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MYOPIA AS A RISK FACTOR FOR OPEN-ANGLE GLAUCOMA : A SYSTEMATIC REVIEW

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Abstract

Introduction: *In myopia, the eye has excessive light refraction power, refracting parallel rays in front of the retina when not accommodated. In myopia, the visual media focus is in front of the macula lutea. Too strong refraction, refractive myopia, or a lengthy eyeball can cause this. This condition produces long-distance hazy vision, or "nearsightness". Myopia is a natural eye growth variant that may or may not be inherited. Stress of accommodation and convergence and anomalies in the connective tissue linking the trabeculae cause myopia-related glaucoma.*

The aim: *This article showed myopia as a risk factor for open-angle glaucoma.*

Methods: *By comparing itself to the standards set by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, this study was able to show that it met all of the requirements. So, the experts were able to make sure that the study was as up-to-date as it was possible to be. For this search approach, publications that came out between 2013 and 2023 were taken into account. Several different online reference sources, like Pubmed and SagePub, were used to do this. It was decided not to take into account review pieces, works that had already been published, or works that were only half done.*

Result: *In the PubMed database, the results of our search brought up 78 articles, whereas the results of our search on SagePub brought up 72 articles. The results of the search conducted for the last year of 2013 yielded a total 32 articles for PubMed and 19 articles for SagePub. In the end, we compiled a total of 16 papers, 10 of which came from PubMed and six of which came from SagePub. We included five research that met the criteria.*

Conclusion: *Myopia has been identified as a potential risk factor for POAG and may also serve as a potential protective factor against the progression of POAG. The potential cause for the observed phenomenon could be attributed to the existence of myopia accompanied by a deficiency in the lamina cribrosa. This defect may contribute to a deceleration in the rate of visual field deterioration, as well as the advancement of POAG. Additional investigation into the underlying mechanisms is still required.*

Keyword: *Intraocular preassure; Myopia; Primary open-angle glaucoma; Visual field*

INTRODUCTION

The eye has a set of optical components that are able to refract light through it. The optical component is the lens system, consisting of the cornea, the aqueous humor in the anterior chamber, the lens, and the vitreous body in the posterior chamber. The refractive lens system is converging toward the retina. A normal eye is known as an emmetropic eye and will place the image of an object right on the retina when the eye does not accommodate or rest to see far. Punctum remotum (R) is the farthest point that can be seen without accommodation.[1]

Emmetropia (eyes without refractive errors) can be defined as a state of eye refraction, in which parallel rays from an infinite distance are focused right on the retina without accommodation. Ametropia (eye with refractive error) can be defined as a state of eye refraction, in which parallel rays from an infinite distance are focused in front of or behind the retina, on one or two meridians. Ametropia can be found in the form of myopia (nearsightedness), hypermetropia (farsightedness), and astigmatism. The word myopia is taken from the Greek "muopia" which means to close the eyes.[2]

Myopia is a condition in which the eye has excessive light refraction power so that parallel rays that come in are refracted in front of the retina, in conditions where the eye is not accommodated. In myopia, the focal point of the visual media is located in front of the macula lutea. This can be caused by the optical system (refraction) being too strong, refractive myopia or the eyeball being too long. This disorder causes blurry vision for long distances, popularly known as "nearsightness". Myopia is a normal biological variation of eye growth that may or may not be related to genetics.[2]

Study estimated 1,406 million people with myopia (22.9% of the world population; 95% confidence interval [CI] = 932–1,932 million [15.2%–31.5%]) and 163 million people with high myopia (2.7% of the world population; 95% CI = 86–387 million [1.4%–6.3%]) in 2000. They predict by 2050 there will be 4758 million people with myopia (49.8% of the world population; 3,620–6,056 million [95% CI = 43.4%–55.7%]) and 938 million people with high myopia (9.8% of the world population; 479–2,104 million [95% CI = 5.7%–19.4%]).[3,4]

The risk of developing glaucoma in normal eyes is 1.2%, in moderate myopia is 4.2%, and in high myopia is 4.4%.[3] Glaucoma in myopia occurs due to stress of accommodation and convergence and abnormalities in the structure of the connective tissue connecting the trabeculae. The multifactorial and progressive nature of primary open-angle glaucoma (POAG) optic nerve injury and visual field (VF) loss is well known.[5,6] Over the past two decades, many glaucoma factors have been studied. Intraocular pressure (IOP) is the key risk factor for glaucomatous optic neuropathy. Even in low-IOP individuals, a large IOP reduction slows disease progression.[7–9]

