



Evaluation of the Association of Senile Macular Degeneration in Patients with Glaucoma

Ulku Demir,¹ Pelin Nazli Gunturkun,² Pembegul Bozgul³

¹Department of Ophthalmology, Inonu University Faculty of Medicine, Malatya, Türkiye

²Department of Ophthalmology, Sivas Numune Hospital, Sivas, Türkiye

³Department of Ophthalmology, Kayseri City Hospital, Kayseri, Türkiye

Abstract

Objectives: The aim of the study was to evaluate the incidence of senile macular degeneration (SMD) in patients with primary open-angle glaucoma (POAG) and pseudoexfoliation glaucoma (PEG).

Methods: The medical files of 2600 patients with glaucoma were analyzed. In this study, 168 patients (90 females and 78 males) with POAG and PEG were included. Patients diagnosed with POAG and PEG with SMD were also recorded. SMD was classified in two categories: Wet type and dry type. Lens status was classified as pseudophakic and phakic. Glaucoma severity was classified according to the Hodapp-Parrish-Anderson criteria. All patients underwent complete ophthalmologic examinations.

Results: Ninety (53.57%) patients were female, and 78 (46.43%) were male. The mean age was 63 ± 8.4 years for women and 66.5 ± 7.8 years for men. Sixty-six (73.3%) of women and 60 (76.9%) of men had POAG, 24 (26.7%) of women and 18 (23.1%) of men had PEG. 18 (20.0%) right and 25 (27.8%) left eyes of women and 30 (38.5%) right and 24 (30.8%) left eyes of men were pseudophakic, 72 (80.0%) right and 65 (72.2%) left eyes of women and 48 (61.5%) right and 54 (69.2%) left eyes of men were phakic. SMD was observed in 10 patients (5.95%); four women and five men had dry-type SMD, while one man had wet-type SMD.

Conclusion: In our study, when gender, age, severity of glaucoma, pseudophakic and phakic status of the lens were evaluated in patients with the association of glaucoma and SMD, these variables had no statistically significant effect on the association of glaucoma and SMD.

Keywords: Cataract, primary open-angle glaucoma, pseudoexfoliation glaucoma, senile macular degeneration

How to cite this article: Demir U, Nazli Gunturkun P, Bozgul P. Evaluation of the association of senile macular degeneration in patients with glaucoma. *Beyoglu Eye J* 2026; 11(1): 42-49.

Address for correspondence: Pembegul Bozgul, MD. Department of Ophthalmology, Kayseri City Hospital, Kayseri, Türkiye
Phone: +90 533 147 44 25 **E-mail:** pembegulbozgul@gmail.com

Submitted Date: August 10, 2025 **Revised Date:** November 22, 2025 **Accepted Date:** December 28, 2025 **Available Online Date:** March 31, 2026

Beyoglu Eye Training and Research Hospital - Available online at www.beyoglueye.com

OPEN ACCESS This is an open access article under the CC BY-NC license (<http://creativecommons.org/licenses/by-nc/4.0/>).



Introduction

Glaucoma is a chronic optic neuropathy characterised by progressive degeneration of retinal ganglion cells, leading to visual field loss. Primary open-angle glaucoma (POAG) is the most common type of glaucoma. The etiology of POAG is multifactorial, and the exact cause is unknown. Vascular changes leading to perfusion disorders in the peripapillary region and optic nerve head are thought to be responsible for the pathogenesis of POAG. Risk factors for glaucoma include family history, ethnicity, advanced age, high intraocular pressure, thin cornea, high myopia, Type 2 diabetes, hypertension, oxidative stress, apoptosis, inflammation, and autoimmunity (1-8).

Pseudoexfoliation syndrome (PES) is a critical cause of glaucoma worldwide. It is an age-related systemic disorder caused by the production and accumulation of an abnormal fibrillar extracellular substance. It is characterised by the deposition of small grey-white deposits in the eye, most commonly at the pupillary margin and on the anterior capsule of the lens and trabecular meshwork. It often leads to the development of pseudoexfoliation glaucoma (PEG), which causes progressive and irreversible visual loss (2,6,7,9).

