BioSCIENCE Original Article
DOI: https://doi.org/10.55684/2024.82.e00050

Myopia as a risk factor for primary open-angle glaucoma development

Miopia como fator de risco para desenvolvimento de glaucoma primário de ângulo aberto

Fernando Henrique de Carvalho **Katayama**[1], Daniel **Traumann**[1], Licia Deon **Weirich**[1], Cassio Tokuji **Tsujiguchi**[1], Clodomir Salgueiro Cordeiro de **Carvalho**[1], Marcos Solano **Vale**[1], Camila Marinelli **Martins**[2]

ABSTRACT

Introduction: Glaucoma is the leading cause of irreversible blindness in the world. It is known that myopia is an important risk factor for the development of glaucoma and, with the increasing incidence of myopia, this risk may increase.

Objective: To determine the influence of myopia on open-angle glaucoma.

Methods: Retrospective study through systematic review and collection of data from medical records between 2020-2023.

Results: The analysis includes data from 12,193 patients, 61.35% women and 38.5% men, with a mean age of 42±15.67 years; 79.91% had low myopia, 14.11% medium and 5.97% high; 24.49% had primary open-angle glaucoma. The frequency of glaucoma was higher in those with high myopia (29.12%; ci 1.07-1.36; p = 0.003), who were 1.21 times more likely to have glaucoma compared to patients with low myopia.

Conclusions: Patients with high myopia were more likely to have glaucoma compared to those with moderate and low myopia. This risk increased proportionally to the degree of myopia.

KEYWORDS: Primary open-angle glaucoma. Myopia. Epidemiology. Risk factor. Ophthalmology.

RESUMO

Introdução: Glaucoma é a principal causa de cegueira irreversível no mundo. Sabe-se que a miopia é fator de risco importante para o seu desenvolvimento e, com o aumento da incidência de miopia, esse risco pode aumentar.

Objetivo: Determinar a influência da miopia sobre o glaucoma de ângulo aberto.

Método: Estudo retrospectivo através de revisão sistemática e coleta de dados de prontuários entre 2020-2023.

Resultado: A análise inclui dados de 12.193 pacientes, sendo 61,35% de mulheres e 38,5% de homens, com idade média de 42 ± 15,67 anos; 79,91% apresentaram miopia baixa, 14,11% média e 5,97% alta; 24,49% apresentaram glaucoma primário de ângulo aberto. A frequência de glaucoma foi maior naqueles com miopia alta (29,12%; IC 1,07-1,36; p = 0,003), e que tiveram 1,21 vezes mais chance de ter glaucoma em comparação com os pacientes com miopia baixa.

Conclusões: Pacientes com miopia alta apresentam maior chance de ter glaucoma em relação aos com miopia moderada e baixa. Este risco aumentou proporcionalmente ao grau da miopia.

PALAVRAS-CHAVE: Glaucoma primário de ângulo aberto. Miopia. Epidemiologia. Fator de risco. Oftalmologia.

Central Message

Patients with high myopia have a higher chance of primary open-angle glaucoma compared to those with moderate and low. Each magnitude of myopia has a certain risk for its occurrence and it increases according to the degree of myopia. Current therapies fail to reverse glaucomatous damage to the visual system; however, with early diagnosis and appropriate treatment, it is possible to prevent the progression of the disease. This article seeks to verify the influence of myopia on open-angle glaucoma

Perspective

Through the analyses, it was shown that patients with high myopia have a higher chance of primary open-angle glaucoma compared to those with moderate and low myopia. This finding alerts to the need for greater medical attention to patients with high myopia, aiming at the prevention and early detection of primary open-angle glaucoma, bearing in mind that this is currently the main cause of irreversible blindness.

