Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

# Risk Factors Associated with Hypertensive Retinopathy in Patients with Essential Hypertension

**Anushka Sagar[1], Mitika Patidar[1], Shubhra Mehta[2], Manoj Mehta[3]**

[1]Postgraduate Resident, Department of Ophthalmology, Ruxmaniben Deepchand Gardi Medical College, Ujjain, Madhya Pradesh, India, [2]Professor, Department of Ophthalmology, Ruxmaniben Deepchand Gardi Medical College, Ujjain, Madhya Pradesh, India, [3]Professor and Head, Department of Ophthalmology, Ruxmaniben Deepchand Gardi Medical College, Ujjain, Madhya Pradesh, India

## Abstract

**Introduction:** Hypertensive retinopathy (HR) is a common microvascular complication of essential hypertension and an important cause of visual impairment in adults. Data on the risk-factor profile of HR from central India are limited.

**Purpose:** The purpose of the study was to study risk factors associated with HR in patients with essential hypertension, correlate HR grade with duration of hypertension and dyslipidemia, and assess resultant visual impairment.

**Materials and Methods:** This hospital-based, prospective, observational study included 140 patients with essential hypertension attending the ophthalmology outpatient department of R.D. Gardi Medical College, Ujjain, over 1 year. Patients underwent detailed ocular examination, fundus evaluation (direct/indirect ophthalmoscopy, optical coherence tomography), blood-pressure measurement and lipid/renal profiling. HR was graded by the Keith-Wagener-Barker classification, with follow-up at 4 and 6 weeks. Data were analysed in SPSS v23.0 using the Chi-square test ($P < 0.05$ significant).

**Results:** Mean age was 61.95 years; 70% were male. Grade 2 HR was the most common (36.4% of eyes), followed by Grade 3 (27–28%); 28.6% eyes showed no retinopathy. Longer duration of hypertension ($P = 0.000$), raised total cholesterol ($P = 0.010$), raised triglycerides ($P = 0.027$), raised low-density lipoprotein: high-density lipoprotein ratio ($P = 0.002$), chronic kidney disease ($P = 0.001$), stroke ($P = 0.033$) and obesity ($P = 0.000$) were significantly associated with higher HR grade; regular exercise was protective ($P = 0.002$). Smoking, occupation and physical activity showed no significant association. Best-corrected visual acuity was 6/18-6/12 in 77.5% of eyes at baseline, improving to 84.64% by 6 weeks.

**Conclusion:** Age, duration of hypertension, dyslipidemia, chronic kidney disease, stroke and obesity were significant risk factors for higher-grade HR, while regular exercise was protective. Early screening and control of modifiable risk factors may reduce vision-threatening HR.

**Key words:** Dyslipidemia, Essential hypertension, Hypertensive retinopathy, Keith-Wagener-Barker classification, Risk factors, Visual acuity

## INTRODUCTION

Hypertension affects more than 1.3 billion people worldwide, with 82% residing in low- and middle-income countries; in India, approximately 220 million adults are hypertensive.[1,2] The retina is highly susceptible to sustained blood-pressure elevation, giving rise to hypertensive retinopathy (HR), hypertensive optic neuropathy, choroidopathy and retinal vascular occlusions.[3,4] HR is a leading cause of visual impairment in adults, with vision loss occurring chiefly through macular edema, optic disc edema and exudative retinal detachment.[4,5] Because the retinal microvasculature mirrors the cerebral and renal microcirculation, retinal changes are considered a surrogate marker of systemic target-organ damage.[6]

HR results from an acute vasoconstrictive phase and a chronic arteriosclerotic phase, producing arteriolar

Access this article online

www.ijss-sn.com

Month of Submission : 05-2026
Month of Peer Review : 06-2026
Month of Acceptance : 07-2026
Month of Publishing : 07-2026

**Corresponding Author:** Dr. Anushka Sagar, Department of Ophthalmology, R.D. Gardi Medical College, Ujjain, Madhya Pradesh, India.

narrowing, arteriovenous nicking, hemorrhages, cotton-wool spots, hard exudates and, in severe disease, papilledema. Severity is graded by the Keith-Wagener-Barker (KWB) classification, which correlates with cardiovascular and cerebrovascular risk.[3,7] Reported risk factors include age, sex, duration of hypertension, dyslipidemia, obesity, smoking, physical inactivity and target-organ damage (chronic kidney disease, stroke, ischemic heart disease), though their relative contribution varies across populations and remains poorly characterised in central India.[8,9]

This study evaluated the risk factors associated with HR in patients with essential hypertension at a tertiary-care center in central India, correlated HR grade with duration of hypertension and dyslipidemia, and assessed the associated visual impairment and its short-term course.