Senile macular degeneration (SMD) is a progressive degenerative eye disease that causes severe and irreversible vision loss involving the central part of the retina where the macula is located. It is a critical cause of blindness worldwide, affecting 196 million people. By 2040, it is expected to affect 288 million people. SMD is a complex, multifactorial disease. Risk factors include genetic predisposition, advanced age (≥ 65 years), family history, smoking, hyperlipidemia, hypertension, oxidative stress, environmental factors, and diet (1,10-13). Retinal pigment epithelium, photoreceptor cells, choriocapillaris, and Bruch's membrane are affected. Clinically, it is divided into two forms. The atrophic form accounts for 85% of the patients and the exudative form accounts for 15% (2). As the eye ages, cellular debris from the retinal pigment epithelium accumulates between Bruch's membrane and the neurosensory layer. These deposits, known as drusen, are the first ophthalmoscopic findings seen in SMD. Drusen are structures composed of lipids, proteins, and carbohydrates. Dry SMD is characterised by progressive loss of visual function due to deterioration of the choriocapillaris, atrophic loss of the outer retina, and deterioration and eventual death of the photoreceptor layer. Geographic atrophy is the most advanced form of dry-type SMD. In wet-type SMD, subretinal or intraretinal neovascularization occurs, and when these new blood vessels infiltrate, it may cause fluid accumulation, hemorrhages, and fibrosis (10,12,14). According to the clinical classification by Ferris et al., (15) if there are no drusen or pigment abnormalities in the fundus, there is no SMD. In late SMD, neovascular SMD and/or geographic atrophy are observed.

Both glaucoma and SMD cause progressive and irreversible vision loss in older patients. These are complex, multifactorial diseases that can significantly impact patients' daily activities and quality of life. Understanding the relationship between glaucoma and SMD is important for identifying the underlying pathological mechanisms and improving prognosis. This study aims to evaluate the incidence of SMD association in patients with POAG and PEG.

Methods

The files of 2600 glaucoma patients who were followed and treated at Inonu University Faculty of Medicine, Department of Ophthalmology, between January 2019 and December 2024 were retrospectively analyzed, and 168 patients with POAG and PEG were included in this study. Patients diagnosed with POAG and PEG with SMD were also recorded. Approval protocol number: 2024/6601 was obtained on December 17, 2024, from the Ethics Committee of Inonu University Faculty of Medicine. This study was conducted in accordance with the Declaration of Helsinki.

In this study, 90 female and 78 male patients with POAG and PEG were included in the study. The mean age of female patients was 63 ± 8.4 years, and the mean age of male patients was 66.5 ± 7.8 years. SMD was classified as a wet type and a dry type. Lens status was classified as pseudophakic and phakic. The severity of glaucoma was classified as early stage (mean deviation [MD] ≤ 6 dB), intermediate stage (MD -6 dB -12 dB), and advanced stage (MD ≥ 12 dB) according to MD values and glaucomatous visual field defect according to Hodapp-Parrish-Anderson criteria (16).

All patients underwent complete ophthalmological examinations, including best-corrected visual acuity, slit-lamp biomicroscopy, fundus examination with a +90D lens after pharmacological dilatation, intraocular pressure measurement with Goldmann applanation tonometry, gonioscopy, optical coherence tomography (OCT) (DRI OCT Triton; Topcon Inc., Tokyo, Japan), color fundus photography, fundus fluorescein angiography (TRC-50DX; Topcon Inc., Tokyo, Japan), and Humphrey (Humphrey-Zeiss Systems, Dublin, CA, USA) 30-2 static threshold perimetry. Patients under 50 years of age, patients with retinal disease, diabetic retinopathy, hypertensive retinopathy, hyperlipidemia, vascular occlusions, infection, uveitis, nonglaucomatous optic neuropathy, neurological or other neuro-ophthalmic diseases, history of chronic drug use, eye surgery other than cataract surgery, ocular trauma, degenerative myopia and ocular laser history within the last 3 months were excluded from this study.

