

Prevalence and Pattern of Ocular Manifestations in Hypertensive Patients Attending the OPD at SKMCH, Muzaffarpur

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Abstract:

Background: Hypertension is a common chronic non-communicable disease and a major public health problem associated with multiple systemic complications. The eye provides a unique opportunity to directly observe vascular changes caused by hypertension, particularly in the retina. Early detection of these ocular manifestations is important for preventing vision-threatening complications and assessing systemic vascular damage.

Aim: To determine the prevalence and pattern of ocular manifestations among hypertensive patients attending the ophthalmology OPD at SKMCH, Muzaffarpur.

Methodology: A hospital-based cross-sectional observational study was conducted in the Department of Ophthalmology at SKMCH, Muzaffarpur, over a period of 8 months. A total of 90 hypertensive patients aged ≥ 30 years were included based on inclusion and exclusion criteria. Detailed history, blood pressure measurement, and comprehensive ophthalmic examination including fundus evaluation were performed. Data were analyzed using SPSS version 27.0.

Results: Ocular manifestations were observed in 48 patients (53.3%). The most common finding was arteriolar narrowing (20%), followed by arteriovenous crossing changes (13.3%), retinal hemorrhages (7.8%), cotton wool spots (5.6%), hard exudates (4.4%), and hypertensive retinopathy with disc changes (2.2%).

Conclusion: More than half of hypertensive patients showed ocular manifestations, highlighting the importance of regular ophthalmic screening for early detection and prevention of hypertensive ocular complications.

Keywords: Hypertension, Ocular manifestations, Hypertensive retinopathy, Fundus examination, Retinal vascular changes.

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Introduction

Hypertension is a non-communicable disease that is highly prevalent in the world; it is a major health issue of concern in the population on the basis of its correlation to notable morbidity and mortality [1]. It is a state whereby blood pressure is consistently at a higher-than-normal physiological level which is beyond the normal body age and sex rate. Some physiological and environmental factors such as physical activities, emotional stress, age, genetic tendencies, and multiple medical conditions affect the level of blood pressure. The levels of blood pressure that are higher than the normal range especially when it is higher than 140/90 mm Hg when at rest, is usually termed as hypertension. A normal systolic pressure falls within the range of 100- 140 mm Hg and the diastolic pressure falls within the range of 60- 90 mm Hg. Constant elevation above these limits may

cause structural and functional alteration in various body organs.

Essential hypertension together with secondary hypertension represents the two main types of hypertension. Essential hypertension accounts for approximately 90–95% of all cases and is defined as a condition that leads to high blood pressure without any known medical explanation [2]. The development of this condition shows strong links to various environmental and lifestyle factors. Essential hypertension develops through a combination of excessive salt intake and smoking and lack of physical activity and obesity and alcohol consumption and genetic factors. The condition of secondary hypertension develops in about 5 to 10 percent of cases because of medical conditions which include renal diseases and endocrine disorders and cardiovascular

abnormalities and certain systemic illnesses. The process of identifying and treating secondary hypertension becomes vital because this condition presents a lower occurrence rate yet it enables doctors to achieve effective blood pressure management through the discovery of its underlying cause.

Hypertension which doctors refer to as the "silent killer" stays undetected for extended periods while it silently harms essential organs [3]. Continuous high blood pressure results in damages to multiple body parts which include the heart brain kidneys and eyes. The eye functions as a special organ because doctors can see how hypertension affects its blood vessels through ophthalmoscopic tests. The retina enables direct observation of bodily blood vessel alterations which scientists can study within living organisms. The eye symptoms of hypertension function as essential measurement tools which show both the intensity of hypertension and how long it has persisted.

Hypertension has become a global health crisis which keeps growing because more people live longer and more cities develop and people adopt new ways of living. The World Health Organization estimates that hypertension affects most of the adult population worldwide and this condition becomes more prevalent as people grow older. Research shows that approximately 60% of people aged 60 and older have hypertension. The high rates of hypertension which persists over time lead to an increased likelihood of developing cardiovascular diseases and cerebrovascular accidents and renal failure and ocular complications. The hypertension condition requires early detection and proper management to stop its development into long-term complications [4].