## MATERIALS AND METHODS

This hospital-based, prospective, observational study was conducted in the Department of Ophthalmology, Ruxmaniben Deepchand Gardi Medical College (RDGMC), Ujjain, Madhya Pradesh, over 1 year, after approval by the Institutional Research Guidance Committee and Ethics Committee. Written informed consent was obtained from all participants. A total of 140 patients with essential hypertension attending the ophthalmology outpatient department (OPD) were enrolled consecutively; the sample size was calculated statistically for 99% confidence. All patients with essential hypertension attending the eye OPD were eligible; those with a hazy cornea precluding fundus examination, secondary hypertension, pregnancy, drug allergy or monocularity were excluded.

Baseline demographic and clinical data (age, sex, occupation, socio-economic status, residence, education, duration of hypertension) were recorded on a structured pro forma. Ocular examination included visual acuity (unaided, aided, pinhole), anterior-segment examination, intraocular pressure, and detailed fundus examination by direct and indirect ophthalmoscopy, confirmed by optical coherence tomography in all patients. Systolic and diastolic blood pressure were recorded. HR was graded by the KWB classification: Grade 1 – mild generalised arteriolar narrowing; Grade 2 – focal narrowing with arteriovenous nicking; Grade 3 – Grade 2 plus hemorrhages, cotton-wool spots, and hard exudates; Grade 4 – Grade 3 plus papilledema/retinal edema.[7] Laboratory work-up included hemoglobin, fasting blood sugar, total cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL) (and derived LDL: HDL ratio), serum urea, creatinine and urine microalbumin. Patients were followed up at 4 and 6 weeks with reassessment of best-corrected visual acuity (BCVA) and HR grade.

Data were analysed in SPSS v23.0 (IBM, Chicago, USA); continuous variables as mean ± standard deviation, categorical variables as frequencies/percentages, with the Chi-square test used for association ($P < 0.05$ significant). The principal limitation was the modest single-center sample size, which reduced power for some comparisons; the study was intended as a pilot to generate hypotheses for larger studies.

## RESULTS

Of 140 patients (280 eyes) studied, the mean age was 61.95 years; 61 (43.57%) were aged 61–70 years, 50 (35.71%) 51–60 years, 19 (13.57%) >70 years, and 10 (7.14%) <50 years (Table 1 and Figure 1). Ninety-eight patients (70%) were male. Ninety-four (67.1%) resided in rural areas, 77 (55%) were illiterate, and 94 (67.1%) belonged to a low socioeconomic stratum ($P < 0.05$ for residence). Sixty-eight patients (48.6%) had been hypertensive for 6–10 years, and 48 (34.28%) for 1–5 years; 92 (65.7%) had noticed diminished vision

**Table 1: Sociodemographic and clinical profile of study participants (*n*=140)**

| Variable | Category | *n* | % |
|---|---|---|---|
| Age group | 40–50/51–60/61–70/>70 yrs | 10/50/61/19 | 7.1/35.7/43.6/13.6 |
| Sex | Male/Female | 98/42 | 70.0/30.0 |
| Residence | Urban/Rural | 46/94 | 32.9/67.1 |
| Education | Literate/Illiterate | 65/77 | 45.0/55.0 |
| Socioeconomic status | Low/Middle | 94/46 | 67.1/32.9 |
| Duration of hypertension | ≤1 year/1–5 years/6–10 years/>10 years | 6/48/68/18 | 4.3/34.3/48.6/12.9 |
| History of smoking | Yes/No | 37/101 | 27.9/72.1 |
| Regular exercise | Yes/No | 26/114 | 18.6/81.4 |
| Total cholesterol | >200 mg/dL | 27 | 19.3 |
| Triglycerides | >150 mg/dL | 33 | 23.6 |
| LDL: HDL ratio | >2.5 | 15 | 10.71 |
| Chronic kidney disease | Present | 17 | 12.1 |
| Stroke | Present | 10 | 7.1 |
| Ischemic heart disease | Present | 20 | 14.3 |

