A COMPARISON STUDY OF TRIGLYCERIDE GLUCOSE INDEX IN CATARACT PATIENTS, WITH & WITHOUT OCULAR PSEUDO-EXFOLIATION.

Dr. Srilekha R Mathapati [1], Dr. Chaitra M C [2]
[1] Post Graduate Student, Department of Ophthalmology, Sri Devaraj Urs Medical College, Kolar, India.
[2] Professor, Department of Ophthalmology, Sri Devaraj Urs Medical College, Kolar, India.
Corresponding author: Dr. Chaitra M C*

ABSTRACT
Background: Cataract is the leading cause of reversible blindness worldwide and is influenced by systemic metabolic factors. Ocular pseudoexfoliation (PEX) is an age-related extracellular matrix disorder associated with increased surgical risk and possible systemic metabolic associations. The triglyceride–glucose (TyG) index is a reliable surrogate marker for insulin resistance and cardiometabolic risk. This study aimed to compare the TyG index and lipid profile in cataract patients with and without PEX.
Methods: This observational study was conducted on 78 cataract patients (39 with PEX and 39 without PEX) at a tertiary care hospital. Patients above 40 years were included and matched for age and gender. Detailed ophthalmic examination and biochemical evaluation including fasting blood glucose and lipid profile were performed. The TyG index was calculated using standard formula. Statistical analysis was done using independent t-test and Chi-square test, with $p < 0.05$ considered significant**.**
Results: The mean age was comparable between PEX and non-PEX groups (66.36 ± 7.74 vs 66.31 ± 7.69 years; $p = 1.00$). No significant differences were observed in fasting blood sugar ($p = 0.16$), total cholesterol ($p = 0.26$), HDL ($p = 0.24$), LDL ($p = 0.77$), VLDL ($p = 0.96$), or triglycerides ($p = 0.96$). The mean TyG index was similar in both groups (PEX: 8.75 ± 0.46 vs non-PEX: 8.79 ± 0.58; $p = 0.72$). A significant negative correlation was observed between age and TyG index ($r = −0.32$, $p = 0.004$).
Conclusion: TyG index and lipid parameters were comparable in cataract patients with and without PEX, suggesting that pseudoexfoliation may not be associated with increased insulin resistance in this population.
Keywords: Cataract, Ocular pseudoexfoliation, TyG index, Vision.
How to cite this article: Mathapati SR, Chaitra MC. A Comparison Study of Triglyceride Glucose Index in Cataract Patients, With & Without Ocular Pseudo-Exfoliation. Int J Drug Deliv Technol. 2026;16(70s): 957-962. DOI: 10.25258/ijddt.16.70s.100

INTRODUCTION

Cataract is the recognised as the leading cause of reversible visual impairment globally, while age being the primary factor for its development, also being affected by systemic and metabolic health. Population based studies have shown higher cataract prevalence and increased rates of cataract surgery among individuals with diabetes, hypertension, central obesity, and other components of metabolic syndrome . These metabolic conditions can contribute to lenticular oxidative stress, disturb lens protein balance, and cause osmotic damage through mechanisms such as chronic hyperglycemia (polyol/sorbitol pathway), advanced glycation end-products, mitochondrial dysfunction, and low-grade inflammation—processes together cause “metabolic load” to premature or more severe lens opacification. [1,2]

Ocular pseudoexfoliation (PEX) is a prevalent, age-associated extracellular matrix condition marked by the accumulation of pseudoexfoliative material on anterior segment structures, particularly the anterior lens capsule and pupillary edge. Clinically, PEX is significant as it elevates the difficulty and risk profile of cataract surgery (e.g., inadequate pupillary dilation, zonular instability, capsular complications) and is a primary contributor to secondary open-angle glaucoma. A substantial body of literature substantiates the notion that PEX is not exclusively localised; pseudoexfoliative material and associated elastotic/vascular alterations have been documented in extraocular tissues, with numerous studies investigating correlations with systemic vascular risk factors and cardiovascular/cerebrovascular diseases—albeit with varying outcomes depending on the population and study design.[3,4]