It has not yet been determined whether myopic changes influence glaucoma progression. In Asia, the prevalence of myopia has increased dramatically. Myopia-related structural alterations, such as elongated axial length, tilted optic disk, parapapillary atrophy (PPA), and thinning of the lamina cribrosa and parapapillary sclera, may influence glaucoma susceptibility. Numerous studies have concluded that myopia, typically measured in terms of spherical equivalent, plays no significant role in the progression of VF. Nonetheless, a few studies have identified a particular degree of myopia as a potential prognostic factor.[10,11] The present investigation demonstrated the myopia as a risk factor for open-angle glaucoma.

METHODS

In accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 standards, the researcher of this study undertook measures to assure strict adherence to these criteria. The adoption of this method is meant to ensure the correctness of the investigation's outcomes. The primary goal of this review was to demonstrate myopia as a risk factor for open-angle glaucoma. The fundamental goal of this work is to highlight the significance of the aforementioned issues discussed in the text.

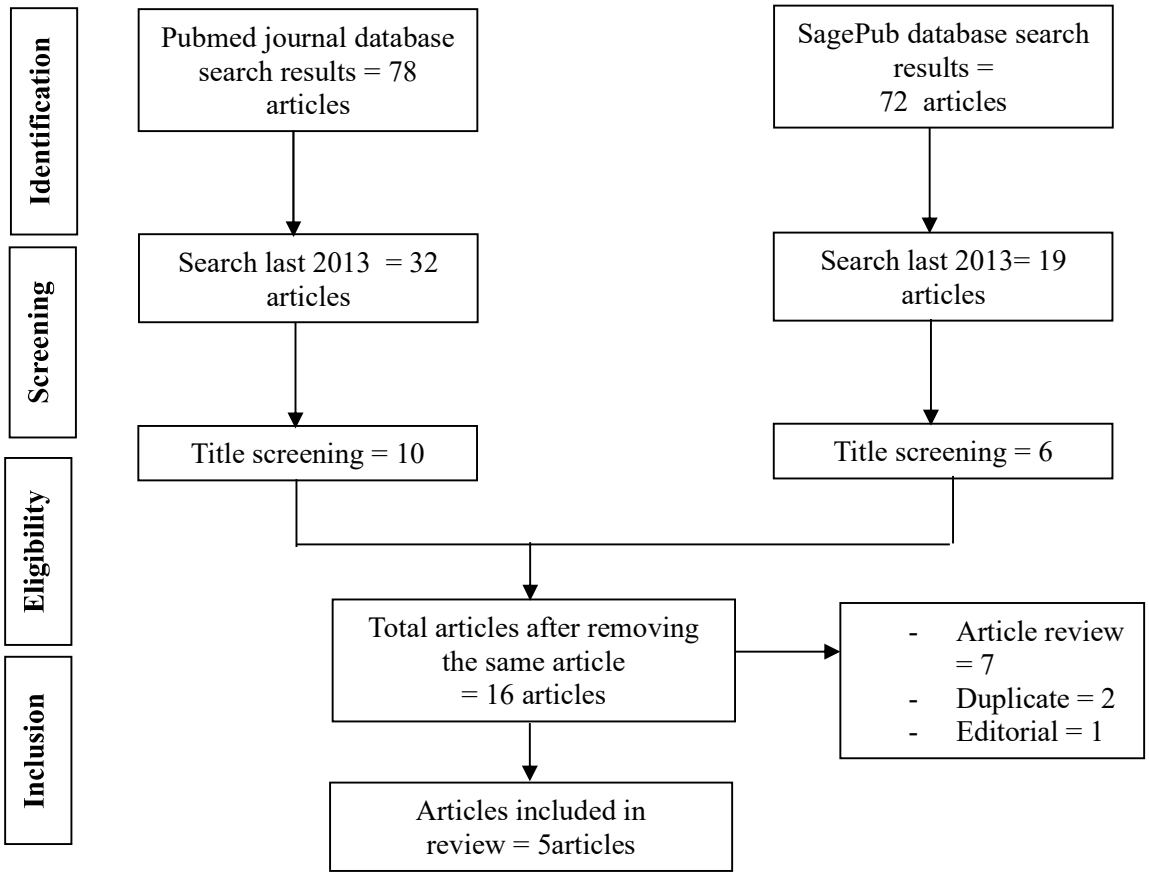

Figure 1. Article search flowchart

To be eligible for participation in the study, researchers had to meet the following criteria: the article's composition should be in English, and its focus should be on the myopia as a risk factor for open-angle glaucoma. Both of these criteria must be met by the paper in order for it to be published. A number of the articles under consideration were published between 2013 and the predetermined timeframe deemed relevant for this systematic review. Editorials, submissions without a Digital Object Identifier (DOI), previously published review articles, and entries that are effectively duplicates of previously published journal pieces are all disallowed.

We used "myopia" and "open-angle glaucoma" as keywords.The search for studies to be included in the systematic review was carried out from August, 9th 2023 using the PubMed and SagePub databases by inputting the words: ((("myopia"[MeSH Terms] AND ("open-angle glaucoma"[MeSH Terms] OR ("open"[All Fields] AND "angle"[All Fields] AND "glaucoma"[All Fields]) AND (clinicaltrial[Filter])) used in searching the literature.
The authors evaluated each study's abstract and title to determine if it me