Hypertensive retinopathy stands as the primary ocular complication that arises from systemic hypertension. Hypertensive retinopathy refers to a group of retinal vascular changes that occur as a consequence of persistently elevated blood pressure [5]. The retinal arterioles together with their adjacent retinal tissue represent the main areas affected by these alterations. Hypertension that persists over time leads to arteriosclerotic changes in retinal blood vessels, which produce thickened vessel walls together with narrowed vascular openings that restrict blood circulation. The retinal blood vessel system undergoes structural changes, which medical experts identify as arteriosclerotic retinopathy. The body experiences two harmful effects from elevated blood pressure, which include endothelial damage and blood-retinal barrier disruption.

The development of hypertensive retinopathy occurs through multiple mechanisms which include vascular constriction and arteriosclerosis and increased vascular permeability [6]. High blood pressure which reaches extreme levels causes retinal arterioles to narrow and specific blood vessels to

experience vasospasm. The continuous blood vessel spasm together with heightened vascular pressure results in the death of both muscular and endothelial tissues that compose the retinal blood vessels. The vascular wall disintegration allows plasma substances to escape into nearby retinal regions which leads to retinal swelling and fluid leakage. The pathological alterations will cause cotton wool spots and hard exudates and retinal hemorrhages to develop.

The advanced ocular manifestations of hypertension develop in patients who experience its most severe cases. Extensive vascular damage and increased intracranial pressure lead to the development of retinal hemorrhages and papilloedema and retinal detachment according to [7]. The complications of this condition lead to severe visual impairments which result in permanent vision loss when medical professionals fail to identify and treat the condition on time. The medical assessment of hypertensive patients requires retinal examination because hypertensive retinopathy develops according to blood pressure levels and their duration.

Systemic hypertension causes various eye diseases beyond hypertensive retinopathy. Uncontrolled hypertension can lead to subconjunctival hemorrhage which occurs when small blood vessels in the conjunctiva break [8]. The condition typically resolves by itself but multiple episodes indicate that blood pressure remains outside control. Hypertensive patients face higher chances of experiencing retinal vascular occlusions which include retinal vein occlusion and retinal artery occlusion. The conditions function as ophthalmic emergencies because they can produce immediate and extreme vision loss. The situation requires both rapid diagnosis and urgent treatment because it can lead to permanent vision loss.

The assessment of eye problems that occur in patients with high blood pressure provides vital information needed for medical practice. Fundoscopic examination allows direct observation of retinal blood vessels which helps detect initial vascular changes that develop from hypertension [9]. The degree of hypertensive retinopathy present in a patient can indicate the extent of their systemic vascular damage and cardiovascular disease risk. People who have hypertension should undergo regular eye assessments especially those who have high blood pressure that has persisted for a long time or remains uncontrolled.

The burden of hypertension in India has risen sharply because of three factors which include lifestyle changes and urban development and the increasing population of elderly citizens. The condition has become more common yet many people still go without diagnosis and proper medical care which results in higher chances of developing both systemic and eye health problems. The detection of

early eye health symptoms can function as a crucial medical marker which enables doctors to assess and treat patients who have high blood pressure.

The study of ocular manifestations in hypertensive patients needs to be conducted because it provides essential information for both ophthalmologists and medical doctors. The identification of these changes protects against vision-threatening complications while enabling the assessment of how hypertension affects overall health. The study of ocular manifestations that result from hypertension will lead to better patient care and improved clinical results.

The study investigated how common ocular symptoms appeared in hypertensive patients who visited the outpatient department at SKMCH in Muzaffarpur. The study results will establish the frequency of eye-related problems in people with high blood pressure, which will demonstrate the necessity of regular eye check-ups for people with high blood pressure.

Methodology

Study Design: The present study was designed as a hospital-based cross-sectional observational study aimed at assessing the prevalence and pattern of ocular manifestations among hypertensive patients attending the outpatient department.

Study Area: The study was conducted in the Department of Ophthalmology, Sri Krishna Medical College and Hospital (SKMCH), Muzaffarpur, Bihar, India.

Study Duration: The study was conducted for a period of 8 months from March 2025 to October 2025.

Study Participants: The study participants consisted of patients diagnosed with systemic hypertension who attended the ophthalmology outpatient department during the study period.

Inclusion Criteria

- Patients diagnosed with systemic hypertension attending the ophthalmology OPD.
- Patients aged 30 years and above.
- Both male and female patients were included.
- Patients who were willing to participate in the study and provided written informed consent.