Values are number (n) and percentage (%) of 140 study participants. LDL: HDL: Low-density lipoprotein: high-density lipoprotein

for 7–12 months. Thirty-seven patients (27.9%) smoked, 114 (81.4%) did not exercise regularly, and 89 (63.6%) reported only light physical activity. Twenty-seven patients (19.3%) had total cholesterol >200 mg/dL, 33 (23.6%) triglycerides >150 mg/dL, and 15 (10.71%) an LDL: HDL ratio >2.5; 17 (12.1%) had chronic kidney disease, 10 (7.1%) had a history of stroke and 20 (14.3%) ischemic heart disease.

On fundus grading, Grade 2 HR was commonest – 51 eyes (36.4%) in each eye – followed by Grade 3 (38 eyes, 27.1% right; 39 eyes, 27.9% left); Grade 1 was seen in 9 (6.4%) and 8 (5.7%) eyes, Grade 4 in 2 eyes (1.4%) each, and 40 eyes (28.6%) in each eye showed no retinopathy (Table 2 and Figure 2).

**Table 2: Distribution of grades of hypertensive retinopathy, right and left eye (*n*=140 patients, 280 eyes)**

| Grade of hypertensive retinopathy | RE, n | RE, % | LE, n | LE, % |
|---|---|---|---|---|
| Grade 1 | 9 | 7.1 | 8 | 5.7 |
| Grade 2 | 51 | 36.4 | 51 | 36.4 |
| Grade 3 | 38 | 27.1 | 39 | 27.9 |
| Grade 4 | 2 | 1.4 | 2 | 1.4 |
| No retinopathy | 40 | 28.6 | 40 | 28.6 |
| Total | 140 | 100.0 | 140 | 100.0 |