Glaucomatous optic nerves were defined as a cup-to-disc ratio ≥ 0.6 and/or asymmetry of the optic nerve cup-to-disc ratio between both eyes >0.2 (17). Typical glaucomatous visual field defects detected by the Humphrey automated

perimetry 30-2 program, according to the Anderson criteria, were recorded. For Humphrey visual fields, false positive, false negative, and loss-of-fixation rates of fewer than 33% were considered.

Statistical Analysis

Gender, age, type of glaucoma, type of SMD, the severity of glaucoma, lens status, and differences of all variables according to gender were analyzed by chi-square analysis. The correlations between glaucoma type and gender, age, and SMD; between glaucoma severity and gender, age, and SMD; and between lens condition and gender, age, and SMD were analyzed using Pearson correlation. The effect of gender, age, type of SMD, the severity of glaucoma, lens condition (dependent variables) on the type of glaucoma (independent variable) was analyzed by regression analysis. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 27.0 software (IBM SPSS Corporation, Chicago, USA). Statistical significance was accepted as $p \leq 0.05$.

Results

Ninety (53.57%) patients were female, and 78 (46.43%) were male. The mean age of the women was 63 ± 8.4 years, and the mean age of the men was 66.5 ± 7.8 years. When the type of glaucoma was analyzed, 66 (73.3%) of the women and 60 (76.9%) of the men had POAG, 24 (26.7%) of the women and 18 (23.1%) of the men had PEG. 18 (20.0%) right and 25 (27.8%) left eyes of women and 30 (38.5%) right and 24 (30.8%) left eyes of men were pseudophakic, 72 (80.0%) right and 65 (72.2%) left eyes of women and 48 (61.5%) right and 54 (69.2%) left eyes of men were phakic. In patients diagnosed with SMD, only dry type was observed in four women, while dry-type SMD was observed in five men, and wet-type SMD was observed in one man. According to the severity of glaucoma, 65 (72.7%) women and 43 (55.1%) men were diagnosed with early-stage glaucoma, 13 (14.4%) women and 13 (16.7%) men with intermediate stage, and 12 (13.3%) women and 22 (28.2%) men with advanced stage in the right eye. In the left eye, there were 61 (67.8%) women and 49 (62.8%) men diagnosed with early stage, 8 (8.9%) women and 11 (14.1%) men diagnosed with intermediate stage, and 21 (23.3%) women and 18 (23.1%) men diagnosed with advanced stage (Table 1).

Age, type of glaucoma, lens status in the left eye, type of SMD in patients with SMD, and severity of glaucoma in the left eye were not statistically significantly different according to gender ($p > 0.05$). However, lens status in the right eye ($p = 0.008$) and severity of glaucoma ($p = 0.037$) were statistically significant according to gender ($p \leq 0.05$). The number of women who were diagnosed with early-stage glaucoma in the right eye and who were phakic was higher (Table 1). There was a statistically significant difference in the severity of glau-

Table 1. Demographic and clinical characteristics of the patients

Variables	n	%	P
Gender			
Woman	90	53.57	-
Male	78	46.43	
Age \pm standard deviation			
Woman	63 ± 8.4	-	0.085
Male	66.5 ± 7.8		
Type of glaucoma			
Woman			0.592
POAG	66	73.3	
PEG	24	26.7	
Male			
POAG	60	76.9	
PEG	18	23.1	
Lens status of right eye			
Woman			0.008*
Pseudophakic	18	20.0	
Phakic	72	80.0	
Male			
Pseudophakic	30	38.5	
Phakic	48	61.5	
Lens status of left eye			
Woman			0.671
Pseudophakic	25	27.8	
Phakic	65	72.2	
Male			
Pseudophakic	24	30.8	
Phakic	54	69.2	
Patients diagnosed with SMD			
Woman			1.000
Dry type	4	100.0	
Wet type	0	0.0	
Male			
Dry type	5	83.3	
Wet type	1	16.7	
Glaucoma severity of right eye			
Woman			0.037*
Early stage	65	72.2	
Middle stage	13	14.4	
Advanced stage	12	13.3	
Male			
Early stage	43	55.1	
Middle stage	13	16.7	
Advanced stage	22	28.2	

Table 1. Continue

Variables	n	%	P
Glaucoma severity of left eye			
Woman			0.559
Early stage	61	67.8	
Middle stage	8	8.9	
Advanced stage	21	23.3	
Male			
Early stage	49	62.8	
Middle stage	11	14.1	
Advanced stage	18	23.1	

$P < 0.05$. SMD: Senile macular degeneration, POAG: Primary open-angle glaucoma, PEG: Pseudoexfoliation glaucoma.

coma in the right eye. For this difference between the right and left eye, it is thought that other factors that could affect the right and left eyes, such as differences in blood flow at the optic nerve head, should be investigated in new studies.