Exclusion Criteria

- Patients with ocular diseases unrelated to hypertension such as traumatic eye injury or congenital ocular disorders.
- Patients with systemic diseases affecting the eye other than hypertension (e.g., advanced diabetic retinopathy not related to hypertension).
- Patients who had undergone recent ocular surgery.
- Patients who were uncooperative or unwilling to participate in the study.

Sample Size: A total of 90 hypertensive patients attending the ophthalmology outpatient department during the study period were included in the study.

Procedure: Informed consent from the participants, hypertensive patients attending the ophthalmology OPD were screened and selected according to the inclusion and exclusion criteria. A detailed history was obtained from each participant including demographic details such as name, age, gender, and relevant medical history related to hypertension and its duration. Blood pressure of all participants was measured using a digital sphygmomanometer with the patient in a sitting position, and two readings were taken during the same visit. The average of the two readings was considered for analysis. Blood pressure was also confirmed using the standard auscultatory method whenever required.

All selected patients underwent a comprehensive ophthalmic examination. Visual acuity was assessed using a standard Snellen's chart. Intraocular pressure (IOP) was measured using a non-contact tonometer. Anterior segment examination was performed using a slit lamp biomicroscope to detect any abnormalities involving the conjunctiva, cornea, anterior chamber, iris, and lens. Pupillary reactions were evaluated, and pupils were dilated using appropriate mydriatic agents to facilitate detailed fundus examination. Fundus examination was carried out using direct and indirect ophthalmoscopy to detect hypertensive changes in the retina. Particular attention was given to identifying signs of hypertensive retinopathy such as arteriolar narrowing, arteriovenous crossing changes, retinal hemorrhages, cotton wool spots, hard exudates, and optic disc changes. The findings of ocular examination were carefully recorded in a structured proforma designed for the study. Based on these observations, the prevalence and pattern of ocular manifestations associated with hypertension were determined among the study participants.

Statistical Analysis: The collected data were entered into Microsoft Excel and subsequently analyzed using Statistical Package for Social Sciences (SPSS) version 27.0. Descriptive statistics such as frequency, percentage, mean, and standard deviation were used to summarize the data. Appropriate statistical tests were applied wherever necessary to evaluate the association between hypertension and ocular manifestations. A p-value of less than 0.05 was considered statistically significant.

Result

Table 1 shows the distribution of study participants according to different age groups. Out of the total 90 participants included in the study, the highest proportion belonged to the 50–59 years age group with 28 participants (31.1%). This was followed by the 60–69 years age group comprising 20 participants (22.2%). The 40–49 years age group accounted for

18 participants (20%). Participants aged 30–39 years and those aged ≥ 70 years each constituted 12 participants, representing 13.3% of the total study population respectively. Overall, the findings indicate that

the majority of the study participants were in the middle to older age groups, particularly between 50 and 69 years.

Age Group (Years)	Frequency (n)	Percentage (%)
30–39	12	13.3
40–49	18	20
50–59	28	31.1
60–69	20	22.2
≥ 70	12	13.3
Total	90	100

Table 2 shows the distribution of study participants according to gender. Out of the total 90 participants included in the study, the majority were males, accounting for 52 individuals (57.8%), while females constituted 38 participants (42.2%). This indicates that male participants were slightly more represented in the study population compared to females. The higher proportion of males may reflect greater

attendance of male patients at the outpatient department or a relatively higher prevalence of the studied condition among males in the study setting. Overall, both genders were adequately represented, allowing for a reasonable comparison and understanding of the distribution of the condition across male and female participants.

Gender	Frequency (n)	Percentage (%)
Male	52	57.8
Female	38	42.2
Total	90	100

Table 3 shows the distribution of study participants according to the duration of hypertension. Out of the total 90 patients included in the study, the highest proportion had a duration of hypertension of less than 5 years, accounting for 34 patients (37.8%). This was followed by 32 patients (35.6%) who had been suffering from hypertension for a duration between 5–10 years. A comparatively smaller

proportion, 24 patients (26.7%), had hypertension for more than 10 years. The findings indicate that a majority of the study participants had a relatively shorter duration of hypertension, with more than one-third being diagnosed within the past five years, while about one-fourth had a long-standing history of the disease exceeding 10 years.