Given that metabolic syndrome, dyslipidaemia, and insulin resistance are consistently associated with cataract pathology, and considering that PEX may signify a systemic condition with vascular and metabolic connections, there is a compelling justification to investigate basic metabolic surrogate markers in cataract patients categorised by the presence or absence of PEX. The triglyceride–glucose (TyG) index is a biomarker estimated from fasting triglycerides and fasting plasma glucose, often expressed as ln[fasting TG (mg/dL) × fasting glucose (mg/dL) / 2].

TyG is extensively researched as a convenient proxy for insulin resistance and has been associated with cardiometabolic risk in substantial populations. Significantly relevant to your subject, recent population-based ocular studies indicate that elevated TyG levels correlate with an increased probability of cataract development in adults, including some sex-specific observations. [5,6]

Although cataracts are prevalent and PEX is a common comorbidity in cataract clinics, standard preoperative assessments often emphasise ocular surgical risk factors, leaving the "metabolic phenotype" of cataract patients, particularly those with PEX, frequently under-explored. If PEX is indeed linked to systemic vascular/metabolic stress, cataract patients with PEX may display a distinct insulin-resistance profile compared to those without PEX. A direct comparison utilising TyG is appealing due to its cost-effectiveness, reproducibility, and reliance on tests often requested in several perioperative and medical assessments (fasting glucose and triglycerides). Evidence supporting this trend include a PubMed-indexed study that particularly assesses the correlation between PEX and the TyG index, positioning TyG as a pertinent measure for vascular injury risk in PEX populations.[7]

The need for evaluation becomes particularly significant in acute in settings where cataract surgery volumes arae high and prevalence of metabolic diseases are increasing. Collecting of local data on Triglyceride diffences between cataract patients with and without PEX can improve the usage of findings in everyday clinical practice, it can support the inclusion of a simple metabolic screening parameter into preoperative cataract assesment—partcularly for PEX patients who may need more closer systemic and ocular survelliance due to their increased risk of complications and glaucoma.

AIMS & OBJECTIVES

To Compare the triglyceride glucose index (TyG) in cataract patients with & without Ocular Pseudoexfoliation.

METHODOLOGY

An observational study was conducted among 78 admitted patients in Ophthalmology at RL Jalappa Hospital and Research Centre affiliated with Sri Devaraj Urs Medical College, Tamaka, Kolar, Karnataka. Patients with cataract and ocular pseudoexfoliation were classified as the PEX group, whereas cataract patients without ocular pseudoexfoliation were classified as the Non-PEX group.

The sample size was established according to the difference in mean Triglyceride-Glucose (TyG) index between the pseudoexfoliation (PEX) and non-PEX groups as documented by Rafye Nur Abay et al. [7] The average TyG index was 8.97 ± 0.5 in the PEX group and 8.6 ± 0.6 in the control group. A minimum sample size of 35 individuals per group was established using MedCalc sample size software, with a 95% confidence interval and 80% power. A total sample size of 39 patients per group was incorporated after accounting for a 10% non-response rate. Participants with a history of glaucoma, chronic or recurrent inflammatory ocular disorders, previous intraocular surgery, ocular trauma, active infections, or those receiving drugs affecting lipid metabolism, such as statins, were excluded. The written informed consent was taken from all patients prior to the study. The Institutional ethical committee permission was obtained for this study.

Demographic data and detailed medical history, including presence of hypertension, diabetes mellitus, smoking, and alcohol consumption, were documented. Detailed ophthalmic evaluation was performed, that included visual acuity assesment using Snellen's chart for distant vision and the jaeger's chart for near vision, refraction, measurement of intraocular pressure with non-contact tonometer, anterior segment examination with slit lamp, and fundus examination by both direct and indirect ophthalmoscope.