[1] *Hospital Dr. Prime, Cascavel, PR, Brazil;*
[2] *AAC&T Research Consulting LTD, Ponta Grossa, PR, Brazil.*

Conflict of interest: None | Funding: None | Received: 05/07/2024 | Accepted: 22/10/2024 | Correspondence: cientifico.aact@gmail.com | Associate Editor: Luiz Fernando Kubrusly

How to cite:
Katayama FHC, Traumann D, Weirich LD, Tsujiguchi CT, de Carvalho CSC, Vale MS, Martins CM. Miopia como fator de risco para desenvolvimento de glaucoma primário de ângulo aberto BioSCIENCE. 2024;82:e050

INTRODUCTION

Glaucoma is the leading cause of irreversible blindness around the world. The overall prevalence in people aged 40-80 years is estimated to be 3.5%. With the increase in life expectancy and consequent population aging, the number of people with glaucoma is estimated to reach 111.8 million by the year 2040. Current therapies fail to reverse glaucomatous damage to the visual system; however, with early diagnosis and proper treatment, it is possible to prevent the progression of the disease. In most cases, glaucoma is a chronic condition that requires lifelong treatment.[1]

It can be classified into open angle or closed angle according to the anatomy of the angle formed at the periphery of the anterior chamber. Each of them can be divided into primary and secondary, indicating the absence or presence of ocular or systemic causes.[2]

Glaucoma is a group of diseases that have a common end with progressive thinning of the nerve fiber layer and concomitant loss of ganglion cells. This structural loss eventually results in functional deficit that commonly affects peripheral vision, and ultimately central vision. In general, myopia has been associated with Primary Open-Angle Glaucoma (POAG); however, Primary Angle-Closure Glaucoma (PCAG) can still occur in myopic eyes, more rarely.[3]

Previous studies projected that in 2010 there would be 60.5 million people with POAG and PCAG, and 79.6 million in 2020, of which 74% would be POAG. Women would represent 55% of POAG cases, and 59% of all glaucoma cases.[4] On the other hand, myopia is a significant concern in the area of public health, since its prevalence has been steadily increasing worldwide. It is estimated that by 2050 the prevalence of myopia and high myopia will be approximately 5 billion and 1 billion people worldwide, respectively.[5]

The relationship between myopia and glaucoma has attracted substantial attention in recent years, as evidence suggests a strong association between these 2 ophthalmic conditions. It is not yet known exactly why myopia increases the risk of POAG, but it is known that myopic eyes have a larger axial diameter, causing greater deformity in the cribrious lamina, which could contribute to changes in the optic disc.[6] Understanding the link between myopia and POAG is of great clinical importance, as it can shed light on the underlying mechanisms, aid in early identification, and influence management strategies for both conditions.

Thus, the present study aims to analyze the epidemiological evidence of myopia and POAG in the population treated at a specialized hospital, seeking to determine the relationship between myopia and POAG as a risk factor for its development.

METHODS

This is a retrospective, descriptive, and cross-sectional study with data obtained through a systematic review of the medical records of patients treated at an ophthalmology hospital in Paraná, Brazil, providing public and private care, between January 1, 2020 and June 2, 2023. The study was approved by the Research Ethics Committee of the State University of Ponta Grossa, Ponta Grossa, PR, Brazil, under number 6.271.777/2023.

The study population included individuals over 18 years of age, of both sexes, diagnosed with POAG and presence of myopia. Medical records with well-documented myopia and POAG classification were included in the sample. Cases of secondary or angle-closure glaucoma were not included. Myopic patients were subdivided into low (>-3D), moderate (-3D to -6D) and high (<-6D) myopia.[5] Patients with POAG were those who had increased optic disc cavitation associated with damage seen by the visual field or optical coherence tomography (OCT) based on the information contained in the medical records (Figure).

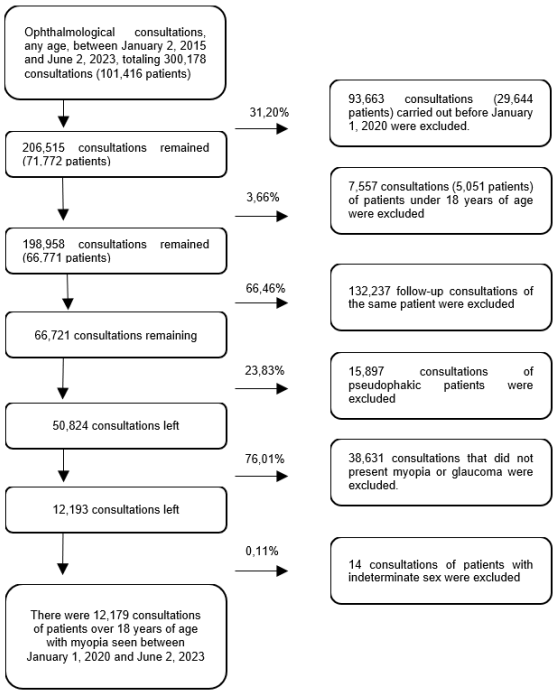

FIGURE — Patient selection flowchart performed by automatic evaluation of electronic medical records

For data collection, an automatic tool for extracting textual data from the R environment was used (R Core Team, 2021). Functions from the "tidyverse" package were used to evaluate the database, functions from the "dplyr" package were used to manipulate the database, and the "striprtf" package was used to extract texts in the patients' evolution.