In our study, there were 10 patients, six males (60.0%) and four females (40.0%), who had SMD with glaucoma type. The mean age of the patients was 72.70 ± 11.02 years. There were six patients (60.0%) with POAG and four patients (40.0%) with PEG, nine patients (90.0%) with dry-type SMD, and one patient (10.0%) with wet-type SMD. There was no correlation between age, gender, glaucoma type, and SMD type ($p > 0.05$) (Table 2).

Table 2. Correlation between type of glaucoma and type of concomitant SMD disease, gender and age variables

Variables	Gender	Age	Type of glaucoma	SMD type
Gender				
r	1			
P				
Age				
r	0.336	1		
P	0.343			
Type of glaucoma				
r	0.167	0.433	1	
P	0.645	0.211		
SMD type				
r	-0.272	0.488	-0.272	1
P	0.447	0.153	0.447	

Pearson correlation method was used to analyze the correlation between gender and age variables in patients with SMD with glaucoma. SMD: Senile macular degeneration.

When the severity of glaucoma, type of SMD, gender, and age characteristics of the patients with glaucoma and SMD were analyzed, there were four (40.0%) patients with early-stage glaucoma, two (20.0%) with intermediate stage, and four (40.0%) with advanced stage in the right eye. In the left eye, there were two (20.0%), 5 (50.0%), and three (30.0%) patients with early, intermediate, and advanced glaucoma, respectively. There was no correlation between the severity of glaucoma in the right and left eye, the type of concomitant SMD, gender, and age variables ($p > 0.05$) (Table 3).

When the lens status in the right and left eye, SMD type, gender, and age characteristics of the patients diagnosed with glaucoma. SMD were analyzed; there were seven (70.0%) patients diagnosed with pseudophakia in the right eye and three (30.0%) with phakia. In the left eye, 7 (70.0%) patients were diagnosed as pseudophakic and 3 (30.0%) as phakic. A statistically significant high-level positive correlation was found between age and lens status (Pseudophakic/Phakic) in the right eye ($p \leq 0.05$). No correlation was found between other variables ($p > 0.05$) (Table 4).

In our study, multiple linear regression analysis was performed to examine the effect of gender, age, severity of glaucoma and lens status on the diagnosis of glaucoma and SMD.

Table 3. Correlation between the severity of glaucoma in the right and left eye, type of SMD, gender and age variables

Variables	Gender	Age	Severity of glaucoma right eye	Severity of glaucoma left eye	SMD type
Gender					
r	1				
P					
Age					
r	0.336	1			
P	0.343				
Severity of glaucoma right eye					
r	-0.228	0.395	1		
P	0.526	0.258			
Severity of glaucoma left eye					
r	0.055	0.455	0.299	1	
P	0.881	0.187	0.402		
SMD type					
r	-0.272	0.488	0.373	0.356	1
P	0.447	0.153	0.289	0.312	

Pearson's correlation method was used to analyze the correlation between the severity of glaucoma in the right and left eye, the type of concomitant SMD, gender and age variables. SMD: Senile macular degeneration.

Table 4. Correlation between lens status in the right and left eye, concomitant SMD type, gender and age variables

	Gender	Age	Lens condition right eye	Lens condition left eye	SMD type
Gender					
r	1				
P					
Age					
r	0.336	1			
P	0.343				
Lens status right eye					
r	-0.167	0.660*	1		
P	0.645	0.038			
Lens status left eye					
r	0.250	0.562	0.583	1	
P	0.486	0.091	0.077		
SMD type					
r	-0.272	0.488	0.272	0.272	1
P	0.447	0.153	0.447	0.447	

Pearson correlation method was used to look at the correlation relationship between the variables of lens status in the right and left eye, type of SMD seen together, gender and age. SMD: Senile macular degeneration.

