

## Main Causes and Treatments of Glaucoma Worldwide: A Brief Article Review

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**Citation:** Pugliese FR, Ruppen IC, Neves PVP, et al. Main Causes and Treatments of Glaucoma Worldwide: A Brief Article Review. *Medi Clin Case Rep J* 2025;3(1):659-660. DOI: doi.org/10.51219/MCCRJ/Fernanda-Romagnole-Pugliese/170

**Received:** 08 January, 2025; **Accepted:** 09 January, 2025; **Published:** 10 January, 2025

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### ABSTRACT

Glaucoma is one of the leading causes of irreversible blindness worldwide, affecting millions of people. It is characterized by a heterogeneous group of conditions that cause damage to the optic nerve, often associated with increased intraocular pressure (IOP). This article reviews the main causes of glaucoma, such as genetic factors, age and systemic conditions, as well as current treatments, including pharmacological therapies, laser procedures and surgeries. A global and interdisciplinary approach is essential for the effective prevention and management of the disease. Research highlights promising advances in personalized treatments and a deeper understanding of the underlying mechanisms of glaucoma, emphasizing the importance of public health strategies to reduce its prevalence.

**Keywords:** Glaucoma; Blindness; Irreversible; Neurodegenerative; Optic nerve

### Introduction

Glaucoma is a chronic neurodegenerative disease that represents a significant global public health challenge. According to the World Health Organization (WHO), it is estimated that 80 million people worldwide are affected by glaucoma, with projections indicating an increase due to population aging<sup>1,2</sup>. The primary hallmark of glaucoma is progressive damage to the optic nerve, leading to visual field loss and potentially progressing to irreversible blindness if not adequately treated.

Although elevated IOP is the main risk factor, many cases occur in individuals with normal intraocular pressure<sup>3</sup>, highlighting the disease's multifactorial complexity. Risk factors such as advanced age, family history, myopia, ethnic background and systemic conditions like diabetes and hypertension contribute to glaucoma susceptibility<sup>4</sup>. The disease can also be classified into different types, including open-angle glaucoma, angle-closure glaucoma, congenital glaucoma and secondary glaucoma, each with distinct pathophysiological mechanisms<sup>5</sup>. The primary

goal of glaucoma treatments is to reduce IOP to prevent further optic nerve damage<sup>6</sup>. Approaches include the use of eye drops, laser therapies and surgical procedures such as trabeculectomy and drainage devices<sup>7</sup>. Recently, research into neuroprotective therapies and regenerative medicine has shown significant advances in glaucoma management<sup>8</sup>.

## Objective

This study aims to analyze the main causes of glaucoma on a global scale and review current treatments, highlighting their effectiveness, limitations and barriers to access, with a focus on blindness prevention.

## Materials and Methods

This study consists of a bibliographic review based on articles indexed in the PubMed, Scopus and Web of Science databases.

## Discussion

Glaucoma is a multifactorial disease with widely studied but not fully understood causes. Among genetic factors, mutations in the MYOC gene, which encodes myocilin and the OPTN gene, related to optineurin, have been linked to hereditary forms of primary open-angle glaucoma (POAG). Population studies show that individuals of African descent are more predisposed to POAG, while primary angle-closure glaucoma (PACG) is more common in Asian populations. These racial factors underscore the importance of tailoring therapeutic approaches to population characteristics. Systemic risk factors such as diabetes and hypertension also play significant roles. Studies suggest that chronic hyperglycemia can damage retinal ganglion cells, contributing to optic neuropathy. Myopia, in turn, is associated with anatomical changes that increase glaucoma susceptibility. Additionally, factors such as corticosteroid exposure, intraocular inflammation and ocular trauma deserve attention as they can trigger secondary glaucoma cases<sup>9</sup>.

Significant advances have been made in pharmacological treatments. Prostaglandin analogs, such as latanoprost and bimatoprost, remain the first-line treatment due to their effectiveness in lowering IOP. However, adherence to treatment remains a challenge, primarily due to side effects and the need for daily application. Laser procedures, such as selective laser trabeculoplasty, offer minimally invasive solutions, especially for patient's intolerant to medications<sup>10</sup>. Recent studies suggest that laser trabeculoplasty can be an effective initial treatment option. In refractory cases, surgeries such as trabeculectomy and drainage devices remain the gold standard, although they carry risks like infections and hypotony<sup>11,12</sup>. An area of growing interest is neuroprotection. Therapies aimed at protecting retinal ganglion cells and the optic nerve have been explored in preclinical and clinical studies. Compounds such as citicoline and brimonidine show promising potential, though further research is needed for validation<sup>13</sup>. Despite advances, challenges persist. Low treatment adherence, particularly in low-income regions, limits the effectiveness of interventions. Additionally, the lack of early diagnosis remains a critical barrier<sup>14</sup>, as glaucoma is often asymptomatic in its early stages. Awareness campaigns and population screening can play a vital role in improving this scenario<sup>15</sup>.

## Conclusion

Glaucoma remains one of the most significant challenges

in ophthalmology, with profound implications for global public health. The causes of the disease are multifactorial, involving genetic, environmental and systemic factors that interact complexly to result in optic neuropathy. Advances in understanding these factors have enabled the development of more effective therapeutic approaches, though gaps remain to be addressed. Current treatments focus predominantly on IOP reduction, with pharmacological, laser and surgical options widely utilized. However, treatment adherence and lack of access to specialized care remain significant challenges. Additionally, the development of neuroprotective therapies represents a promising area with the potential to transform disease management. For the future, investing in early diagnosis and population screening strategies, particularly in underdeveloped regions, is essential. Public health policies ensuring equitable access to treatments and glaucoma education are crucial. Furthermore, scientific research should continue exploring new frontiers, including biomarker utilization and the application of artificial intelligence in disease diagnosis and monitoring. An integrated approach combining prevention, treatment and technological innovation will be essential to mitigate glaucoma's impact and improve patient quality of life worldwide.

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