Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 2426-2435 | ISSN:2251-6727

Several Influential Risk Factors for Diabetic Retinopathy Among Productive-Age Patients With Type 2 Diabetes Mellitus at Dr. Kariadi Central General Hospital Semarang: A Case–Control Study

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(Received: 25 October 2025 Revised: 27 November 2025 Accepted: 04 December 2025)

KEYWORDS

Diabetic retinopathy, risk factors, type 2 diabetes mellitus, productive age.

ABSTRACT:

Diabetic retinopathy is a chronic microvascular complication of type 2 diabetes mellitus and a major cause of visual impairment, particularly affecting individuals in the productive age group. This study aimed to analyze risk factors associated with diabetic retinopathy among productive-age patients with type 2 diabetes mellitus at Dr. Kariadi General Hospital Semarang. A case control study was conducted involving 68 cases and 68 controls. Data were collected through electronic medical records and patient interviews. Bivariate analysis showed significant associations associations ($p < 0.05$) age 45–59 years (p 0.000; OR = 4.091), non-adherence to dietary recommendations (p 0.000; OR = 7.547), duration of diabetes ≥ 10 years ($p = 0.016$; OR = 2.457), hypertension (p 0.000; OR = 4.339), non-adherence to medication ($p = 0.025$; OR = 2.322), and HbA1c levels ≥6.5% (p 0.000; OR = 7.869). Meanwhile, physical activity, and obesity did not show significant associations ($p > 0.05$). Multivariate analysis identified significant predictors including age 45–59 years ($p = 0.002$; OR = 5.028), non-adherence to diet ($p < 0.001$; OR = 13.900), diabetes duration ≥10 years ($p = 0.030$; OR = 3.114), hypertension ($p = 0.049$; OR = 2.776), non-adherence to medication ($p = 0.011$; OR = 3.793), and HbA1c ≥6.5% ($p < 0.001$; OR = 11.278). The strongest predictors were poor dietary adherence and elevated HbA1c. Key risk factors for diabetic retinopathy in productive age patients include non adherence to dietary recommendations, high HbA1c levels, older age (45–59 years), longer diabetes duration, hypertension, and medication non-adherence. Strengthening dietary compliance, glycemic control, and regular HbA1c monitoring is essential to prevent or delay retinopathy progression.

Introduction

Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both.1,2,3 According to the International Diabetes Federation (IDF), diabetes is a condition in which the body is unable to produce sufficient insulin or cannot effectively utilize insulin, leading to elevated blood glucose levels that may damage various organs, including the heart, kidneys, eyes, and nerves.4,5

The global burden of diabetes continues to rise. In 2021, an estimated 537 million adults were living with diabetes, an increase from 463 million in 2019, and this figure is projected to reach 643 million by 2030 and 783 million by 2045.4 Indonesia ranks fifth globally in the number of people with diabetes, with 19.5 million cases reported in 2021, up from 10.7 million in 2019.5

The IDF Diabetes Atlas 2024 further highlights this phenomenon, noting that approximately 589 million adults aged 20–79 years (11.1%) were living with diabetes.6 In Indonesia, diabetes prevalence has also continued to increase. In 2024, the IDF estimated a prevalence of 11.3% (approximately 20.4 million

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JCHR (2025) 15(6), 2426-2435 | ISSN:2251-6727

people),7 whereas the Indonesia Health Survey (SKI) reported a prevalence of 11.7% among individuals aged ≥15 years based on blood glucose measurements.8 At the regional level, Central Java Province experienced a 16% increase in diabetes cases in the same year.8 Type 2 diabetes mellitus is the most prevalent form, marked by glucose intolerance due to impaired insulin production or suboptimal insulin utilization.2,9

One major chronic complication of concern is diabetic retinopathy (DR), a progressive microvascular retinal disorder that can lead to visual impairment and blindness.11,12 Chronic hyperglycemia induces microvascular retinal changes that are initially asymptomatic but may progress to sight-threatening conditions if not adequately managed.12,13 Globally, approximately 25–33% of individuals with diabetes develop DR.12,13 In Asia, prevalence ranges from 10–43%, with an average of 12.5% in Southeast Asia.14 In Indonesia, DR prevalence is estimated between 10–32%, although some studies have reported rates as high as 43%, with 12% progressing to the proliferative stage and around 7–8% reaching sight-threatening stages.12,13,17,18

