

# Association Between Blood Pressure Levels and Diabetic Retinopathy Stage Among Patients at Karsa Husada General Hospital, Batu City: A Cross-Sectional Study

**Background:** Diabetic retinopathy is a microvascular disease of the retina that is progressive and threatens vision. One of the risk factors that can influence diabetic retinopathy is blood pressure. High blood pressure can worsen retinal microvascular conditions as it can cause blood vessels to thicken, leak, and form new ones.

**Objective:** This study aimed to determine the relationship between blood pressure levels and the diabetic retinopathy stage at Karsa Husada General Hospital, Batu City.

**Methods:** This research is an analytical observational study with a cross sectional study design. Data was collected from hospital medical records. There were a total of 40 cases of diabetic retinopathy at Karsa Husada General Hospital, Batu City in 2020-2022. The sample size consists of 32 patients which met the inclusion and exclusion criteria. The data collection technique uses a non-probability sampling technique, purposive sampling type. Data analysis uses univariate and bivariate analysis.

**Results:** 28.1% of patients had normal blood pressure, 21.9% had normal-high blood pressure, 31.3% had hypertension grade 1, and 18.8% had hypertension grade 2. There were 14 (43.8%) diagnosed with Non-Proliferative Diabetic Retinopathy (NPDR), meanwhile there were 18 (56.3%) diagnosed with Proliferative Diabetic Retinopathy (PDR). Bivariate data analysis conducted using the Chi Square test yielded a p value of 0.315.

**Conclusion:** Despite the established understanding that hypertension can exacerbate microvascular complications in the retina, our findings suggest that there is no significant relationship between blood pressure levels and diabetic retinopathy stage.

**Keywords:** Diabetic Retinopathy, Hypertension, Vascular Diseases

**Yuliono Trika Nur Hasan <sup>1</sup>, Nuril Farid Abhsori <sup>2</sup>, Sakinah Baraja <sup>3</sup>**

<sup>1</sup> Department of Ophthalmology, Faculty of Medicine and Health Sciences, Maulana Malik Ibrahim Islamic State University Malang, Malang Indonesia

<sup>2</sup> Faculty of Medicine and Health Sciences, Maulana Malik Ibrahim Islamic State University Malang, Malang, Indonesia

<sup>3</sup> Department of Surgery, Faculty of Medicine and Health Sciences, Maulana Malik Ibrahim Islamic State University Malang, Malang Indonesia

**Category: Original Research**

**Date Received: 16 April 2024**

**Date Accepted: 10 May 2024**

**Correspondence to:**

Nuril Farid Abhsori

Faculty of Medicine and Health Sciences, Maulana Malik Ibrahim Islamic State University Malang, Malang, Indonesia

+6282264003162

[nurilfarid3@gmail.com](mailto:nurilfarid3@gmail.com)

## Introduction

Diabetic Retinopathy (DR) is a progressive microvascular disease affecting the retina of the eye which can threaten vision. This retinal disease is often associated with prolonged hyperglycemia<sup>(1)</sup> which is intricately associated with diabetic complications and other conditions, such as high blood pressure. High blood pressure can harm the structure of the retinal blood vessels.<sup>(2)</sup> Chronic hyperglycemia can also change the structure of the retinal blood vessels, one of which is neovascularization in diabetic retinopathy.<sup>(3)(4)</sup>

In 2019, The International Diabetes Federation (IDF) found that the prevalence of diabetic retinopathy reached approximately 27% among diabetic cases from 2015 to 2018. The specific prevalence of this retinal disease in the Southeast Asia (SEA) region is around 12.5%. IDF also estimates that this prevalence will increase by approximately 12.2% 2030. This proves that countries in the SEA region have a high prevalence rate of DR.<sup>(5)</sup>

Diabetic retinopathy is the second most common microvascular complication after nephropathy in Indonesia. The prevalence in Indonesia is 43.1% with treatment rate of 26.1% among affected individuals.<sup>(1)</sup> In 2020, the East Java Province had approximately 11,008,334 patients with both diabetic retinopathy and hypertension. The number of DR cases are expected to increase every year, considering that 70% of Batu City residents are diagnosed with either diabetes mellitus or hypertension. Most of these patients range in age from 20 to 64 years old.<sup>(1)(6)</sup>