When variance inflation factor values were analyzed, it was seen that they were <10, and there was no multi-connection problem. The regression model was found to be statistically significant ($p=0.043z0.05$). This model examines the factors (fixed variables) that influence the diagnosis of glaucoma and SMD (dependent variable). These fixed variables were determined to be gender, age, right eye glaucoma severity,

left eye glaucoma severity, right eye lens status, and left eye lens status. 7.7% of the variation in the glaucoma and SMD diagnosis variable can be explained by these fixed variables. In the established model, except for the constant coefficient, other variables did not have a statistically significant effect on the diagnosis of glaucoma and SMD ($p>0.05$) (Table 5).

Discussion

Glaucoma and SMD are prevalent vision-threatening diseases whose incidence increases with advancing age. There are many common underlying mechanisms in the development of glaucoma and SMD. Mitochondrial dysfunction, inflammation, oxidative stress, and the accumulation of damaged molecules are reported as key mechanisms. The pathogenesis of SMD is not fully understood, but the currently accepted hypothesis is that metabolic and mitochondrial dysfunction are the main triggers of the disease. The pathogenesis of glaucoma is much better understood than that of SMD. It is caused by a disturbed balance between the aqueous humor production in the ciliary body and its outflow (4,7,8,14,18-20). PES is an age-related systemic disease characterized by the deposition of fibrillar protein aggregates called pseudoexfoliation fibrils on the tissue surfaces of the anterior and posterior segments of the eye. The early stage of the disease is called PES, and the more severe stage is called PEG.^[21] There was no difference in age according to gender in the glaucoma patients included in our study ($p=0.085$). About 74.99% of the patients had POAG, and 24.99% were PEG. There was no difference in the type of glaucoma and severity of glaucoma in the left eye according to gender ($p>0.05$). However, there was a statistically significant difference in the severity of glaucoma in the right eye ($p=0.037$) ($p\leq0.05$). The number of women diagnosed with early-stage glaucoma in the right eye was higher.

SMD has emerged as a globally significant and increasingly prevalent eye disease. The prevalence of SMD steadily

Table 5. Regression analysis results

	Unstandardized coefficients		Standardised coefficients		t	Sig.	Collinearity statistics	
	B	Std. error	Beta				Tolerance	VIF
Fixed	-0.330	0.164			-2.016	0.045*		
Gender	-0.013	0.037	-0.028		-0.362	0.718	0.930	1.076
Age	0.004	0.002	0.148		1.735	0.085	0.788	1.270
Glaucoma severity right	0.010	0.025	0.033		0.389	0.698	0.774	1.293
Glaucoma severity left	0.027	0.024	0.096		1.124	0.263	0.780	1.283
Lens status right	0.023	0.051	0.044		0.444	0.658	0.593	1.685
Lens status left	0.034	0.048	0.066		0.706	0.481	0.665	1.503

Dependent variable: Diagnosis of glaucoma and SMD. R=0.277 R²=0.077 F=2.232 P=0.043. r: Correlation coefficient, R: Multiple correlation coefficient, R²: Multiple coefficient of determination, Beta: Standardised B coefficient, B: Regression coefficient, Std Error: Standard error, t: Value determining the statistical significance of the relationship, Sig: Significance value, VIF: Variance inflation factor, F: F value, S: Fixed (point where it crosses the Y-axis).