Data from Dr. Kariadi General Hospital Semarang show an increasing trend in DR cases over the past three years. In 2022, 178 out of 431 patients with type 2 diabetes (41.3%) were diagnosed with DR. This increased to 230 of 543 patients (42.36%) in 2023 and 225 of 493 patients (45.64%) in 2024. Notably, most cases occurred among individuals in the productive age group (15–59 years), accounting for 62.36% in 2022, 72.61% in 2023, and 73.33% in 2024. These findings indicate that DR is not only a clinical problem but also poses substantial socioeconomic implications. Among individuals of productive age, visual impairment may reduce quality of life, lower work productivity, increase family burden, and escalate national healthcare expenditures.19-24 This population segment represents a strategic workforce, meaning the consequences of DR extend beyond health and create multidimensional impacts that may be more profound than in older adults.

Previous studies have identified several risk factors for DR in patients with type 2 diabetes, including diabetes duration, HbA1c ≥6.5%, hypertension, dyslipidemia, body mass index, age, and sex.25-30,18,31,35 However, most research in Indonesia has focused on general populations without specifically examining the productive-age group. Individuals aged 15–59 years have distinct physiological characteristics, lifestyle patterns, health behaviors, and occupational burdens compared to older adults (>60 years), which may influence their risk profile.32,33,35,36 Additionally, many studies have examined only one or two risk factors without considering comprehensive interactions between demographic, clinical, and behavioral variables such as education, sex, glycemic control, hypertension, dietary compliance, physical activity, and diabetes duration.37-45

Given the high burden of DR among productive-age individuals and the limitations of previous research, this study is essential to identify the risk factors associated with diabetic retinopathy in type 2 diabetes patients of productive age. Dr. Kariadi General Hospital Semarang was selected as the study site because it serves as a major referral center in Central Java and provides a diverse patient population, allowing for a more comprehensive analysis of DR risk factors within this age group.

METHOD

This study employed a quantitative observational design using a case–control approach and was conducted at Dr. Kariadi General Hospital Semarang from March to October 2025. The dependent variable was the occurrence of diabetic retinopathy among patients with type 2 diabetes mellitus, while the independent variables included demographic characteristics only age, behavioral factors (physical activity level and dietary adherence, medication adherence), and clinical factors (body mass index/BMI, duration of diabetes, hypertension, and HbA1c levels).

Sampling was carried out using a purposive sampling technique based on electronic medical record data. The case population consisted of 68 patients with type 2 diabetes mellitus diagnosed with diabetic retinopathy during the study period. The control population comprised 68 patients with type 2 diabetes mellitus without complications.

The study employed a case control design involving patients with type 2 diabetes mellitus treated at Dr. Kariadi General Hospital. The case group consisted of individuals aged 15–59 years who had been diagnosed with type 2 diabetes mellitus and confirmed to have diabetic retinopathy based on ophthalmologist-verified

Journal of Chemical Health Risks
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JCHR (2025) 15(6), 2426-2435 | ISSN:2251-6727

funduscopy results. Eligible participants were required to have complete medical record data—including age, body mass index, hypertension history, duration of diabetes, and HbA1c levels—and to provide written informed consent. Patients were excluded if they had other ocular disorders interfering with retinopathy assessment, a history of major ocular surgery or severe trauma, severe systemic diseases, pregnancy or breastfeeding, or significant cognitive or psychiatric impairment.

The control group included type 2 diabetes mellitus patients aged 15–59 years without diabetic retinopathy, confirmed through funduscopy, and with complete relevant medical records. Controls were selected during the same data-collection period and also provided informed consent. The same exclusion criteria applied to ensure comparability between groups and to minimize potential diagnostic and metabolic confounders.

The collected data were analyzed using SPSS version 27. Data analysis comprised univariate analysis to describe the frequency distribution of each variable, bivariate analysis was performed using the chi-square test or an alternative test such us Fisher's exact test to assess associations between independent and dependent variables, and multivariate analysis using logistic regression to identify dominant risk factors associated with diabetic retinopathy among patients with type 2 diabetes mellitus, with statistical significance set at $p < 0.05$.