Diabetic retinopathy is classified into two stage: the Non-Proliferative stage, which represents the initial phase of the disease and the Proliferative stage, which occurs in the advanced phase.<sup>(1)(7)</sup> The European Society of Cardiology (ESC) classifies blood pressure into: normal, normal-high, and hypertension grade 1 to 3.<sup>(8)</sup> Hypertension is diagnosed if the Systolic Blood Pressure (SBP) is  $\geq 140$  mmHg and/or Diastolic Blood Pressure (DBP)  $\geq 90$  mmHg.<sup>(9)</sup>

The physiological changes in the retina caused by hyperglycemia may lead to microangiopathy and micro obstruction. These conditions can result in ischemia.<sup>(10)</sup> Apart from hyperglycemia, ischemia can also be caused by hypertension, as it is considered to worsen the condition of diabetic retinopathy.<sup>(2)</sup>

Thus, the purpose of this study was to determine the relationship between blood pressure levels and diabetic

retinopathy stage in patients at Karsa Husada General Hospital Batu City.

## Method

This research was conducted in January 2023 at Karsa Husada Hospital, Batu City using a cross-sectional approach with secondary medical record data. The target population for this study was Diabetic Retinopathy (DR) patients with a total minimal sample of 32 people who met the inclusion and exclusion criteria. Diagnosis of DR was established based on American Academy of Ophthalmology guidelines.<sup>(11)</sup> The research was carried out after obtaining approval from the ethics commission of the Karsa Husada Batu General Hospital. The study was assessed by Health Research Ethics Committee, Karsa Husada General Hospital, Batu, and obtained ethical approval on 24 November 2022 (ethical certificate 070/001/008/102.13/2022).

The inclusion criteria for this study were as follows: 1) Patients diagnosed with DR, either NPDR and PDR stages at Karsa Husada Hospital, Batu City,<sup>(11)</sup> 2) Patients diagnosed with blood pressure data classified as normal, normal-high, hypertension grade 1 and hypertension grade 2,<sup>(8)</sup> 3) Patients' medical records containing information such as age, sex, blood sugar levels, BMI, education, occupation, smoking habits, history of other diseases and drug therapy.<sup>(1)</sup> Exclusion criteria included the following: 1) Patients suffering from immune diseases, 2) Patients having a history of malignant disease, 3) Incomplete medical record data. BMI was also categorised into four groups according to the conventional WHO classification: underweight (18.5 kg/m<sup>2</sup>), normal (18.5–24.9 kg/m<sup>2</sup>), overweight (25–29.9 kg/m<sup>2</sup>), and obese ( $\geq 30$  kg/m<sup>2</sup>).<sup>(12)</sup>

The results of the study were presented in cross-tabulations and analysed using the chi-square test to determine the significant correlation between research variables. Significance conditions are met if the p-value is less than 0.05. In addition, this test is used because the blood pressure levels data is in ordinal scale while the stage of DR is in a nominal scale.<sup>(13)</sup>

The formula used to calculate the minimal sample for this cross-sectional study is as follows:

$$n = \frac{Z^2 p(1 - p)N}{d^2(N - 1) + Z^2 p(1 - p)}$$

Information:

n = Number of samples

N = Number of population

Z = Degree of confidence (95% level = 1.96)

p = Proportion of a particular case to a population, if the proportion is unknown then it is set at 50% (0.50)

d = Degree of deviation to a population expected to be 5% (0.05).

Based on calculations using this formula, the minimum number of samples is 32 with calculation as follows:

$$\begin{aligned}
 n &= \frac{Z^2 p(1-p)N}{d^2(N-1) + Z^2 P(1-p)} \\
 &= \frac{(1,96)^2 \cdot 0,5 (1-0,5) \cdot 40}{(0,05)^2 \cdot (40-1) + (1,96)^2 \cdot 0,5 (1-0,5)} \\
 &= \frac{38}{1,2} \\
 &= 32
 \end{aligned}$$

## Result

### Summary of the study

Based on **Table 1**, most of the patients comprised approximately 18 patients (56.3%), fell within the age range of 50-59 years. Male accounted for 18 patients (56.3%) and BMI obesity were dominant with around 15 patients (46.9%). Grade 1 hypertension was observed in approximately 10 patients (31.3%), while PDR was detected in 18 patients (56.3%). Based on **Table 2**, a p-value of 0.315 (> 0.05) was obtained for the correlation between blood pressure levels and the diabetic retinopathy stage.