Data entry and analysis: The collected data were entered into Microsoft Excel and analysed using SPSS version 22 software. Categorical variables were expressed as frequencies and percentages, and the Chi-square test was utilised to assess associations. Continuous variables were expressed as mean ± standard deviation, and the independent t-test was utilised to evaluate mean differences between the two groups. A p-value below 0.05 was considered statistically significant.

RESULTS

Table 1. Age Group Distribution of Study Participants in PEX and Non-PEX Groups

Age Group (years)	PEX Group (n = 39)	Non-PEX Group (n = 39)	Total (n = 78)
40–50	1	1	2
51–60	9	9	18
61–70	18	18	36
71–80	9	9	18
81–90	2	2	4
Total	**39**	**39**	**78**
Mean ± SD	**66.36 ± 7.74**	**66.31 ± 7.69**	**66.33 ± 7.66**
p-value = 1.00			

The age group distribution of study participants in the PEX and Non-PEX groups. The two groups were age-matched, with equal number of participants across each predefined decade-based age category. Most of the participants in both groups were within 61–70-year age group, accounting for the largest segment of the study population, followed by 51–60-year age group and 71–

80-year age groups. Those aged 40–50 years and 81–90 years constituted realtively smaller proportions in both groups. The uniform age distribution across all categories demonstrates effective age matching between the PEX and Non-PEX groups, therby ensuring comparability and minimizing potential confounding effect of age in subsequent analyses. [Table 1]

Both groups had an identical composition, with 19 females and 20 males in each. Statistical analysis showed no significant difference in gender distribution between the two groups ($\chi^2 = 0.00$, df = 1, p = 1.00), indicating perfect gender matching between cases and controls. [Figure 1]

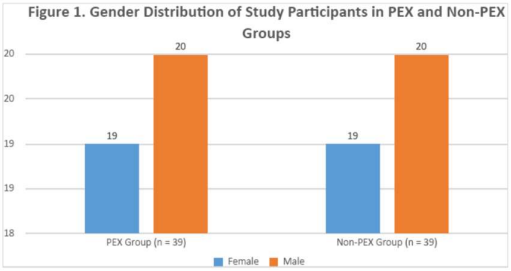

Table 2. Comparison of variables between PEX and Non-PEX Groups

Variables	Group	Mean	SD	Minimum	Maximum	P value
FBS	**PEX Group (n = 39)**	106.44	22.97	78.00	169.00	0.16
	Non-PEX Group (n = 39)	115.87	34.54	82.00	252.00	
Total Cholesterol	**PEX Group (n = 39)**	163.64	44.16	88.00	250.00	0.26
	Non-PEX Group (n = 39)	151.82	47.91	50.00	308.00	
HDL Cholesterol	**PEX Group (n = 39)**	37.74	14.86	15.00	88.00	0.24
	Non-PEX Group (n = 39)	42.00	16.96	15.00	86.00	
LDL Cholesterol	**PEX Group (n = 39)**	105.90	46.30	26.00	232.00	0.77
	Non-PEX Group (n = 39)	108.54	32.34	37.00	212.00	
VLDL Cholesterol	**PEX Group (n = 39)**	27.77	12.67	11.20	60.00	0.96
	Non-PEX Group (n = 39)	27.63	12.50	8.40	54.00	
Triglycerides	**PEX Group (n = 39)**	138.87	63.35	56.00	300.00	0.96
	Non-PEX Group (n = 39)	138.13	62.48	42.00	270.00	