This study received ethical approval from the Health Research Ethics Committee of Dr. Kariadi General Hospital Semarang, under approval number 16468/EC/KEPK-RSDK/2025.

RESULTS

Table.1 Result of univariate analysis

Variable	F	%
Age		
45 – 59 years	67	49.3
< 45 years	69	50.7
Physical activity level		
Low	56	41.2
Medium - high	80	58.8
Obesity		
Yes	54	39.7
No	82	60.3
Dietary adherence in diabetes mellitus		
Non adherent	77	56.6
Adherent	59	43.4
Duration of diabetes mellitus		
≥ 10 years	71	52.2
< 10 years	65	47.8
Hypertension		
Yes	86	63.2
No	50	36.8
Medication adherence		
Non adherent	74	54.4
Adherent	62	45.6
HbA1c levels		
≥6,5%	84	61.8
<6,5%	52	38.2
Type 2 diabetic retinopathy status		
Diabetic retinopathy	68	50
Without diabetic retinopathy	68	50

Source: Primary data, 2025

Based on Table 1, the demographic and clinical characteristics of respondents indicate a relatively balanced age distribution, with slightly more individuals aged <45 years (50.7%) compared to those aged 45–59 years (49.3%). In terms of physical activity, the majority of respondents reported medium to high activity levels (58.8%), while 41.2% had low levels of physical activity.

Most respondents were classified as non-obese (60.3%), and 39.7% were obese. Dietary adherence among individuals with diabetes mellitus was generally low, as more than half of the respondents (56.6%) were categorized as non-adherent to dietary recommendations, whereas only 43.4% were adherent.

The duration of diabetes mellitus showed a nearly equal distribution, although a slightly higher proportion

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of respondents had been living with the disease for ≥10 years (52.2%) compared to those with a duration of <10 years (47.8%). Hypertension was common among the study population, with 63.2% of respondents reporting hypertension, while 36.8% did not have a history of hypertension.

Medication adherence presented a similar pattern, where 54.4% of respondents were classified as non-adherent, indicating suboptimal adherence to prescribed diabetes medications. Furthermore, glycemic control appeared inadequate in most participants, as reflected by 61.8% having HbA1c levels ≥6.5%, while only 38.2% achieved levels <6.5%.

Lastly, the prevalence of type 2 diabetic

retinopathy was evenly distributed, with 50% of respondents diagnosed with diabetic retinopathy and 50% without the condition. These findings highlight a considerable burden of modifiable risk factors and inadequate disease management among the study population.

Table 2. Result of bivariate analysis Variable Diabetic retinopathy

Diabetes mellitus with diabetic retinopathy		Diabetes mellitus without diabetic retinopathy		p-value	OR (CI 95%)
N	%	N	%		
Age					
45 - 59 years	45	66.2	22	32.4	0.000 4.091 (2.002-8.358)
< 45 years	23	33.8	46	67.6	
Physical Activity Level					
Low	26	38.2	30	44.1	0.601 0.784 (0.396-1.555)
Medium - high	42	61.8	38	55.9	
Obesity					
Yes	26	38.2	28	41.2	0.861 0.884 (0.445-1.758)
-					
No	42	61.8	40	58.8	
Dietary Adherence in Diabetes Mellitus					
Non adherent	54	79.4	23	33.8	0.000 7.547 (3.483-16.352)
Adherent	14	20.6	45	66.2	
Duration of Diabetes Mellitus					
≥ 10 years	43	63.2	28	41.2	0.016 2.457 (1.232-4.899)
< 10 years	25	36.8	40	58.8	
Hypertension					Yes
	54	79.4	32	47.1	0.000 4.339 (2.036-9.246)
No	14	20.6	36	52.9	
Medication adherence					
Non adherent	44	64.7	30	44.1	0.025 2.322 (1.164-4.631)
Adherent	24	35.3	38	55.9	
HbA1c level					
≥6.5%	57	83.8	27	39.7	0.000 7.869 (3.508-17.650)
<6.5%	11	16.2	41	60.3	

Source: Primary data, 2025

Bivariate analysis of 136 respondents revealed varying degrees of association between demographic, behavioral, and clinical factors and the occurrence of

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diabetic retinopathy. Age demonstrated a significant association, where individuals aged 45–59 years had a markedly higher likelihood of developing diabetic retinopathy (66.2% vs. 32.4%; $p < 0.001$; OR = 4.091, 95% CI: 2.002–8.358). This finding suggests increased vulnerability related to age-associated microvascular decline.