increases with age, showing no significant gender differences (15,22). Glaucoma affects contrast discrimination and light/dark adaptation. SMD causes loss of contrast sensitivity, metamorphopsia and blurred vision (12). SMD affects activities requiring central vision, such as reading, writing and recognizing faces, whereas glaucoma affects activities requiring peripheral vision, such as walking and driving. As many patients have both conditions, they have a combined effect on their daily lives. Both glaucoma and SMD can cause significant limitations in the daily activities of patients and have a profound effect on their quality of life (4,14,18,23). In our study, 10 (5.95%) of 168 glaucoma patients had SMD. Of the patients with SMD, six (60%) were male and four (40%) were female. Nine (90%) had dry-type, and 1 (10%) had wet-type SMD. The mean age of the patients was 72.70 ± 11.02 years. There was no correlation between glaucoma type, SMD type, gender and age variables ($p > 0.05$). In the right eye, four (40.0%), two (20.0%) and four (40.0%) patients were diagnosed with early, intermediate and advanced glaucoma, respectively. In the left eye, two (20.0%), five (50.0%) and three (30.0%) patients were diagnosed with early, intermediate and advanced glaucoma, respectively. There was no correlation between the severity of glaucoma in the right and left eye, SMD type, gender and age variables ($p > 0.05$).

In a study by Hirvela *et al.*, (22) no association was found between SMD and glaucoma. In a study by Mergen *et al.*, (17) glaucoma was diagnosed or suspected at a significantly lower rate in patients with exudative SMD compared to non-exudative patients. Ganglion cell loss leads to retinal nerve fiber loss, causing thinning of the retinal nerve fiber layer and changes at the optic disc head (24). Aritürk *et al.* (25) found no significant difference in the neural rim, mean cup/disc ratio and peripapillary retinal nerve fiber layer thickness in the optic disc in the presence of macular degeneration compared to the control group in their studies. They stated that the coexistence of both diseases is rare, and although both diseases are independent of each other, vascular insufficiency is partially involved in their etiology. Vascular factors are important in the development of neovascular SMD. It has been reported that choroidal and retinal blood flow is decreased in patients with neovascular SMD. Ischemia and hypoxia resulting from inadequate perfusion of the choroid are thought to activate the development of angiogenesis. Angiogenesis usually causes visual loss by disrupting normal macular function (3). Zengin *et al.* (26) reported that the accumulation of pseudoexfoliative material in the walls of ophthalmic vessels affects the development of SMD, and there is a low prevalence relationship between PES and wet-type SMD. In their study, Gunes *et al.* (27) reported that PES was associated with SMD. In our study, no correlation was observed between PEG and SMD disease. In patients with

coexisting glaucoma and SMD, when gender, age, severity of glaucoma in the right and left eye, and pseudophakic and phakic status were evaluated, no statistically significant effect of these variables on the coexistence of glaucoma and SMD was observed ($p > 0.05$).

Cataracts cause blurred vision, monocular diplopia, contrast sensitivity and color vision impairment, reducing visual quality. Cataracts, glaucoma and SMD incidence increases with age (23,28). Wang *et al.*, (29) in a study of 6019 patients, reported that age-related maculopathy developed in 6.0–7.7% of aphakic patients and 0.7% of phakic patients. Klein *et al.* (30) reported that cataract surgery increased the risk of late-type age-related maculopathy. It has been reported that late SMD has an increased prevalence in patients with cataract diagnosis and cataract surgery, although the cause is unknown (31). In our study, there were 7 (70.0%) patients with pseudophakic and 3 (30.0%) with phakic diagnoses in the right and left eyes. A statistically significant high-level positive correlation was found between the status of the lens in the right eye and the age variable ($p \leq 0.05$).

This study has limitations due to its retrospective nature. The small number of patients and the information about the patients are limited to the information recorded during the patient's examination. The contribution of the study is that there are very few studies on this subject, which has remained under-researched, and the findings are consistent with previous studies.

Conclusion

Limited research has investigated the relationship between glaucoma and retinal diseases. Understanding the association between glaucoma and SMD is crucial for uncovering underlying pathological mechanisms, improving prognosis, guiding follow-up, and optimizing treatment strategies. Further studies could play a pivotal role in preventing visual loss, enhancing patients' quality of life, and decreasing the prevalence of glaucoma and SMD.

Disclosures

Ethics Committee Approval: This study was approved by the Inonu University Ethics Committee (Date: 17.12.2024, Number: 41) and conducted in accordance with the tenets of the Declaration of Helsinki.

Informed Consent: Written informed consents were obtained from all patients.

Conflict of Interest: None declared.

Funding: The authors declare that this study has received no financial support.

Use of AI for Writing Assistance: Not declared.

