8% to 7% can reduce the risk of retinopathy by 30%–40% (Gong et al., 2023). Every 1% decrease in HbA1c reduces the risk of microvascular complications by 35%, other diabetes complications by 21%, and the risk of death by 21% (Braber et al., 2021).

After controlling for other variables, there were four dominant variables associated with the incidence of diabetic retinopathy in type 2 DM patients, namely DM diet, duration of DM, hypertension, and HbA1c, which had a p-value <0.05, which means that these four variables had a significant association with the incidence of diabetic retinopathy in type 2 DM patients. The most dominant variable associated was the DM diet, with a p-value of <0.0001 and a Wald value of 27.713. The OR value was 85,734, which means that patients who did not follow a DM diet were 85,734 times at risk of developing diabetic retinopathy in type 2 DM patients.

Based on the results of the multivariate analysis in Table 3, the regression equation is as follows:

$y = \alpha + \beta 1X1 + \beta 2X2 + \ldots + \beta iXi$

Information:

α = constant

β = variable value

X = variable

y = -5.703 + 4.451 (no DM diet) + 1.188 (duration of DM ≥ 5 years) + 2.777 (hypertension) + 2.196 (HbA1c ≥6.5%)

The result of this equation (y) is then incorporated into the following formula to predict the probability:

p = 1/((1+e^(-y)))

Information:

p = probability of incident diabetic retinopathy

y = α + β1X1 + β2X2+. . . +βiXi

β = coefficient value of each variable

X = independent variable value

CONCLUSION

The variables associated with the incidence of diabetic retinopathy were age ≥70 years (p=0.006), DM diet (p<0.0001, OR=20.914), duration of DM (p=0.003, OR=3.010), hypertension (p=0.013, OR=2.619), other diseases including cataracts (p=0.040, OR=9.00), glaucoma (p=0.007), coronary heart disease (CHD) (p=0.040, OR=9.00), and cardiomegaly (p=0.016), current blood glucose (p=0.045, OR=2.478), and HbA1c (p<0.0001, OR=6.152). DM diet adherence is the most dominant factor associated with diabetic retinopathy in type 2 DM patients. The regression equation model on the multivariate analysis of the risk of diabetic retinopathy incidence was y = -5.703 + 4.451 (no DM diet) + 1.188 (duration of DM ≥5 years) + 2.777 (hypertension) + 2.196 (HbA1c ≥6.5%).

This study can provide information about factors associated with the incidence of diabetic retinopathy, so that type 2 DM patients before the duration of DM <5 years old can carry out early screening and control (routine treatment) through medical check-ups to find out and monitor HbA1c levels <6.5%, control blood pressure/hypertension, carry out DM diet compliance, exercise, and DM treatment to prevent the occurrence of diabetic retinopathy.

The recommendation of this study for policymakers in the hospital internal medicine service unit in Central Java Provincial Hospital is to prioritize type 2 DM patients with a duration of DM ≥5 years by making follow-up efforts in management and treatment through HbA1c screening, monitoring DM diet adherence in pa-

tients, and monitoring and controlling patients' blood pressure to reduce the incidence of diabetic retinopathy. The limitation of this study is that it does not examine the variables of LDL, total cholesterol, and fasting glucose levels due to the limited data available in the electronic medical records of Central Java Provincial Hospital.

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