Physical activity levels were not significantly associated with diabetic retinopathy ($p = 0.601$; OR = 0.784). Similarly, BMI status showed no meaningful relationship ($p = 0.861$; OR = 0.884), indicating that obesity was not a distinguishing factor in retinopathy occurrence among the participants.

Dietary adherence demonstrated one of the strongest associations. Non-adherent individuals had a substantially higher prevalence of diabetic retinopathy (79.4% vs. 33.8%; $p < 0.001$), with an odds ratio of 7.547 (95% CI: 3.483–16.352). This implies that poor adherence to dietary recommendations increases retinopathy risk by nearly eightfold.

Duration of diabetes mellitus was also significantly associated, with respondents who had lived with diabetes for ≥10 years more likely to develop retinopathy (63.2% vs. 41.2%; $p = 0.016$; OR = 2.457, 95% CI: 1.232–4.899). This reflects cumulative microvascular damage attributed to prolonged hyperglycemia.

Hypertension emerged as a notable risk factor. Hypertensive respondents exhibited a significantly higher proportion of retinopathy cases (79.4% vs. 47.1%; $p < 0.001$), with an OR of 4.339 (95% CI: 2.036–9.246), emphasizing the role of elevated blood pressure in accelerating retinal vascular injury.

Medication adherence was also significantly associated with retinopathy ($p = 0.025$). Non-adherent respondents showed a higher proportion of retinopathy cases (64.7% vs. 44.1%), corresponding to an OR of 2.322 (95% CI: 1.164–4.631), indicating the importance of consistent pharmacologic management for glycemic stabilization.

Biochemical indicators presented the strongest associations. HbA1c levels ≥6.5% were significantly associated with diabetic retinopathy (83.8% vs. 39.7%; $p < 0.001$; OR = 7.869, 95% CI: 3.508–17.650). This reinforces inadequate glycemic control as a major predictor of microvascular complications.

Overall, the factors significantly associated with diabetic retinopathy in this study include age ≥45 years, non-adherence to dietary recommendations, longer diabetes duration, hypertension, non-adherence to medication, and elevated HbA1c levels. Among these, dietary non-adherence and poor glycemic control (HbA1c ≥6.5%) were the strongest predictors, underscoring the critical role of behavioral and metabolic management in preventing diabetic retinopathy.

Table 3. Result of multivariate analysis

Variabel	B	p-value	OR	CI 95%
Age	1,615	0,002	5,028	1.796-14.076
Dietary adherence in diabetes mellitus	2,632	0.000	13,900	4.471-43.218
Duration of Diabetes Mellitus	1,136	0.030	3,114	1.118-8.676
Hypertension	1,021	0.049	2,776	1.004-7.676
Medication adherence	1,333	0.011	3,793	1.352-10.639
HbA1c level	2,423	0.000	11,278	3.641-34.938

The logistic regression analysis identified several variables that were significantly associated with diabetic retinopathy among productive-age patients with type 2 diabetes mellitus. Significant predictors included age, dietary adherence, duration of diabetes, hypertension, medication adherence, and HbA1c level (all $p < 0.05$).

Individuals aged 45–59 years had a five-fold higher risk of developing diabetic retinopathy compared to those <45 years ($p = 0.002$; OR = 5.028). Non-adherence to the diabetes diet was the strongest predictor, increasing the risk by 13.9 times (p 0.000; OR = 13.900). A duration of diabetes ≥10 years also elevated the risk by approximately threefold ($p = 0.030$; OR = 3.114).

Hypertension was significantly associated with a 2.8 fold higher risk ($p = 0.049$; OR = 2.776). Non-adherence to diabetes medication increased the likelihood of retinopathy nearly fourfold ($p = 0.011$; OR = 3.793). Additionally, HbA1c levels ≥6.5% were linked to an 11.3 fold increased risk (p 0.000; OR =

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11.278).