Author Contributions: Concept – U.D., P.B., P.N.G.; Design – P.B., U.D., P.N.G.; Supervision – P.B., U.D.; Resource – P.B., U.D.,

P.N.G.; Materials – P.B., U.D.; Data Collection and/or Processing – P.B., U.D., P.N.G.; Analysis and/or Interpretation – P.B., U.D.; Literature Search – U.D., P.B., P.N.G.; Writing – U.D., P.B.; Critical Reviews – U.D., P.B., P.N.G.

Peer-review: Externally peer-reviewed.

References

- Hu CC, Ho JD, Lin HC, Kao LT. Association between open-angle glaucoma and neovascular age-related macular degeneration: a case-control study. *Eye (Lond)* 2017;31:872–7. [\[CrossRef\]](#)
- Chiras D, Kitsos G, Petersen MB, Skalidakis I, Kroupis C. Oxidative stress in dry age-related macular degeneration and exfoliation syndrome. *Crit Rev Clin Lab Sci* 2015;52:12–27. [\[CrossRef\]](#)
- Kozobolis VP, Detorakis ET, Tsilimbaris MK, Vlachonikolis IG, Tsambarlakis IC, Pallikaris IG. Correlation between age-related macular degeneration and pseudoexfoliation syndrome in the population of Crete (Greece). *Arch Ophthalmol* 1999;117:664–9. [\[CrossRef\]](#)
- Dimalanta L, Pithadia K, Shenkute NT, Strelow B, Zhang Z, Ulrich J, Zhang AY, Fleischman D. Disease associations among patients afflicted with both glaucoma and age-related macular degeneration. *J Clin Med* 2024;13:5941. [\[CrossRef\]](#)
- Weinreb RN, Leung CK, Crowston JG, Medeiros FA, Friedman DS, Wiggs JL, Martin KR. Primary open-angle glaucoma. *Nat Rev Dis Primers* 2016;2:16067. [\[CrossRef\]](#)
- Düzova E, Demirok G, Üney G, Kaderli A, Yakın M, Özbek-Uzman S, Ekşiöğlü Ü. Optical coherence tomography angiography findings in primary open-angle and pseudoexfoliation glaucoma. *Turk J Ophthalmol* 2022;52:252–61. [\[CrossRef\]](#)
- Ozkan D, Altan C, Er MO, Gultekin F, Kuraş S, Artunay O. The role of oxidative status in the pathogenesis of primary open-angle glaucoma, pseudoexfoliation syndrome and glaucoma. *Eur J Ophthalmol* 2023;33:352–60. [\[CrossRef\]](#)
- Vernazza S, Tirendi S, Bassi AM, Traverso CE, Saccà SC. Neuroinflammation in primary open-angle glaucoma. *J Clin Med* 2020;9:3172. [\[CrossRef\]](#)
- Yüksel N, Yılmaz Tuğan B. Pseudoexfoliation glaucoma: clinical presentation and therapeutic options. *Turk J Ophthalmol* 2023;53:247–56. [\[CrossRef\]](#)
- Flores R, Carneiro Â, Vieira M, Tenreiro S, Seabra MC. Age-related macular degeneration: pathophysiology, management, and future perspectives. *Ophthalmologica* 2021;244:495–511. [\[CrossRef\]](#)
- Erik A, Seylam Küşümler A. The effect of nutrition and lifestyle on age-related macular degeneration. *İzmir Katip Çelebi Univ Health Sci J* 2022;7:345–50.
- Dziedzic J, Kasarekto K, Cudnoch-Jędrzejewska A. Dietary antioxidants in age-related macular degeneration and glaucoma. *Antioxidants (Basel)* 2021;10:1743. [\[CrossRef\]](#)
- Bucan K, Lukic M, Bosnar D, Kopic A, Jukic T, Konjevoda S, Glavadanovic S, Gverovic Antunica A. Analysis of association of risk factors for age-related macular degeneration. *Eur J Ophthalmol* 2022;32:410–6. [\[CrossRef\]](#)
- Fleckenstein M, Schmitz-Valckenberg S, Chakravarthy U. Age-related macular degeneration: a review. *JAMA* 2024;331:147–57. [\[CrossRef\]](#)