The authors evaluated each study's abstract and title to determine if it met the inclusion criteria. The authors then determined which prior studies would serve as the article's sources and selected those studies. Numerous studies that appeared to indicate the same trend were analyzed in order to reach this conclusion. All submissions must be written in English and unpublished before submission. Only publications satisfying all inclusion criteria were considered for the systematic review. This reduces the number of search results to only those that are relevant to your query. We disregard any study's results that do not meet our criteria. The research findings will then be thoroughly analyzed.

This study's investigation revealed the following: names, authors, publication dates, location, study activities, and parameters. Before deciding which publications to investigate further, each author performed independent research on the research included in the publication's title and abstract. The subsequent step is to evaluate all of the articles that satisfy the inclusion criteria for the review. Then, we will choose which articles to include in the review based on the findings. This criterion is used to select documents for additional examination. To facilitate as much as possible the selection of papers for evaluation. This section discusses the prior studies conducted and the aspects of those studies that justified their inclusion in the review.

RESULT

In the PubMed database, the results of our search brought up 78 articles, whereas the results of our search on SagePub brought up 72 articles. The results of the search conducted for the last year of 2013 yielded a total 32 articles for PubMed and 19 articles for SagePub. In the end, we compiled a total of 16 papers, 10 of which came from PubMed and six of which came from SagePub. We included five research that met the criteria.

Yao, et al (2023)[12] conducted a study with 2,717,346 California Medicare beneficiaries in 2019, 1,440,769 (53.0%) were aged 65-74 years, 60,211 (2.2%) had myopia, and 171,988 (6.3%) had POAG. In adjusted logistic regression analyses, beneficiaries with myopia had higher odds of POAG compared with beneficiaries without myopia (odds ratio [OR] = 2.41; 95% CI = 2.35-2.47). In multivariable models stratified by race and ethnicity, the association between myopia and POAG was stronger in Asian (OR = 2.74; 95% CI = 2.57-2.92), Black (OR = 2.60; 95% CI = 2.31-2.94), and Hispanic (OR = 3.28; 95% CI = 3.08-3.48) beneficiaries compared with non-Hispanic White beneficiaries (OR = 2.14; 95% CI = 2.08-2.21).