Duration of Hypertension	Frequency (n)	Percentage (%)
<5 years	34	37.8
5–10 years	32	35.6
>10 years	24	26.7
Total	90	100

Table 4 shows the prevalence of ocular manifestations among hypertensive patients included in the study. Out of the total 90 patients evaluated, ocular manifestations were present in 48 patients, accounting for 53.3% of the study population. In contrast, 42 patients (46.7%) did not exhibit any ocular manifestations related to hypertension. The findings

indicate that more than half of the hypertensive patients attending the OPD had some form of ocular involvement, highlighting the significant impact of hypertension on ocular health and emphasizing the importance of regular ophthalmic examination for early detection and management of hypertensive eye changes.

Ocular Manifestations	Frequency (n)	Percentage (%)
Present	48	53.3
Absent	42	46.7
Total	90	100

Table 5 shows the pattern of ocular manifestations observed among hypertensive patients in the study. Out of the total 90 patients, the most common finding was arteriolar narrowing, which was observed in 18 patients (20%). This was followed by arteriovenous (AV) crossing changes seen in 12 patients (13.3%). Retinal hemorrhages were present in 7 patients (7.8%), while cotton wool spots were identified in 5 patients (5.6%). Hard exudates were found

in 4 patients (4.4%), and hypertensive retinopathy with disc changes was noted in only 2 patients (2.2%). However, a large proportion of patients, 42 (46.7%), did not show any ocular manifestation. These findings indicate that while a considerable number of hypertensive patients exhibited retinal vascular changes, nearly half of the patients had no detectable ocular involvement during examination.

Ocular Manifestation	Frequency (n)	Percentage (%)
Arteriolar narrowing	18	20
Arteriovenous (AV) crossing changes	12	13.3
Retinal hemorrhages	7	7.8
Cotton wool spots	5	5.6
Hard exudates	4	4.4
Hypertensive retinopathy with disc changes	2	2.2
No ocular manifestation	42	46.7
Total	90	100

Discussion

The current research assessed how common and what types of eye problems occurred among hypertensive patients who visited the ophthalmology outpatient department. The research examined 90 hypertensive patients and discovered that hypertension causes significant damage to eye structures especially to retinal blood vessels. The results showed that the majority of participants belonged to the middle-aged and elderly groups, with the highest proportion in the 50 to 59 years age group which accounted for 31.1 percent and the 60 to 69 years age group which accounted for 22.2 percent. These findings replicate the study results of Erden S, (2012) [10] which showed that most hypertensive patients who experienced eye problems belonged to the 50 to 60 years age group and the 60 to 70 years age group. Heiran et al. (2022) [11] found that about 58 percent of cases with hypertensive retinopathy affected people older than 50 because aging makes them more vulnerable to retinal blood vessel harm from continuous high blood pressure episodes. The study results demonstrate that older participants show the established connection between rising age and chronic hypertension which leads to eye blood vessel transformation.

The research discovered that there were more male participants who made up 57.8% of the study sample than female participants who made up 42.2% of the study sample. The study conducted by Kozikowska et al. (2020) [12] reported that males made up 60% of hypertensive patients who had ocular symptoms while females made up the remaining 40%. The study conducted by Liew et al. (2023) [13] found that approximately 55% of patients with hypertensive retinopathy were males. The higher occurrence of the condition in men may stem from their smoking habits and work-related tensions and eating

patterns, which lead to hypertension development and progression. The risk of ocular complications from hypertension remains present for both sexes because the difference between male and female risk levels stays within moderate limits.

The duration of hypertension also plays a crucial role in the development of retinal changes. The present study found that 37.8 percent of patients had hypertension for less than five years while 35.6 percent of patients had hypertension for 5 to 10 years and 26.7 percent of patients had hypertension for more than ten years. Bhargava et al. (2012) [14] reported similar findings which showed that 39 percent of hypertensive patients had a disease duration of less than five years while 34 percent had hypertension for 5 to 10 years. Patients with shorter hypertensive durations experienced ocular symptoms which indicated that retinal alterations begin to form during the initial phases of the condition. Wong and Mitchell (2004) [15] found that people who have hypertension for more than ten years' experience greater risks of developing hypertensive retinopathy. The severity of ocular complications depends on how long blood pressure levels remain elevated and how effectively healthcare providers manage those blood pressure levels.