Although mean FBS value was higher in the Non-PEX group than in PEX group, the difference did not reach statistical significance (p = 0.16), suggesting similar fasting glycemic status between the two groups. The mean total cholesterol levels were higher in the PEX group compared to the Non-PEX group. However, this difference was not statistically significant (p = 0.26), suggesting comparable total cholesterol profiles in both groups. Non-PEX group exhibited higher mean HDL cholesterol compared to PEX group. This difference was not statistically significant (p = 0.24), indicating comparable HDL levels between the two groups. No meaningful difference in LDL cholesterol levels between the PEX and Non-PEX groups. The difference was not statistically significant (p = 0.77), indicating similar LDL profiles between both groups. The difference was not statiscally significant (p = 0.96), indicating comparable VLDL concentrations between both groups. The mean triglyceride levels were nearly the same in both PEX and Non-PEX groups. The difference was not statistically significant (p = 0.96), indicating no association between triglyceride levels and pseudoexfoliation status. [Table 2]

Table 3. Comparison of Triglyceride–Glucose (TyG) Index Between PEX and Non-PEX Groups

Group	Mean	SD	Minimum	Maximum
PEX Group (n = 39)	8.75	0.46	8.05	9.90
Non-PEX Group (n = 39)	8.79	0.58	7.61	10.43
p-value = 0.72				

The TyG index between the PEX and Non-PEX groups.

The mean TyG index values were similar in both groups, with no statistically significant difference observed (p = 0.72), suggesting no difference in insulin resistance between cataract patients with and without pseudoexfoliation. [Table 3]

The correlation between age and the Triglyceride–Glucose (TyG) index among the study participants. A statistically significant **moderate negative correlation** was observed between age and TyG index (r = −0.32, p = 0.004), indicating that TyG index values tended to decrease with increasing age in the study population. [Figure 2]

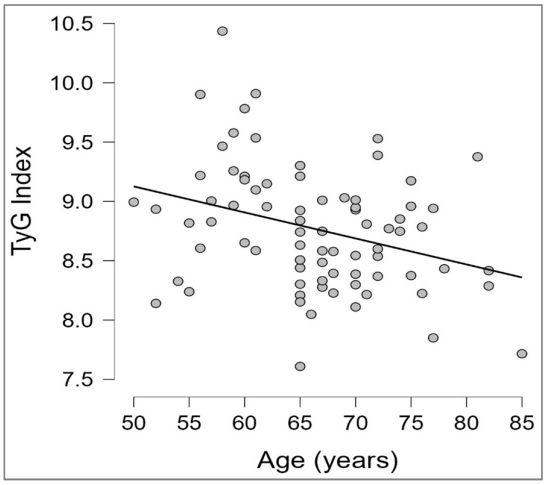

Figure 2: Scatter Plot of Age (years) vs. TyG Index

DISCUSSION

Ocular pseudoexfoliation (PEX) is an age-associated extracellular matrix disorder marked by specific anterior segment deposits and a strong association with cataracts and, in many cases, secondary glaucoma. A prevalent theme in the literature is whether pseudoexfoliation (PEX) signifies a more extensive "systemic" phenotype, especially concerning vascular and metabolic risk, as pseudoexfoliative material and associated elastotic/oxidative pathways have been identified in extraocular tissues. The triglyceride–glucose (TyG) index serves as simple surrogate marker for insulin resistance, calculated using fasting triglycerides and fasting glucose levels. It was initially validated against the gold-standard insulin resistance assessment (euglycemic clamp) and HOMA-IR in prior foundational studies. Considering that insulin resistance, oxidative stress, low-grade inflammation, endothelial dysfunction, and atherogenic dyslipidaemia represent biologically plausible links between systemic metabolic health and ocular degenerative diseases, the TyG index has recently been examined concerning ophthalmic outcomes, including cataracts and vascular occlusive diseases. [8,9]

The average age in our research was around 66 years for both groups (PEX: 66.36 ± 7.74; Non-PEX: 66.31 ± 7.69), with the predominant population situated within the 61–70 year age bracket, and there was strong congruence across age strata (p = 0.71). This aligns with the recognised age distribution of PEX, which generally increases after age 50 and peaks in later decades, reflecting the recruitment practices of most PEX clinical studies that target populations undergoing cataract surgery, where older individuals are predominant. In the South Indian systemic-vascular association study conducted by Vardhan et al. (2017), which also involved patients undergoing cataract surgery, PEX was assessed in an elderly cataract demographic, affirming that our age distribution aligns with"real-world" cataract-PEX clinical cohorts from the same region. [4]