Then the data underwent a Chi-Square analysis test to see the relationship between the blood pressure levels and the diabetic retinopathy stage. Based on the Chi-Square test result, p-value of 0.315 was obtained, which means that the significance value is > 0.05. Thus there is no relationship between blood pressure levels and the diabetic retinopathy stage in patients at RSU Karsa Husada General Hospital, Batu City.

## Discussion

### Consistency With Previous Studies

In this study, the gender most affected by DR was male, comprising 56.3% of the patients. This finding aligns

**Table 1. General characteristics of respondents**

Characteristics	Frequency
Age	
• 30-39 years	5 (15.6)
• 40-49 years	3 (9.4)
• 50-59 years	18 (56.3)
• ≥ 60 years	6 (18.8)
Gender	
• Male	18 (56.3)
• Female	14 (43.8)
Education	
• Diploma/Bachelor	6 (18.8)
• Senior High School	10 (31.3)
• Junior High School	12 (37.5)
• Elementary School	4 (12.5)
Occupation	
• Soldier/ Police	2 (6.3)
• Private	7 (21.9)
• Self-employed	10 (31.3)
• Not working	13 (40.6)
Body Mass Index (BMI)	
• Underweight	0 (0)
• Normal	12 (37.5)
• Overweight	5 (15.6)
• Obesity 1	14 (43.8)
• Obesity	1 (3.1)
Smoking habit	
• No	27 (84.4)
• Smoking	5 (15.6)
History of Other Diseases	
• None	16 (50.0)
• Tuberculosis	1 (3.1)
• Strokes	2 (6.3)
• Kidney failure	2 (6.3)
• Heart failure	11 (34.4)
Drug Therapy	
• Oral administration	14 (43.8)
• Insulin Injection	18 (56.3)
Fasting Blood Glucose (FBG) levels	
• < 100 mg/dL	5 (15.6)
• 100-125 mg/dL	3 (9.4)
• ≥ 126 mg/dL	24 (75.0)
Blood Pressure	
• Normal	9 (28.1)
• Normal-high	7 (21.9)
• Grade 1 Hypertension	10 (31.3)
• Grade 2 Hypertension	6 (18.8)
Diabetic Retinopathy Stage	
• NPDR	14 (43.8)
• PDR	18 (56.3)

BMI (Body Mass Index); FBG (Fasting Blood Glucose); NPDR (Non-proliferative Diabetic Retinopathy); PDR (Proliferative Diabetic Retinopathy)

**Table 2. Bivariate analysis of the relationship between blood pressure level and stages of diabetic retinopathy**

Variable	Blood Pressure					p value
	Normal	Normal-high	Grade 1 Hypertension	Grade 2 Hypertension	Total	
	n (%)	n (%)	n (%)	n (%)	n (%)	
NPDR	2 (6.3)	4 (12.5)	4 (12.5)	4 (12.5)	14 (43.8)	0.315
PDR	7 (21.9)	3 (9.4)	6 (18.8)	2 (6.3)	18 (56.3)	
Total	9 (28.1)	7 (21.9)	10 (31.3)	6 (18.8)	32 (100)	

NPDR (Non-proliferative Diabetic Retinopathy); PDR (Proliferative Diabetic Retinopathy)

with a research by Cherchi (2020) which states that the prevalence of diabetic retinopathy is higher in men than women, with rates of 22.0% versus 19.3%. The higher incidence in men is often caused by unhealthy lifestyles, hormones changes, smoking, alcohol consumption, and lower levels of compliance with blood sugar control compared to women.<sup>(14)(15)</sup>