RE: Right eye; LE: Left eye

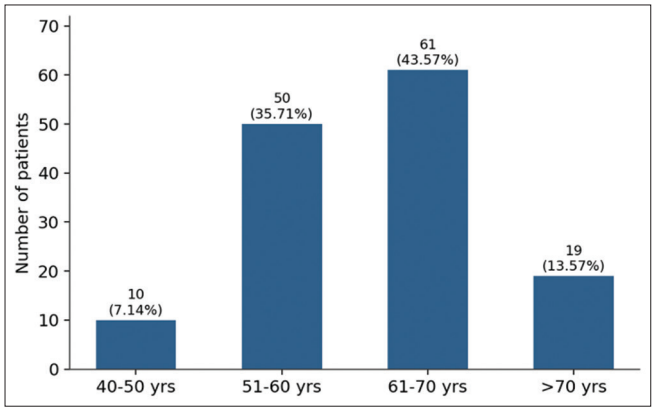


**Figure 1: Age distribution of study participants (*n* = 140)**

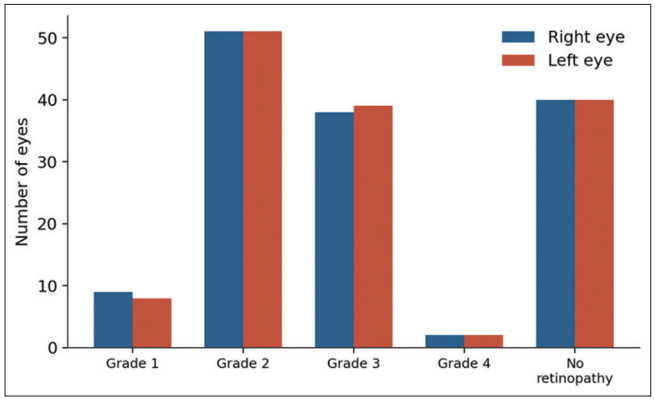


**Figure 2: Distribution of grades of hypertensive retinopathy (*n* = 140 patients)**

Age ($P = 0.000$) and duration of hypertension ($P = 0.000$) were significantly associated with HR grade, with higher grades clustering in patients aged 51–70 years and those hypertensive for 6–10 years; all Grade-4 cases occurred beyond 70 years of age. Dyslipidemia was significantly associated with severity – raised cholesterol ($P = 0.010$), raised triglycerides ($P = 0.027$) and raised LDL: HDL ratio ($P = 0.002$), each rose sharply from the no-retinopathy group through to Grade 4. Chronic kidney disease ($P = 0.001$), stroke ($P = 0.033$) and obesity ($P = 0.000$) were also significantly associated with higher HR grade, while regular exercise was protective ($P = 0.002$). Sex, occupation, ischemic heart disease, smoking and physical-activity level showed no statistically significant association ($P > 0.05$) (Table 3).

BCVA was 6/18-6/12 in 77.5% of the 280 study eyes at baseline (78.57% right, 76.42% left), 6/36-6/24 in 21.07%, and <6/60 in 1.42%. This proportion improved to 80.36% at 4 weeks and 84.64% at 6 weeks of follow-up (Table 4 and Figure 3).

## DISCUSSION

In this study of 140 patients with essential hypertension, HR severity was significantly associated with age, duration of hypertension, dyslipidemia, obesity, chronic kidney disease, and stroke, broadly consistent with existing literature.

The mean age (61.95 years) and predominance of HR in the 51–70-year age groups agree with Warad *et al.* (mean age 69.09 years, majority >60 years)[10] and Ray *et al.* (63.3% of HR patients >50 years).[11] The male preponderance (70%) is comparable to Mondal *et al.* (66.1% male)[12] and Warad *et al.* (62% male).[10] The significant association between duration of hypertension and HR grade ($P = 0.000$) mirrors Mondal *et al.* (34.56% vs. 23.84% prevalence in hypertension >5 vs. ≤5 years, $P < 0.001$)[12] and Veeramani and Nusaiba

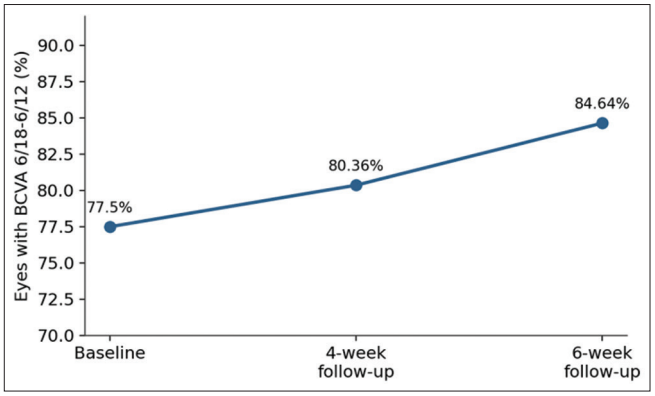


**Figure 3: Trend in best-corrected visual acuity over follow-up (combined eyes, *n* = 280)**

**Table 3: Association between risk factors and grade of hypertensive retinopathy (*n*=140 patients)**

| Risk factor | Key finding (trend across Grade 1→4) | *P*-value | Sig. |
|---|---|---|---|
| Age group | Higher grades clustered in 51–70 years; all Grade-4 cases>70 years | 0.000 | Yes |
| Sex | No significant difference between males and females | 0.198 | No |
| Duration of hypertension | 6–10 years contributed 60.8% of Grade 2, 55.3% of Grade 3, 50.0% of Grade 4 | 0.000 | Yes |
| Total cholesterol >200 mg/dL | 11.1%→27.5%→10.5%→0%→ versus 15.0% no retinopathy | 0.010 | Yes |
| Triglycerides >150 mg/dL | Rose to 100% of Grade-4 eyes versus 25.0% no retinopathy | 0.027 | Yes |
| LDL: HDL ratio >2.5 | Rose to 100% of Grade-4 eyes versus 7.5% no retinopathy | 0.002 | Yes |
| Body mass index (obesity) | 57.9% Grade 3, 100% Grade 4 obese versus 22.5% no retinopathy | 0.000 | Yes |
| Chronic kidney disease | Rose from 7.5% (no retinopathy) to 100% (Grade 4) | 0.001 | Yes |
| Stroke | Rose from 0% (Grade 1) to 50% (Grade 4) | 0.033 | Yes |
| Ischemic heart disease | No significant association with grade | 0.566 | No |
| History of smoking | Positive trend, not statistically significant | 0.228 | No |
| Regular exercise | Protective: 40% no-retinopathy group versus 0–13.2% Grades 1–4 | 0.002 | Yes |
| Physical activity level | No significant association with grade | 0.123 | No |
| Occupation | No significant association with grade | >0.05 | No |