Overall, the most dominant factors contributing to diabetic retinopathy were poor dietary adherence and elevated HbA1c levels, followed by older age (45–59 years), longer duration of diabetes, hypertension, and medication non-adherence. These findings highlight the importance of glycemic control through dietary compliance, treatment adherence, and regular monitoring of HbA1c to prevent or delay the progression of diabetic retinopathy in productive-age patients with type 2 diabetes mellitus.

DISCUSSION

This study identified six significant predictors of diabetic retinopathy (DR) among productive-age adults with type 2 diabetes mellitus, namely age, dietary adherence, HbA1c level, duration of diabetes, hypertension, and medication adherence. Individuals aged 45–59 years had a fourfold increased risk of DR compared with younger adults. This finding aligns with previous evidence showing that aging exacerbates retinal microvascular injury through cumulative metabolic stress, vascular degeneration, and oxidative damage.35,32,52 Conversely, physical activity and obesity were not significantly associated with DR, consistent with studies showing that microvascular complications are more strongly driven by glycemic control, duration of disease, and hypertension than by lifestyle or anthropometric factors alone.29,34,38,55

Dietary adherence emerged as the strongest predictor of DR, with non-adherence increasing risk more than sevenfold and remaining dominant in multivariate analysis. This is consistent with literature indicating that unstable glycemic patterns, high glycemic load foods, and oxidative stress from poor diet quality accelerate retinal vascular injury.56,57 Similarly, a diabetes duration of ≥10 years increased the likelihood of DR, confirming previous findings that prolonged hyperglycemia progressively damages retinal capillaries and disrupts vascular integrity.28,30,58 Hypertension was also strongly associated with DR, in line with evidence that elevated vascular pressure, endothelial dysfunction, and impaired autoregulation accelerate microvascular damage.29,59,60 Non-adherence to antidiabetic medication nearly doubled the risk, consistent with systematic reviews showing that poor medication adherence contributes to poor glycemic control and increased microvascular complications.42-44,61-63 HbA1c ≥6.5% significantly increased DR risk as well, supporting extensive evidence that chronic hyperglycemia is a primary driver of microvascular injury.51,52,64

These findings are consistent with Indonesian and international studies demonstrating that poor glycemic control, hypertension, and longer diabetes duration are the most robust predictors of DR across diverse populations.15-18,64-66 Notably, this study highlights dietary non-adherence as a particularly dominant risk factor among productive-age adults, a group marked by irregular work schedules, variable meal patterns, and lower treatment consistency.21,68 This suggests the need for tailored behavioral and nutritional interventions targeting this age group.

Several limitations should be acknowledged. The case control design restricts causal inference, limiting the ability to determine temporal relationships between exposures and outcomes. Self reported measures including dietary adherence, physical activity, and medication adherence may introduce recall or social desirability bias. Reliance on secondary medical records may also result in misclassification due to incomplete or inconsistent documentation. The study population, drawn from a tertiary referral hospital, may not represent patients in primary care or community settings, where disease severity and management differ. Additionally, several important confounders such as dyslipidemia, smoking, alcohol use, depression, and genetic predisposition were not examined despite their established roles in DR pathogenesis. Finally, HbA1c reflects only recent (2–3-month) glycemic control and may not capture long-term glycemic variability relevant to DR progression.

CONCLUSION

This study identified several significant risk factors associated with diabetic retinopathy among productive age patients with type 2 diabetes mellitus. Age 45–59 years, non-adherence to diabetes dietary recommendations, diabetes duration of ≥10 years, hypertension, medication non-adherence, and HbA1c levels ≥6.5% were all significantly associated with the occurrence of diabetic retinopathy. In contrast, physical activity level and body mass index did not show a meaningful association.

Among all factors examined, non-adherence to the diabetes diet emerged as the most dominant predictor,

indicating its critical role in glycemic control and microvascular complication prevention. Strengthening dietary compliance, improving medication adherence, and optimizing glycemic monitoring are essential strategies to reduce the risk and progression of diabetic retinopathy in productive-age individuals with type 2 diabetes mellitus.

ACKNOWLEDGMENT

Thanks to Dr. Kariadi Hospital Semarang which permitted to conduct research based on medical records of their patients.

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