The age group most commonly diagnosed with DR was 50-59 years. According to Reubun (2022), people aged 50 years and older are considered to be more prone to experience diabetic retinopathy. Correlatively, as a person's age increases, their level of glucose intolerance also increases, putting individuals with a long history of Diabetes Mellitus (DM) at a higher risk.<sup>(16)</sup> In addition, as individuals age, their body function decreases due to the process of cell apoptosis, particularly in the retina. This decline can be accelerated by inflammatory reactions and increased oxidative stress.<sup>(17)</sup>

Respondents predominantly diagnosed with grade 1 hypertension, 10 respondents (31.3%). The results of this study are consistent with Liu (2020), who stated that among 2189 respondents with diabetic retinopathy from Chinese, Malay and Indian ethnic groups, 1,046 respondents (47.8%) dominated by normal-high hypertension patients with readings of 130- 139 mmHg. This occurs because abnormal Pulse Pressure (PP) is considered to increase shear stress within the blood flow, potentially leading to the destruction of retinal capillary endothelial in the eye. High blood pressure can cause leaks in the retinal vessels.<sup>(18)(6)</sup>

Based on the results of the analysis of diabetic retinopathy, it was found that the majority of patient with diabetic

retinopathy were in the Non Proliferative Diabetic Retinopathy (NPDR) stage, with 14 respondents (43.8%), while 18 respondents (56.3%) had Proliferative Diabetic degree were Retinopathy (PDR). The results of this study are consistent with Primaputri's research (2022), which indicates that patients with diabetic retinopathy are predominantly in the PDR stage compared to NPDR stage with a ratio of 68.0% versus 51.0%. This is because many individuals with chronic diabetes mellitus do not undergo regular eye examinations at existing health facilities, resulting in numerous cases remaining undiagnosed at an early stage.<sup>(19)</sup> Many patients who come to the hospital are already in the PDR stage, which means that retinal neovascularization has happened.<sup>(20)</sup>

Based on data analysis using the Chi-Square test, a p-value of 0.315 was obtained, ( $p > 0.05$ ), indicating that there is no significant relationship between the blood pressure level and diabetic retinopathy stage.

The results of this bivariate analysis are also relevant to Tariq's (2023) research, which states that there is no significant relationship between hypertension and the diabetic retinopathy, as indicated by a p value of 0.804. This occurs due to a lack of awareness among the public and minimal access to healthcare. It does not rule out the possibility that, many patients with NPDR or PDR have normal blood pressure.<sup>(21)</sup>

This study yields similar result to those of Halim (2022), which suggests that there is no significant relationship between systolic and diastolic blood pressure and the diabetic retinopathy, as indicated by a p-value  $> 0.05$ .<sup>(22)</sup> This occurs because the majority of diabetic retinopathy patients are already taking antihypertensive and anti-

diabetes medications. Consequently, when examined at a health facility, their blood pressure is often controlled or not as high as those who do not regularly take antihypertensive medications.<sup>(23)</sup>

The results of this study are different from Nauli (2018), which stated that there is a significant relationship between hypertension and the diabetic retinopathy with a p-value of 0.043. Diabetes Mellitus (DM) is closely related to hypertension, with one of the interactions involving hormones controlling blood sugar levels through the Renin Angiotensin-Aldosterone System (RAAS). In diabetic patients, there is an increase in RAAS, which can lead to hypertensive conditions. The combination of diabetes and hypertension affects the microvascular condition of the retina, leading to the release of retinal pericyte cells.<sup>(24)</sup>

## Strength and Limitations

This study is the first cross-sectional study to explore the relationship between blood pressure levels and diabetic retinopathy stage in Batu City, particularly within the Malang Raya region, especially at Karsa Husada Batu General Hospital.

The limitations of this study, which may contribute to insignificant results, include the fact that hypertension is not the sole factor causing diabetes retinopathy. Diabetic retinopathy has multifactorial causes, with the chronicity of diabetes mellitus being the primary factor. Additionally, the authors did not conduct further analysis to correlate these factors. Secondly, since the majority of respondents were taking antihypertensive medication, many of them displayed normal blood pressure during the checks which may not accurately represent their hypertension condition. Thirdly, the influence of less detailed classification of diabetic retinopathy stages is another limitation, as medical records solely list NPDR and PDR stages. Meanwhile, it's essential to monitor the development of diabetic retinopathy starting from the mild, moderate, and severe NPDR stages, in order to understand the progress of diabetic retinopathy in detail, particularly in cases influenced by increased blood pressure.