Similarly, our gender distribution was intentionally balanced (19 girls and 20 males in each group; p = 1.00). Numerous PEX findings indicate either a marginal male preponderance, a marginal female predominance, or no discernible difference, contingent upon the demographic, sample framework, and lifespan effects. The key strength of our data set is the removal of gender imbalance as a confounding factor in the comparison of metabolic parameters— this is important as triglycerides, HDL, and insulin resistance indicators can differ with sex and hormonal influence.By doing such matching, our metabolic comparisons are more accurate than other observational studies in which PEX and control groups display differ in age and sex distributions.

In our study, mean fasting blood sugar (FBS) were higher in Non-PEX group (115.87 ± 34.54) compared to the PEX (106.44 ± 22.97); however, this difference was not statistically significant (p = 0.16). This lack of significant difference is consistent with ogoing uncertainty regarding the association between diabetes and PEX. A recent meta-analysis (Yu et al., 2023) reported that there was no definitive link between diabetes mellitus and exfoliation syndrome, with some studies showing a potential inverse assoaciation in older populations—highlighting heterogeneity in findings and the possible influence survival or ascertainment biases. [10]

The implications for understanding our study are pragmatic: since our groups were matched and fasting blood sugar levels did not differ significantly, it is improbable that baseline fasting glycemia is solely responsible for any observed variations (or absence thereof) in the TyG index across groups. In other words, the PEX status in our cataract sample did not correspond to an alternative fasting glycaemic state, supporting the idea that PEX is not only a "diabetes marker," although metabolic dysfunction may intersect with PEX biology in some subgroups.

Our findings indicate no statistically significant changes in total cholesterol, HDL, LDL, VLDL, and

triglycerides there is no significant difference between the PEX and Non-PEX groups (all $p > 0.05$). This pattern exists within a non-uniform body of literature: Lesiewska et al. (2017) assessed lipid and CRP profiles in PEX, reporting on vascular risk markers, including lipid fractions and ratios; this study contributes to the ongoing effort to determine if PEX patients exhibit a more atherogenic profile. [11] Mirza et al. (2019) highlighted "atherogenic indices" (e.g., TC/HDL, TG/HDL) and proposed that lipid ratios can provide greater insight than individual lipid readings in assessing vascular/metabolic risk in PEX. [12] Simultaneously, emerging clinical datas have shown only selective differences (such as LDL variations in some PEX subgroups), suggesting that lipid parametrs may be restricetd and context-dependent rather than consistent across all populatons.

In this context, our data add important nuance: particularly among cataract patients, and with careful matching, PEX does not inherently correspond a distinct conventional lipid profile. This clinically supports a balanced approach— patients with PEX should evaluated for systemic risk associations as per regular medical practice, though our findings do not support the assumption that a “PEX phenotype” is consistently assocated with poor fasting lipids profile across all cataract populations.

Our primary finding indicates that the TyG index was comparable in both cohorts (PEX 8.75 ± 0.46 vs Non-PEX 8.79 ± 0.58; $p = 0.72$), implying no significant difference in insulin resistance surrogate status between cataract patients with and without PEX. This discovery is notably intriguing when juxtaposed with rising population-level evidence indicating that elevated TyG correlates with an increased incidence of cataracts. Jin et al. (2025) identified a correlation between elevated TyG quartiles and cataract risk, particularly among males. The primary focus of these research is the comparison between individuals with cataracts and those without, or the prevalence of cataracts within a wider community sample. Conversely, our complete sample comprises cataract patients, hence prompting a separate inquiry: does PEX delineate a unique metabolic subgroup within cataract? The absence of a TyG difference indicates that, in cataract instances, PEX status alone may not effectively differentiate insulin resistance, at least not in a detectable manner within our sample size. [6]