*P*-value by Chi-square test; *P*<0.05 considered statistically significant. Sig. = statistically significant

**Table 4: BCVA at baseline and follow-up, both eyes combined (*n*=280 eyes)**

| Time point | <6/60 (%) | 6/36-6/24 (%) | 6/18-6/12 (%) | 6/9-6/6 (%) | *n* |
|---|---|---|---|---|---|
| Baseline | 1.42 | 21.07 | 77.5 | 0.0 | 280 |
| 4-week follow-up | 1.42 | 17.86 | 80.36 | 0.0 | 280 |
| 6-week follow-up | 1.42 | 14.64 | 84.64 | 0.0 | 280 |

Values are the percentage of the 280 study eyes (right+left) in each BCVA category.
BCVA: Best-corrected visual acuity

(35.24% vs. 17.94%, $P = 0.008$),[13] supporting the concept that cumulative pressure load drives arteriosclerotic retinal change.

Dyslipidemia – raised cholesterol, triglycerides, and LDL: HDL ratio – was significantly associated with HR severity, corroborating Gupta *et al.*[14] and Badhu *et al.*,[15] who each reported significant lipid-retinopathy associations, supporting routine lipid screening in hypertensive patients. Chronic kidney disease and stroke were significantly linked to higher HR grade, consistent with Mondal *et al.*[12] and Kolman *et al.*, who showed HR is independently associated with stroke and cardiovascular risk irrespective of blood pressure;[16] Habib *et al.* similarly linked HR severity to angiographic coronary disease severity.[17] Ischemic heart disease was not significantly associated with HR grade here, echoing Ray *et al.*[11] These findings support fundus examination as a convenient window into systemic vascular risk.

Obesity was significantly associated with higher HR grade, consistent with Warad *et al.*[10] and the atherosclerosis risk in communities study linking hypertensive retinal signs to abdominal obesity;[18] regular exercise was protective, in keeping with Warad *et al.* and European Society of Cardiology/European Society of Hypertension guidelines recommending ≥30 min of moderate aerobic exercise 5–7 days/week for hypertensives.[10,19] Physical activity level and smoking did not reach significance here, likely reflecting the largely rural, occupationally active cohort and the modest number of smokers; smoking has nonetheless been linked to retinal nerve fibre thinning and choroidal changes elsewhere.[20]

The majority of eyes had BCVA of 6/18-6/12 at presentation, improving further with treatment by 6 weeks, indicating that much of the visual impairment in HR is reversible with prompt blood-pressure and risk-factor control. The principal limitation of this study is its modest single-center sample, which reduced power for some comparisons; larger multicentric studies with longer follow-up are warranted.

## CONCLUSION

HR was most prevalent beyond 50 years of age and in men, with Grade 2 being the commonest grade. Longer duration of hypertension, dyslipidemia, obesity, chronic kidney disease and stroke were significant risk factors for higher-grade disease, while regular exercise was protective; most affected eyes retained useful vision, which improved further with treatment. These findings support routine fundus screening in hypertensive patients and aggressive control of dyslipidemia, weight, chronic kidney disease and duration-related risk, alongside promotion of regular exercise, to reduce the burden of vision-threatening HR.