## Conclusion

The majority of patients with diabetic retinopathy were in the PDR stage with 18 respondents (56.3%), while the remaining 14 respondents were in the NPDR stage (43.8%).

The majority of patients with diabetic retinopathy and blood pressure problems were grade 1 hypertension, comprising 10 respondents (31.3%), and followed by 6 respondents (18.8%) with grade 2 hypertension.

There was no significant relationship between blood pressure levels and diabetic retinopathy type with a p-value of 0.315.

## Recommendation

Suggestions for future research includes using responses from individuals who have not undergone anti-hypertensive or diabetes mellitus therapy and employing a more detailed DR diagnostic classification. In addition, it is expected to use a larger sample size in cross-sectional studies, in order to provide more representative results.

## Acknowledgement

The author would like to thank Dr. Iwal Reza Ahdi, SpPD for his valuable guidance and input, the Faculty of Medicine and Health Sciences, Faculty of Medicine and Health Sciences, Maulana Malik Ibrahim Islamic State University Malang, who has facilitated this research, as well as the staff of the Ophthalmology and Internal Medicine section of Karsa Husada Batu Hospital for their expert work.

## Conflict of Interest

The authors declare no conflict of interest.

## Source of Funding

No funding was obtained for this study.

## Abbreviations

DR (Diabetic Retinopathy)

BMI (Body Mass Index)

FBG (Fasting Blood Glucose)

NPDR (Non-proliferative Diabetic Retinopathy)

PDR (Proliferative Diabetic Retinopathy)