Table 1. The litelature include in this study

Author	Origin	Method	Sample Size	Result
Yao, 2023[12]	United State of America	Cross sectional study	2,717,346 California Medicare beneficiaries	In the 2019 Medicare population of California, myopia was associated with increased odds of POAG. This association was stronger among Asian, Black, and Hispanic recipients than among non-Hispanic White recipients. These results suggest potential disparities in glaucoma risk by race and ethnicity among myopic individuals and may indicate a greater need for glaucoma screening among myopic individuals from racial and ethnic minority backgrounds.
Tham, 2016[13]	Singapore	Cross sectional	9,422 participants (18,469 eyes) in the Singapore Epidemiology of Eye Diseases Study	The aforementioned findings have the potential to offer further understanding regarding the pathogenesis of POAG, with a specific emphasis on its relevance among Asian populations.
Qiu, 2015[14]	China	Randomized controlled trial	270 eyes / 270 primary open-angle glaucoma (POAG)	There was a correlation between vertical cup-to-disk ratio (VCDR) and myopia and the visual field (VF) prognosis of primary open-angle glaucoma (POAG). There is some evidence that axial myopia acts as a barrier to the advancement of VF.
Vijaya, 2014[15]	India	Prospective cohort study	4316 subjects without POAG	A considerable segment of the population exhibited incident POAG. The utilization of baseline risk variables may aid in the identification of individuals who are at the greatest risk of developing a certain disease.
Pan, 2013[16]	Singapore	Cross-sectional study	3,400 Indians	Individuals with myopic eyes exhibit a reduced likelihood of developing age-related macular degeneration (AMD) and diabetic retinopathy (DR), while displaying an increased susceptibility to nuclear cataract, posterior subcapsular cataract (PSC), and POAG. The correlation between myopia and AMD, diabetic retinopathy (DR), and POAG can largely be attributed to the elongation of axial length (AL). Nevertheless, the correlation between myopia and nuclear cataract can be attributed to the refractive properties of the lens rather than the axial length.

Tham, et al (2016)[13] showed higher IOP, longer axial length and more negative spherical equivalent were independently associated with POAG, after adjusting for relevant covariates ($p \leq 0.005$). Significant interaction between IOP and myopia on POAG was observed ($P = 0.025$). Eyes with moderate-to-high myopia (<−3.0 dioptres) with high IOP (≥20 mmHg) were 4.27 times (95% CI = 2.10–8.69) likely to have POAG, compared to eyes without myopia (>[−0.5] dioptres) and

with IOP <20 mmHg. Eyes with AL of ≥25.5 mm and high IOP (≥20 mmHg) were 16.22 times (95% CI = 7.73 to 34.03) likely to have POAG, compared to eyes with shorter AL (<23.5 mm) and lower IOP (<20 mmHg).

Qiu, et al (2015)[14] conducted a study. For the 0.22 dB/y cutoff threshold, logistic regression revealed that VCDR (p = 0.004) and the degree of myopia (p = 0.004) were statistically significant. When logistic regression was repeated excluding the extent of myopia, axial length (p = 0.008, odds ratio [OR] = 0.796) and VCDR (p = 0.001) attained statistical significance. Compared to eyes with AL23 mm, the OR values for 23 <AL≤24 mm, 24 <AL≤25 mm, 25 <AL ≤26 mm, and AL>26 mm were 0.334 (p = 0.059), 0.309 (p = 0.044), 0.266 (p = 0.019), and 0.260 (p = 0.018), respectively. The significance of VCDR (p = 0.004) and the extent of myopia (p = 0.008) were unaffected by the 0.30dB/y cutoff threshold. Vijaya, et al (2014)[15] showed incident POAG developed in 129 subjects (2.9%; 95% CI = 2.4–3.4; male-to-female ratio = 65:64) in 6 years. Baseline age was a risk factor. In reference to the group 40 to 49 years of age, the incidence increased from 2.3 (95% CI = 1.4–3.7) for the group 50-59 years of age to 3.5 (95% CI = 2.2–5.7) for the group 60 to 69 years of age (P <0.001). Other baseline risk predictors were urban residence (OR = 1.6; 95% CI = 1.1–2.2; P = 0.01), higher IOP (OR = 2.0; 95% CI = 1.5–2.6/10 mmHg; P < 0.001), myopia (OR = 1.7; 95%, CI = 1.1–2.5; P < 0.001), and axial length (OR = 1.5; 95% CI = 1.0–2.2/mm; P = 0.03). Thinner corneas with higher IOP at baseline had the highest incidence of POAG. In 80% of the urban population and 100% of the rural population, incident glaucoma was previously undetected. Pan, et al (2013)[16] showed myopic eyes (spherical equivalent [SE] = <−0.5 D) were less likely to have AMD (early plus late AMD) (OR = 0.45; 95% CI = 0.25–0.79) or DR (OR = 0.68; 95% CI = 0.46–0.98) compared with emmetropic eyes; each millimeter increase in AL was associated with a lower prevalence of AMD (OR = 0.76; 95% CI = 0.65–0.89) and DR (OR = 0.73; 95% CI = 0.63–0.86). Myopic eyes were more likely to have nuclear (OR = 1.57; 95% CI = 1.13–2.20) and posterior subcapsular (OR = 1.73; 95% CI = 1.10–2.72) cataract, but not cortical cataract (P = 0.64); each millimeter increase in AL was associated with a higher prevalence of PSC (OR = 1.29; 95% CI = 1.07–1.55), but not nuclear (P = 0.77) or cortical (P = 0.39) cataract. Eyes with high myopia (SE <−6.0 D) were more likely to have POAG (OR = 5.90; 95% CI = 2.68–12.97); each millimeter increase in AL was associated with a higher prevalence of POAG (OR = 1.43; 95% CI = 1.13–1.80).