This is mechanistically plausible as PEX pathogenesis is closely associated with extracellular matrix remodelling (e.g., LOXL1-related pathways), oxidative stress, local ocular tissue factors, and age-related matrix degeneration, whereas TyG indicates systemic insulin resistance and atherogenic dysmetabolism. These pathways may overlap (oxidative stress/endothelial dysfunction)____yet they are not necessarily interdependent; therefore PEX may occur even in metabolically "average" cataract patients, while those with metabolically high-risk cataract patients may or may not develop PEX, depending on underlying genetic and environmental variables.

An important secondary observation in our study was a moderate negative correlation between age and TyG ($r = -0.32$, $p = 0.004$), suggesting that TyG levels tend to decrease in older individuals. This pattern contrsast wiyh usual trend observed in general populations, where insulin resistance usually increases with age; however, actual older population may demonstrate more complex patterns due to treatment effects (statins, glucose-lowering therapy), dietary modifications, survivor bias, frailty, and metabolic changes associated with sarcopenia. Modern geriatric and metabolic research have incresingly focused on the association between TyG and age related phenotypes,including frailty and biological ageing, showcasing that TyG is significantly associated with aging-related risks, but not consistent across all elderly age groups and health conditions. [13]
Within our cataract-surgery cohort-predominantly consiting of older age groups, a negative age–TyG correlation reflect that the oldest patients comprise a higher proportion of individuals with lower triglyceride levels (attributed to nutrition, medications, or frailty related changes) and/or more strict glycaemic control among patient under regular medical supervision may alsocontribute to this. This finding is important to interpret ascohor specific observation rather than a universally applicable biological pattern.

Overall, our study provides clear and clinically relevant reference,among cataract patientswith age and gender matched, ocular pseudoexfoliation was not associated with higher fasting glucose, adverse lipid profiles, increased triglycerides, or increased TyG index. This differs from some reports highlighting atherogenic lipid patterns or vascular risk markers in PEX, although that aligns with other studies demonstrate variability and low effect sizes, also meta-analytic studies showing an inconsistent association between diabetes–PEX across different populations.

CONCLUSION

Cataract patients with ocular pseudoexfoliation do not exhibit significant differences in fasting glucose levels, lipid parameters, or Triglyceride–Glucose (TyG) index when compared with age- and gender-matched cataract patients without pseudoexfoliation. These findings suggest that, within catarct populations, pseudoexfoliation is not assaociated with additional burden of insulin resistance or an adverse metabolic profile, when assessed using standard biochemical markers and the TyG index. The absence of a notable difference in the TyG index between the two groups supports that pseudoexfoliation in cataract patients may represent an age-related extracellular matrix disorder rather than a manifestation of systemic

metabolic dysfunction. These results rely on observation that metabolic screening and risk assesment in cataract patients should be directed by established clinical indications rather than presence of pseudoexfoliation alone, while highlighting the importance of individualised & multidisciplinary approach to patient care.