## References

- Dameria D, Andayani G, Rahman K, Soedarman S. Pedoman Nasional Pelayanan Kedokteran Retinopati Diabetika. Perdami [Internet]. 2018;6–26. Available from: <https://perdami.or.id/wp-content/uploads/2022/03/Panduan-Nasional-Pelayanan-Kedokteran-Retinopati-Diabetik.pdf>
- Scanlon PH. Improving the screening of risk factors in diabetic retinopathy. *Expert Rev Endocrinol Metab* [Internet]. 2022;17(3):235–43. Available from: <https://doi.org/10.1080/17446651.2022.2078305>
- Satari M, Aghadavod E, Mirhosseini N, Asemi Z. The effects of microRNAs in activating neovascularization pathways in diabetic retinopathy. *J Cell Biochem*. 2019;120(6):9514–21.
- Nair M, Mishra D. Classification of diabetic retinopathy severity levels of transformed images using K-means and thresholding method. *Int J Eng Adv Technol*. 2019;8(4):51–9.
- World Health Organization. Strengthening Diagnosis and Treatment of Diabetic Retinopathy in the South-East Asia Region [Internet]. Vol. 69, World Health Organisation Library. 2020. 1–46 p. Available from: <https://apps.who.int/iris/handle/10665/334224>
- Dewi PN, Fadrian F, Vitresia H. Profil Tingkat Keparahan Retinopati Diabetik Dengan Atau Tanpa Hipertensi pada di RSUD Dr. M. Djamil Padang. *J Kesehat Andalas*. 2019;8(2):204.
- Wong TY, Sun J, Kawasaki R, Ruamviboonsuk P, Gupta N, Lansingh VC, et al. Guidelines on Diabetic Eye Care: The International Council of Ophthalmology Recommendations for Screening, Follow-up, Referral, and Treatment Based on Resource Settings. *Ophthalmology* [Internet]. 2018;125(10):1608–22. Available from: <https://doi.org/10.1016/j.ophtha.2018.04.007>
- Mancia G, De Backer G, Dominiczak A, Cifkova R, Fagard R, Germano G, et al. 2007 Guidelines for the Management of Arterial Hypertension: The Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). Vol. 25, *Journal of Hypertension*. 2007. 1105–1187 p.
- Lukito. KONSENSUS PENATALAKSANAAN HIPERTENSI 2021 : UPDATE KONSENSUS PERHI 2019: PERHIMPUNAN DOKTER HIPERTENSI INDONESIA. 2021.
- Shukla U. Diabetic Retinopathy. *Natl Libr Med*. 2023;
- Panel APR. erred Practice Pattern: Diabetic Retinopathy PPP - Updated 2017. *Am Acad Ophtalmol* [Internet]. 2015;27–8. Available from: <http://dx.doi.org/10.1016/B978-0-323-53042-2.00251-0>
- Irmawati, Nuhaedah. Metodologi Penelitian - Kesehatan Lingkungan, Kementerian Kesehatan RI. In: 1st ed. Jakarta: Jurusan Kesehatan Lingkungan Poltekkes Kemenkes Jakarta II; 2017.
- Cherchi S, Gigante A, Spanu MA, Contini P, Meloni G, Fois MA, et al. Sex-Gender Differences in Diabetic Retinopathy. *Diabetology*. 2020;1(1):1–10.
- Tilahun M, Gobena T, Dereje D, Welde M, Yideg G. Prevalence of diabetic retinopathy and its associated factors among diabetic patients at debre markos referral hospital, Northwest Ethiopia, 2019: Hospital-based cross-sectional study. *Diabetes, Metab Syndr Obes*. 2020;13:2179–87.
- Reubun RJS, Tamtelatihu CL, Yunita M. Prevalensi Retinopati Diabetik Pada Penderita Diabetes Melitus Di Klinik Utama Provinsi Maluku. *Care J Ilm Ilmu Kesehat*. 2022;10(3):366–76.
- Ezeani I. Prevalence and Risk Factors for Diabetes Mellitus in A State in South East Nigeria: Results of a Population Based House to House Survey. *Bentham Sci*. 2020;16(2).
- Liu L, Quang ND, Banu R, Kumar H, Tham YC, Cheng CY, et al. Hypertension, blood pressure control and diabetic retinopathy in a large populationbased study. *PLoS One* [Internet]. 2020;15(3):1–15. Available from: <http://dx.doi.org/10.1371/journal.pone.0229665>
18. Riset A, Primaputri A, Sri Irmandha K, Karim M, Hapsari P, Surdam Z, et al. FAKUMI MEDICAL JOURNAL Hubungan Jenis Retinopati Diabetik dengan Lama Menderita Diabetes Melitus dan Kadar HbA1C. 2022;2(8):585–91.
- Hammoudi J, Bouanani NEH, Chelqi EH, Bentata Y, Nouayti H, Legssyer A, et al. Diabetic retinopathy in the Eastern Morocco: Different stage frequencies and associated risk factors. *Saudi J Biol Sci* [Internet]. 2021;28(1):775–84. Available from: <https://doi.org/10.1016/j.sjbs.2020.11.010>
- Salman Tariq, Mafaza Naseem, M. Rizwan Khan, M. Imran Janjua, Hurmat Fatima Azeem, Fuad Ahmad Khan Niazi. Risk factors of diabetic retinopathy - a cross sectional study from Holy Family Hospital, Rawalpindi. *Prof Med J*. 2023;30(02):168–73.
- Halim A, Syumarti S, Rini M, Ratnaningsih N, Iskandar E, Sovani I, et al. Prevalence and Associated Factors of Diabetic Retinopathy in People with Type 2 Diabetes Attending Community Based Diabetic Retinopathy Screening in Greater Bandung, Indonesia. *Int J Retin*. 2022;5(1):1.
- Gupta M, Singh A, Duggal M, Singh R, Bhadada S, Khanna P. Natural History of Diabetic Retinopathy Through Retrospective Analysis in Type 2 Diabetic Patients—An Exploratory Study. *Front Public Heal*. 2021;9(November):1–10.
- Nauli RR, Virgana R, Kartasasmita AS, Sovani I, Iskandar E, Ihsan G. Correlation Between Systemic Risk Factors and Diabetic Retinopathy in Patients with Diabetes Mellitus at Cicendo National Eye Hospital. *Int J Retin*. 2018;1(2):51–7.