The study discovered that 53.3% of patients with hypertension displayed eye-related symptoms. The research shows results which match the findings from Kozikowska et al. (2020) who discovered that 48% of their patients with systemic hypertension had hypertensive retinopathy. The research of Heiran et al. (2022) showed that about half of hypertension patients showed retinal alterations. Some studies reported higher prevalence rates than what we found in our research. Bhargava et al. (2012) documented that 60% of patients with hypertension at a tertiary care center showed eye-related symptoms. The

different results between studies exist because researchers examined different patient groups who had various sample sizes and hypertension durations and blood pressure management methods. The research results show that more than half of people with hypertension will experience some form of eye condition.

The current research discovered that arteriolar narrowing served as the primary retinal finding which appeared in 20 percent of the studied patients. This finding is in agreement with the study by Wong and Mitchell (2004), which reported generalized arteriolar narrowing in approximately 22–25% of hypertensive patients and identified it as an early indicator of hypertensive retinopathy. Heiran and his colleagues, (2022) found that 24 percent of their studied hypertensive patients showed arteriolar narrowing. Arteriolar narrowing occurs because of continuous blood vessel constriction together with the body's development of arterial walls through ongoing high blood pressure conditions.

The present study found that arteriovenous (AV) crossing changes appeared as the second most frequent condition, which affected 13.3% of the studied patients. Suri MF. (2008) [16] showed similar results when he found that 15% of his hypertensive patients displayed AV nicking. The process of AV crossing changes develops when arterioles become thickened and press down on the venules which run underneath them at their intersection points. The changes serve as signs of chronic illness because they represent the typical pattern of retinal damage that occurs in people with hypertension.

The present study found that retinal hemorrhages appeared in 7.8% of patients and cotton wool spots occurred in 5.6% of patients and hard exudates appeared in 4.4% of patients. Previous research has established the same patterns which scientists documented in their studies. Mittal et al. (2013) reported retinal hemorrhages in 9% of hypertensive patients, cotton wool spots in 6%, and hard exudates in 5%. The findings indicate advanced stages of hypertensive retinopathy which result in higher levels of vascular permeability and retinal ischemia and microvascular occlusion. Cotton wool spots show specific areas where the retinal nerve fiber layer has suffered localized infarction, while hard exudates show lipid buildup from ongoing vascular leakage.

The present study found that hypertensive retinopathy with disc changes occurred in 2.2% of patients as its least common finding. The observation corresponds to the results which Kawasaki et al. (2012) [17] reported because they found that optic disc edema occurred in less than 3% of hypertensive patients while their research showed that such changes occur only in cases of severe or malignant hypertension. Ikram et al. (2012) [18] reported that optic disc involvement occurs in about 2 to 3 percent of cases

which show hypertensive retinopathy. The study found that severe manifestations occurred among few patients because most of them received treatment before their diseases reached advanced stages.

The present research results confirm the established link between hypertension and retinal vascular changes which include arteriolar narrowing and AV crossing alterations. The study results demonstrate that ocular symptoms occur so frequently in hypertensive patients that doctors should conduct regular eye examinations for these individuals. The early discovery of retinal alterations enables doctors to prevent vision loss while it also acts as a key marker for assessing hypertension-related damage to blood vessels.

Conclusion

The present study highlights that teenage pregnancy remains a high-risk obstetric condition associated with significant maternal and fetal complications. A considerable proportion of mothers were unbooked and belonged to rural areas, reflecting gaps in antenatal care utilization. Maternal anemia and hypertensive disorders were common, while preterm delivery and low birth weight constituted major fetal concerns. Although the majority of deliveries were vaginal and over half of the neonates had normal outcomes, the notable rates of cesarean section, preterm birth, low Apgar scores, and stillbirth emphasize persistent vulnerabilities. The significant association between unbooked status and preterm delivery underscores the critical role of regular antenatal care. Strengthening adolescent-friendly health services, improving nutritional support, and promoting early and adequate prenatal supervision are essential to enhance fetomaternal outcomes in teenage pregnancies.