Statistical analysis

Initially, a descriptive analysis of the data was performed with estimates of mean, median, standard deviation, 25-75% percentile, interquartile range, minimum and maximum of quantitative variables, and simple and relative frequencies of qualitative variables. To verify the association between the qualitative variables, the chi-square test was used, which was considered significant when $p < 0.05$, and the intensity of the

association was calculated with the odds ratio (OR) and 95% confidence interval. For quantitative variables, the Anderson-Darling test was performed. Stacked bar, line, and bar graphs were produced for easy visualization. All analyses were performed in the R 4.[1.0] environment.

RESULT

After applying the exclusion criteria, a total of 12,193 patients were included, of which 61.43% were women and 38.57% were men. The mean age of 42 ± 15.67 years; 79.90% had low myopia, 14.12% medium and 5.98% high; 24.49% had POAG.

Table 1 shows the distribution of patients with POAG according to the level of myopia, demonstrating that the frequency of POAG was higher in patients with high myopia (29.12%; CI 1.07-1.36; p = 0.003), and that these patients were 1.21 times more likely to have POAG compared to patients with low myopia.

No statistical significance was observed in the comparison between genders and the presence of POAG. In relation to the age group, the frequency of POAG was higher in those over 50 years of age (p <0.001), and those aged 60 years or older were 1.74 times more likely to have POAG (Table 2).

Although there was no statistically significant difference between genders and the presence of POAG, when comparing the presence of it according to gender and myopia level, a higher frequency was found in men with high myopia (p = 0.002), with a chance of having POAG of 1.34 (Table 3).

In the comparison between age groups, only patients in the 30-39 years age category and with high myopia showed statistical significance (p = 0.029) for the presence of POAG. The chance of having POAG in these patients was 1.38 times that of individuals with low myopia in the same age group (Table 4).

TABLE 1 — Presence of glaucoma and OR according to myopia level

Variable		No POAG			With POAG			OR	CI (95%)	p-value
		n	lin %	col %	n	lin %	col %			
Myopia level	Low	7383	75,87	80,28	2348	24,13	78,71	Ref	-	-
	Moderate	1297	75,41	14,10	423	24,59	14,18	1,02	0,93 - 1,12	0,679
	High	516	70,88	5,61	212	29,12	7,11	1,21	1,07 - 1,36	0,003

Chi-square test; n = absolute frequency; lin % = relative frequency; OR = odds ratio; CI (95%) = 95% confidence interval.

TABLE 2 — Presence of POAG according to gender and age group

Variable		No POAG			With POAG			OR	CI (95%)	p-value
		n	lin %	col %	n	lin %	col %			
Sex	Female	5686	76,01	61,83	1795	23,99	60,17	Ref	-	-
	Male	3510	74,71	38,17	1188	25,29	39,83	1,05	0,99 - 1,12	0,106
Age group	19 to 29 years old	2459	79,30	26,74	642	20,70	21,52	Ref	-	-
	30 to 39 years old	2246	79,76	24,42	570	20,24	19,11	0,98	0,88 - 1,08	0,660
	40 to 49 years old	2095	77,22	22,78	618	22,78	20,72	1,10	1,00 - 1,21	0,055
	50 to 59 years old	1248	71,03	13,57	509	28,97	17,06	1,40	1,27 - 1,55	<0.001
	60 years or older	1148	64,06	12,48	644	35,94	21,59	1,74	1,58 - 1,90	<0.001

*Chi-square test; n = absolute frequency; col % = relative frequency.