- Ferris FL 3rd, Wilkinson CP, Bird A, Chakravarthy U, Chew E, Csaky K, Sadda SR; Beckman Initiative for Macular Research Classification Committee. Clinical classification of age-related macular degeneration. *Ophthalmology* 2013;120:844–51. [\[CrossRef\]](#)
- Hodapp E, Parrish RK, Anderson DR. Clinical decisions in glaucoma. Maryland Heights: Mosby; 1993. p. 52-61.
- Mergen B, Ramsey DJ. Underdiagnosis of glaucoma in patients with exudative age-related macular degeneration. *Eye (Lond)* 2021;35:3350–7. [\[CrossRef\]](#)
- Skalicky SE, Fenwick E, Martin KR, Crowston J, Goldberg I, McCluskey P. Impact of age-related macular degeneration in patients with glaucoma: understanding the patients' perspective. *Clin Exp Ophthalmol* 2016;44:377–87. [\[CrossRef\]](#)
- Supuran CT. The management of glaucoma and macular degeneration. *Expert Opin Ther Pat* 2019;29:745–7. [\[CrossRef\]](#)
- Cimaglia G, Votruba M, Morgan JE, André H, Williams PA. Potential therapeutic benefit of NAD⁺ supplementation for glaucoma and age-related macular degeneration. *Nutrients* 2020;12:2871. [\[CrossRef\]](#)
- Padhy B, Alone DP. Is pseudoexfoliation glaucoma a neurodegenerative disorder? *J Biosci* 2021;46:97. [\[CrossRef\]](#)
- Hirvelä H, Luukinen H, Läärä E, Sc L, Laatikainen L. Risk factors of age-related maculopathy in a population 70 years of age or older. *Ophthalmology* 1996;103:871–7. [\[CrossRef\]](#)
- Eichenbaum JW. Geriatric vision loss due to cataracts, macular degeneration, and glaucoma. *Mt Sinai J Med* 2012;79:276–94. [\[CrossRef\]](#)
- Medeiros FA, Zangwill LM, Bowd C, Vessani RM, Susanna R Jr, Weinreb RN. Evaluation of retinal nerve fiber layer, optic nerve head, and macular thickness measurements for glaucoma detection using optical coherence tomography. *Am J Ophthalmol* 2005;139:44–55. [\[CrossRef\]](#)
- Aritürk N, Aykut M. Optic disc changes in patients with age related macula degeneration. *Glo-Kat* 2010;5:207–12.
- Zengin MO, Karti O, Karahan E, Kusbeci T. An evaluation of the relationship between clinically unilateral pseudoexfoliation syndrome and age-related macular degeneration. *Ophthalmic Surg Lasers Imaging Retina* 2018;49:12–19. [\[CrossRef\]](#)
- Gunes A, Yasar C, Tok L, Tok O. Prevalence of pseudoexfoliation syndrome in Turkish patients with senile cataract. *Semin Ophthalmol* 2017;32:297–301. [\[CrossRef\]](#)
- Skalicky SE, Martin KR, Fenwick E, Crowston JG, Goldberg I, McCluskey P. Cataract and quality of life in patients with glaucoma. *Clin Exp Ophthalmol* 2015;43:335–41. [\[CrossRef\]](#)

-
29. Wang JJ, Klein R, Smith W, Klein BE, Tomany S, Mitchell P. Cataract surgery and the 5-year incidence of late-stage age-related maculopathy: pooled findings from the Beaver Dam and Blue Mountains eye studies. *Ophthalmology* 2003;110:1960–7. [\[CrossRef\]](#)
 30. Klein BE, Howard KP, Lee KE, Iyengar SK, Sivakumaran TA, Klein R. The relationship of cataract and cataract extraction to age-related macular degeneration: the Beaver Dam Eye Study. *Ophthalmology* 2012;119:1628–33. [\[CrossRef\]](#)
 31. Freeman EE, Munoz B, West SK, Tielsch JM, Schein OD. Is there an association between cataract surgery and age-related macular degeneration? Data from three population-based studies. *Am J Ophthalmol* 2003;135:849–56. [\[CrossRef\]](#)