DISCUSSION

The pathogenesis of POAG is inadequately understood; an increase in intraocular pressure can be caused by an increase in aqueous humor secretion or a decrease in its outflow. For the initiating mechanisms of POAG, two main theories have been proposed: "the mechanical theory" and "the vascular theory". According to the mechanical theory, an elevated IOP compresses the structure in and around the optic nerve head, disrupting axoplasmic transport within nerve fibers. This results in the demise of RGCs and their axons, which causes neuroretinal rim thinning and excavation of optic nerve head.[17,18]

On the basis of this theory, reducing IOP would be an effective way to prevent further harm to the optic nerve system. Current evidence indicates that pharmacologic and surgical interventions to reduce intraocular pressure can delay the progression of visual field loss. According to the vascular theory, glaucomatous optic neuropathy is a result of inadequate blood supply due to elevated IOP or other factors that reduce ocular blood flow, such as high systemic blood pressure or vasospasm. Thus, although elevated IOP is still considered to be the primary risk factor for glaucoma, there is growing evidence that vascular risk factors play significant roles in the pathogenesis of glaucoma.[17]

Although the mechanisms underlying the association between glaucoma and myopia are inadequately understood, it has been hypothesized that the optic nerve head in myopic eyes may be structurally more vulnerable to glaucomatous damage due to changes in the structure and arrangement of connective tissue.[17] The increased risk of developing glaucomatous change may be related to the already reduced thickness of the retinal nerve fiber layer (RNFL) in myopic eyes, or the reduced RNFL thickness in myopia may be a risk factor for the development of glaucoma.[19]

Pathophysiologically, it is still not clear how axial myopia affects the outcome of VF. Changes in the size of the eye may affect the acrophase and the rise and fall of the IOP throughout the day. For every 1 mm Hg increase in IOP, an eyeball with a longer axial length may change less. Jeong et al (2014)[20] found a negative association between the increase in IOP in the usual position at night and the length of the axis. Compared to patients with slight myopia and non-myopia, those in the myopic group (3.0 D and axial length >24 mm) had a lower acrophase and a smaller range of 24-hour IOP changes. With less accumulated IOP damage and less lamina deformation, the optic nerve might not get hurt as quickly.

During the progression of the disease, myopic glaucoma patients may experience biomechanical changes in the lamina cribrosa and peripapillary sclera. Studies have shown that the biomechanical environment of the optic nerve and peripapillary sclera has a significant impact, and that sclera remodelling of the posterior sclera and lamina cribrosa occurs in glaucoma eyes.[21] By restricting the deformation of the sclera canal, the firmer structure may prevent additional glaucomatous damage. This lends credence to our hypothesis that the extent of nonpathological myopia may be correlated with sclera remodeling. The longer and wider eyes of mice suggest that a stiffer sclera may be resistant to glaucoma injury.[22–24]

CONCLUSION

Myopia has been identified as a potential risk factor for POAG and may also serve as a potential protective factor against the progression of POAG. The potential cause for the observed phenomenon could be attributed to the existence of myopia accompanied by a deficiency in the lamina cribrosa. This defect may contribute to a deceleration in the rate of visual field deterioration, as well as the advancement of POAG. Additional investigation into the underlying mechanisms is still required.

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