TABLE 3 — Presence of glaucoma according to sex by level of myopia

Variable			No POAG			n	With POAG				
		Myopia level	n	lin %	col %		lin %	col %	OR	CI (95%)	p-value
Sex	Female	Low	4527	76,12	79,62	1420	23,88	79,11	Ref	-	-
		Moderate	839	76,41	14,76	259	23,59	14,43	0,99	0,88 - 1,11	0,836
		High	320	73,39	5,63	116	26,61	6,46	1,11	0,95 - 1,31	0,198
	Male	Low	2856	75,48	81,37	928	24,52	78,11	Ref	-	-
		Moderate	458	73,63	13,05	164	26,37	13,80	1,08	0,93 - 1,24	0,324
		High	196	67,12	5,58	96	32,88	8,08	1,34	1,13 - 1,60	0,002

*Chi-square test; n = absolute frequency; lin % = relative frequency; OR = odds ratio; CI (95%) = 95% confidence interval

TABLE 4 — Presence of POAG according to age group by level of myopia

Variable		Myopia level	No POAG			With POAG			OR	CI (95%)	p-value
			n	lin %	col %	n	lin %	col %			
Age group in years	19-29	Low	1811	79,60	73,65	464	20,40	72,27	Ref	-	-
		Moderate	474	79,26	19,28	124	20,74	19,31	1,02	0,85 - 1,21	0,854
		High	174	76,32	7,08	54	23,68	8,41	1,16	0,91 - 1,49	0,243
	30-39	Low	1801	80,44	80,19	438	19,56	76,84	Ref	-	-
		Moderate	340	78,52	15,14	93	21,48	16,32	1,10	0,90 - 1,34	0,360
		High	105	72,92	4,67	39	27,08	6,84	1,38	1,05 - 1,83	0,029
	40-49	Low	1781	77,50	85,01	517	22,50	83,66	Ref	-	-
		Moderate	211	76,73	10,07	64	23,27	10,36	1,03	0,82 - 1,30	0,771
		High	103	73,57	4,92	37	26,43	5,99	1,17	0,88 - 1,56	0,281
	50-59	Low	1044	71,56	83,65	415	28,44	81,53	Ref	-	-
		Moderate	134	70,16	10,74	57	29,84	11,20	1,05	0,83 - 1,32	0,688
		High	70	65,42	5,61	37	34,58	7,27	1,22	0,93 - 1,60	0,176
	60 or more	Low	946	64,79	82,40	514	35,21	79,81	Ref	-	-
		Moderate	138	61,88	12,02	85	38,12	13,20	1,08	0,90 - 1,30	0,398
		High	64	58,72	5,57	45	41,28	6,99	1,17	0,93 - 1,48	0,201

*Chi-square test; n = absolute frequency; lin % = relative frequency; OR = odds ratio; CI (95%) = 95% confidence interval.

DISCUSSION

The study provides data that demonstrate how the prevalence of POAG was present in the population and period studied, evaluating in which gender and age group it was more expressive, as well as the relationship with the level of myopia of the patients.

A higher occurrence of POAG was observed in women, which agrees with data found in the literature, that women have more visual problems of any type and a higher prevalence of glaucoma.[7] Data from the World Health Organization suggests that the risk of visual problems of any kind is 2 times higher in women than in men in any region of the world.[8] Another study suggests that women have a higher risk of PCAG, but no predilection for sex for the development of POAG, and emphasizes that women have greater longevity, increasing the risk of developing POAG due to age.[9] There are reports that reduced estrogen exposure may be associated with the development of POAG, as women who entered menopause early - before the age of 45 - have a 2.[6-fold] increased risk of developing POAG compared to those who entered menopause after age 50.[10] On the other hand, the Ocular Hypertension Treatment Study (OHTS) indicates the male gender in univariate analysis as a useful predictor for the onset of POAG.[11]

The statistical analysis showed a positive association between the degree of myopia and the occurrence of glaucoma, since patients with high myopia were more likely to develop POAG compared to the moderate and low myopia group. These findings are consistent with the study published in the Beijing Eye Study, in which the frequency of glaucomatous optic neuropathy was higher in the myopia group than in the other groups studied, and this association was even greater in the group with high myopia than in the group with moderate or low, and even lower in the group with hyperopia or emmetropia.[12]

There are reports in the literature of a positive association between POAG and myopia, considering age and level of refractive error. Studies show that the prevalence of POAG increases with age, as well as the prevalence of many other health problems tend to increase with the individual's frailty.[9] The risk of POAG in young people and those with high myopia is higher than in older people, and the prevalence of POAG is higher in the groups under 60 years of age.[13] This information corroborates the findings of the present study, in which patients in the age group of 30-39 years and with high myopia are more likely to have POAG.