References

1. Ouyang F, Cheng X, Zhou W, He J, Xiao S. Increased mortality trends in patients with chronic non-communicable diseases and comorbid hypertension in the United States, 2000–2019. *Frontiers in Public Health*. 2022 Jul 11; 10:753861.
2. Carretero OA, Oparil S. Essential hypertension: part I: definition and etiology. *Circulation*. 2000 Jan 25;101(3):329-35.
3. Kalehoff JP, Oparil S. The story of the silent killer: a history of hypertension: its discovery, diagnosis, treatment, and debates. *Current Hypertension Reports*. 2020 Sep;22(9):72.
4. Zhou B, Perel P, Mensah GA, Ezzati M. Global epidemiology, health burden and effective interventions for elevated blood pressure and hypertension. *Nature Reviews Cardiology*. 2021 Nov;18(11):785-802.
5. Dziejak J, Zaleska-Żmijewska A, Szaflik JP, Cudnoch-Jędrzejewska A. Impact of arterial hypertension on the eye: a review of the

- pathogenesis, diagnostic methods, and treatment of hypertensive retinopathy. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*. 2022 Jan 20;28:e935135-1.
6. Dziędziak J, Zaleska-Żmijewska A, Szaflik JP, Cudnoch-Jędrzejewska A. Impact of arterial hypertension on the eye: a review of the pathogenesis, diagnostic methods, and treatment of hypertensive retinopathy. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*. 2022 Jan 20;28:e935135-1.
 7. Shiao T, Levin AV. Retinal hemorrhages in children: the role of intracranial pressure. *Archives of pediatrics & adolescent medicine*. 2012 Jul 1;166(7):623-8.
 8. Çalış Karanfil F, Karanfil M, Toklu Y. Association of nocturnal subconjunctival hemorrhage and non-dipper blood pressure pattern: A benign clue for serious diseases. *European Journal of Ophthalmology*. 2022 Sep;32(5):3043-9.
 9. Del Pinto R, Mulè G, Vadalà M, Carollo C, Cottone S, Agabiti Rosei C, De Ciuceis C, Rizzoni D, Ferri C, Muiesan ML. Arterial hypertension and the hidden disease of the eye: diagnostic tools and therapeutic strategies. *Nutrients*. 2022 May 25;14(11):2200.
 10. Erden S, Bicakci E. Hypertensive retinopathy: incidence, risk factors, and comorbidities. *Clinical and Experimental Hypertension*. 2012 Oct 1;34(6):397-401.
 11. Heiran A, Azarchehry SP, Dehghankhalili S, Afarid M, Shaabani S, Mirahmadizadeh A. Prevalence of diabetic retinopathy in the Eastern Mediterranean Region: a systematic review and meta-analysis. *Journal of International Medical Research*. 2022 Oct;50(10):03000605221117134.
 12. Kozikowska M, Luboń W, Kucharz E, Mrukwa-Kominek E. Ocular manifestations in patients with systemic sclerosis. *Reumatologia/Rheumatology*. 2020 Dec 23;58(6):401-6.
 13. Liew G, Xie J, Nguyen H, Keay L, Ikram MK, McGeechan K, Klein BE, Wang JJ, Mitchell P, Klaver CC, Lamoureux EL. Hypertensive retinopathy and cardiovascular disease risk: 6 population-based cohorts meta-analysis. *International Journal of Cardiology Cardiovascular Risk and Prevention*. 2023 Jun 1;17:200180.
 14. Bhargava M, Ikram MK, Wong TY. Ocular manifestations of hypertension. *Hipertensión y Riesgo Vascular*. 2012 Jul 1;29(3):96-105.
 15. Wong TY, Mitchell P. Hypertensive retinopathy. *New England Journal of Medicine*. 2004 Nov 25;351(22):2310-7.
 16. Suri MF, Qureshi AI. Hypertensive retinopathy and risk of cardiovascular diseases in a national cohort. *Journal of vascular and interventional neurology*. 2008 Jul;1(3):75.
 17. Kawasaki R, Xie J, Cheung N, Lamoureux E, Klein R, Klein BE, Cotch MF, Sharrett AR, Shea S, Wong TY, MESA*. Retinal microvascular signs and risk of stroke: the Multi-Ethnic Study of Atherosclerosis (MESA). *Stroke*. 2012 Dec;43(12):3245-51.
 18. Carollo C, Vadalà M, Sorce A, Sinatra N, Orlando E, Cirafici E, Bennici M, Polosa R, Bonfiglio VM, Mulè G, Geraci G. Relationship Between Renal Resistive Index and Retinal Vascular Density in Individuals with Hypertension. *Biomedicines*. 2025 Jan 28;13(2):312.