REFERENCES

1. Sabanayagam C, Wang JJ, Mitchell P, Tan AG, Tai ES, Aung T, et al. Metabolic syndrome components and age-related cataract: the Singapore Malay eye study. Invest Ophthalmol Vis Sci. 2011 Apr 14;52(5):2397–404. doi:10.1167/iovs.10-6373 PubMed PMID: 21228391.
2. Lindblad BE, Håkansson N, Wolk A. Metabolic syndrome and some of its components in relation to risk of cataract extraction. A prospective cohort study of men. Acta Ophthalmol. 2019 Jun;97(4):409–14. doi:10.1111/aos.13929 PubMed PMID: 30353683; PubMed Central PMCID: PMC6587757.
3. Andrikopoulos GK, Alexopoulos DK, Gartaganis SP. Pseudoexfoliation syndrome and cardiovascular diseases. World J Cardiol. 2014 Aug 26;6(8):847–54. doi:10.4330/wjc.v6.i8.847 PubMed PMID: 25228963; PubMed Central PMCID: PMC4163713.
4. Vardhan S A, Haripriya A, Ratukondla B, Ramulu P, Shivakumar C, Nath M, et al. Association of Pseudoexfoliation With Systemic Vascular Diseases in a South Indian Population. JAMA Ophthalmol. 2017 Apr 1;135(4):348–54. doi:10.1001/jamaophthalmol.2017.0064 PubMed PMID: 28278318.
5. Fritz J, Bjørge T, Nagel G, Manjer J, Engeland A, Häggström C, et al. The triglyceride-glucose index as a measure of insulin resistance and risk of obesity-related cancers. Int J Epidemiol. 2020 Feb 1;49(1):193–204. doi:10.1093/ije/dyz053 PubMed PMID: 30945727.
6. Jin Q, Huang J, Gao L, Zhu J. Association between triglyceride-glucose index and cataract among outpatient US adults. Front Med (Lausanne). 2025;12:1523711. doi:10.3389/fmed.2025.1523711 PubMed PMID: 40491769; PubMed Central PMCID: PMC12146377.
7. Abay RN, Katipoğlu Z. The correlation between pseudoexfoliation syndrome and the Triglyceride-Glucose index. Graefes Arch Clin Exp Ophthalmol. 2022 Dec;260(12):3903–8. doi:10.1007/s00417-022-05737-z PubMed PMID: 35723782.
8. Guerrero-Romero F, Simental-Mendía LE, González-Ortiz M, Martínez-Abundis E, Ramos-Zavala MG, Hernández-González SO, et al. The product of triglycerides and glucose, a simple measure of insulin sensitivity. Comparison with the euglycemic-hyperinsulinemic clamp. J Clin Endocrinol Metab. 2010 Jul;95(7):3347–51. doi:10.1210/jc.2010-0288 PubMed PMID: 20484475.
9. Simental-Mendía LE, Rodríguez-Morán M, Guerrero-Romero F. The product of fasting glucose and triglycerides as surrogate for identifying insulin resistance in apparently healthy subjects. Metab Syndr Relat Disord. 2008 Dec;6(4):299–304. doi:10.1089/met.2008.0034 PubMed PMID: 19067533.
10. Yu M, Hwang HH, Wiggs JL, Pasquale LR, Kang JH. Association between Diabetes and Exfoliation Syndrome. Ophthalmol Sci. 2023 Nov 18;4(3):100436. doi:10.1016/j.xops.2023.100436 PubMed PMID: 38250562; PubMed Central PMCID: PMC10797545.
11. Lesiewska H, Łukaszewska-Smyk A, Odrowąż-Sypniewska G, Krintus M, Mańkowska-Cyl A, Malukiewicz G. Chosen Vascular Risk Markers in Pseudoexfoliation Syndrome: An Age-Related Disorder. J Ophthalmol. 2017;2017:5231095. doi:10.1155/2017/5231095 PubMed PMID: 29225964; PubMed Central PMCID: PMC5684544.
12. Mirza E. Atherogenic indices in pseudoexfoliation syndrome. Eye (Lond). 2019 Dec;33(12):1911–5. doi:10.1038/s41433-019-0506-z PubMed PMID: 31278384; PubMed Central PMCID: PMC7002409.
13. Hou J, Zhao S, Shi J, Zhang Y. Prospective association between the triglyceride-glucose index and frailty in middle-aged and older adults: insights from a nationwide cohort study. Eur J Med Res. 2026 Jan 22;31(1):118. doi:10.1186/s40001-026-03895-y PubMed PMID: 41572329; PubMed Central PMCID: PMC12828927.