Thus, the findings of the present study can serve as a warning for the need for greater attention by clinical professionals to patients with high myopia, aiming at the prevention and early detection of open POAG, considering that this is currently the main cause of irreversible blindness.

CONCLUSION

Patients with high myopia have a higher chance of POAG than those with moderate and low. Each magnitude of myopia had its own risk for the occurrence of POAG, and this risk increased with the degree of myopia. No statistically significant difference was found between the sexes and the presence of POAG. Regarding the age group, the frequency of POAG was higher in patients over 50 years of age, and those aged 60 years or older were more likely to have POAG.

Authors' contributions

Conceptualization: Fernando Henrique de Carvalho Katayama; Camila Marinelli Martins.

Methodology: Fernando Henrique de Carvalho Katayama; Camila Marinelli Martins.

Formal analysis: All authors.

Writing (proofreading and editing): All authors

REFERENCES

1. Tham YC, Li X, Wong TY, Quigley HA, Aung T, Cheng CY. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. Ophthalmology. 2014;121(11):2081-90. https://doi.org/10.1016/j.ophtha.2014.05.013
2. Kang JM, Tanna AP. Glaucoma. Med Clin North Am. 2021;105(3):493-510. https://doi.org/10.1016/j.mcna.2021.01.004
3. Chang RT. Myopia and Glaucoma. Int Ophthalmol Clin. 2011;51(3):53-63. https://doi.org/10.1097/IIO.0b013e31821e5342
4. Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. Br J Ophthalmol. 2006;90(3):262-7. https://doi.org/10.1136/bjo.2005.081224
5. Ha A, Kim CY, Shim SR, Chang IB, Kim YK. Degree of Myopia and Glaucoma Risk: A Dose-Response Meta-analysis. Am J Ophthalmol. 2022;236:107-19. https://doi.org/10.1016/j.ajo.2021.10.007
6. Marcus MW, de Vries MM, Montolio FGJ, Jansonius NM. Myopia as a Risk Factor for Open-Angle Glaucoma: A Systematic Review and Meta-Analysis. Ophthalmology. 2011;118(10):1989-94. https://doi.org/10.1016/j.ophtha.2011.03.012
7. Vajaranant TS, Nayak S, Wilensky JT, Joslin CE. Gender and glaucoma: what we know and what we need to know. Curr Opin Ophthalmol. 2010;21(2):91-9. https://doi.org/10.1097/ICU.0b013e3283360b7e
8. Resnikoff S, Pascolini D, Etya'ale D, Kocur I, Pararajasegaram R, Pokharel GP, et al. Global data on visual impairment in the year 2002. Bull World Health Organ. 2004;82(11):844-51.
9. McMonnies CW. Glaucoma history and risk factors. J Optom. 2017;10(2):71-8. https://doi.org/10.1016/j.optom.2016.02.003
10. Lee AJ, Mitchell P, Rochtchina E, Healey PR. Female reproductive factors and open angle glaucoma: the Blue Mountains Eye Study. Br J Ophthalmol. 2003;87(11):1324-8. https://doi.org/10.1136/bjo.87.11.1324
11. Gordon MO, Beiser JA, Brandt JD, Heuer DK, Higginbotham EJ, Johnson CA, et al. The Ocular Hypertension Treatment Study: baseline factors that predict the onset of primary open-angle glaucoma. Arch Ophthalmol. 2002;120(6):714-20. https://doi.org/10.1001/archopht.120.6.714
12. Xu L, Wang Y, Wang S, Wang Y, Jost SB. High myopia and glaucoma susceptibility the Beijing Eye Study. Ophthalmology. 2007;114(2):216-20. https://doi.org/10.1016/j.ophtha.2006.06.050
13. Shim SH, Sung KR, Kim JM, Kim HT, Jeong J, Kim CY, et al. The Prevalence of Open-Angle Glaucoma by Age in Myopia: The Korea National Health and Nutrition Examination Survey. Curr Eye Res. 2017;42(1):65-71. https://doi.org/10.3109/02713683.2016.1151053