## ETHICS APPROVAL

Approved by the Institutional Ethics Committee and Research Guidance Committee, R.D. Gardi Medical College, Ujjain; written informed consent obtained from all participants

## REFERENCES


1. Mills KT, Bundy JD, Kelly TN, Reed JE, Kearney PM, Reynolds K, *et al*. Global disparities of hypertension prevalence and control: A systematic analysis of population-based studies from 90 countries. Circulation 2016;134:441-50.
2. Gupta R. Trends in hypertension epidemiology in India. J Hum Hypertens 2004;18:73-8.
3. Modi P, Arsiwalla T. Hypertensive Retinopathy. Treasure Island, FL: StatPearls Publishing; 2023.
4. Bhargava M, Ikram MK, Wong TY. How does hypertension affect your eyes? J Hum Hypertens 2012;26:71-83.
5. Wong TY, Mitchell P. Hypertensive retinopathy. N Engl J Med 2004;351:2310-7.
6. Cheung CY, Ikram MK, Sabanayagam C, Wong TY. Retinal microvasculature as a model to study the manifestations of hypertension. Hypertension 2012;60:1094-103.
7. Keith NM, Wagener HP, Barker NW. Some different types of essential hypertension: their course and prognosis. Am J Med Sci 1974;268:336-45.
8. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: Analysis of worldwide data. Lancet 2005;365:217-23.
9. Wong TY, Klein R, Klein BE, Tielsch JM, Hubbard LD, Nieto FJ. Retinal microvascular abnormalities and their relation to hypertension, cardiovascular diseases and mortality. Surv Ophthalmol 2001;46:59-80.
10. Warad C, Simon RR, Wani R, Singh R, Pavuluri S, Kothiwale VA. Incidence and determinants of hypertensive retinopathy in hypertension patients at a teaching hospital in North Western Karnataka. Indian J Clin Exp Ophthalmol 2023;9:634-40.
11. Ray S, Sahu BK, Naskar S. Hypertensive retinal changes: Its prevalence and associations with other target organ damage. Indian J Med Sci 2020;72:195-200.
12. Mondal RN, Matin MA, Rani M, Hossain MZ, Shaha AC, Singh RB, *et al*. Prevalence and risk factors of hypertensive retinopathy in hypertensive patients. J Hypertens 2017;6:241.
13. Veeramani P, Nusaiba I. A study on hypertensive retinopathy and duration of hypertension. Int J Res Pharm Sci 2022;13:145-9.
14. Gupta RP, Gupta S, Gahlot A, Sukharamwala D, Vashi J. Evaluation of hypertensive retinopathy in patients of essential hypertension with high serum lipids. Med J DY Patil Univ 2013;6:165-9.
15. Badhu B, Dulal S, Baral N, Lamsal M, Shrestha JK, Koirala S. Serum level of low-density lipoprotein cholesterol in hypertensive retinopathy. Southeast Asian J Trop Med Public Health 2003;34:199-201.
16. Kolman SA, Van Sijl AM, Van der Sluijs F, Van Deree MA. Consideration of hypertensive retinopathy as an important end-organ damage in patients with hypertension. J Hum Hypertens 2017;31:121-5.
17. Habib SA, Jibran MS, Khan SB, Gul AM. Association of hypertensive retinopathy with angiographic severity of coronary artery disease determined by SYNTAX score. J Ayub Med Coll Abbottabad 2019;31:189-91.
18. Wong TY, Duncan BB, Golden SH, Klein R, Couper DJ, Klein BE, *et al*. Associations between the metabolic syndrome and retinal microvascular signs: The atherosclerosis risk in communities study. Invest Ophthalmol Vis Sci 2004;45:2949-54.
19. Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, *et al*. 2018 ESC/ESH Guidelines for the management of arterial hypertension. J Hypertens 2018;36:1953-2041.
20. Demirci S, Gunes A, Demirci S, Kutluhan S, Tok L, Tok O. The effect of cigarette smoking on retinal nerve fiber layer thickness in patients with migraine. Cutan Ocul Toxicol 2016;35:21-5.


**How to cite this article:** Sagar A, Patidar M, Mehta S, Mehta M. Risk Factors Associated with Hypertensive Retinopathy in Patients with Essential Hypertension. Int J Sci Stud 2026;14(4):7-11.

**Source of Support:** Nil, **Conflicts of Interest:** None declared.