Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/wvjf0z72

ASSOCIATION OF DYSLIPIDEMIA WITH RETINAL VASCULAR DISEASE PROGRESSION AND ITS PUBLIC HEALTH IMPLICATIONS IN THE COMMUNITY

Muhammad Irfan Ullah[1], Junaid Afsar Khan[2], Roomana Anwar[3], Erum Tariq[4], Madeeha Jadoon[5], Farooq Ahmed Noor[6]

[1]Medical Officer, Department of Eye Unit, DHQ Teaching Hospital, DI Khan, Pakistan
[2]Assistant Professor, Department of Ophthalmology, CMH Medical College & IOD, Lahore, Pakistan
[3]Associate Professor, Department of Biochemistry, HBS Medical and Dental College, Islamabad, Pakistan
[4]Assistant Professor, Department of Biochemistry, Quetta College of Dentistry, Quetta, Pakistan
[5]Associate Professor and Head of Biochemistry, Women Dental College, Abbottabad, Pakistan
[6]Associate Professor, Department of Community Medicine, AJK Medical College, Muzaffarabad, Pakistan

Corresponding author: Junaid Afsar Khan,
Assistant Professor, Department of Ophthalmology, CMH Medical College & IOD, Lahore, Pakistan, Email: jakjadoon@gmail.com

ABSTRACT

Background: Disorders of the retina's vasculature, such as diabetes-related damage to the retina and blockages of the retinal veins, are leading causes of reduced eyesight globally. In low-resource communities, where access to screening and healthcare services is often limited, this association may contribute to unrecognized disease progression and visual impairment.

Methodology: A cross-sectional observational study was conducted from January 2024 to January 2025 at DHQ Teaching Hospital, Dera Ismail Khan. Seventy-six patients diagnosed with retinal vascular diseases were enrolled. Detailed ophthalmic examinations and retinal imaging were performed to classify disease severity. Fasting blood samples were collected to assess serum lipid profiles including total cholesterol, LDL-C, HDL-C, triglycerides, and atherogenic index. Data were statistically analyzed to evaluate correlations between lipid profiles and disease severity, while also considering access to regular eye care as a community-level variable.

Results: Patients with moderate to severe retinal vascular disease demonstrated significantly higher mean levels of total cholesterol (204.2 ± 39.3 mg/dL), LDL-C (130.3 ± 29.9 mg/dL), triglycerides (174.8 ± 58.3 mg/dL), and atherogenic index (4.41 ± 1.58) compared to those with mild disease ($p < 0.05$). Conversely, HDL-C was significantly reduced in advanced disease stages (38.6 ± 6.9 mg/dL). Only 38.2% of participants reported regular access to eye care services, suggesting that delayed detection and untreated dyslipidemia may contribute to worsening retinal disease in the community.

Conclusion: The findings suggest that dyslipidemia is associated with the progression of retinal vascular diseases. Elevated LDL-C and triglycerides, alongside reduced HDL-C, may contribute to worsening retinal microvascular damage. In settings where access to eye care is limited, unrecognized lipid abnormalities may lead to late-stage retinal complications. These results underscore the

importance of integrating lipid screening and management into community-based eye health programs to mitigate the burden of retinopathy and prevent avoidable vision loss.

Keywords: Retinal diseases, lipid profile, LDL cholesterol, diabetic retinopathy, atherogenic index, retinal vascular occlusion.

INTRODUCTION

Retinal vascular diseases pose a significant challenge to eye health, particularly in regions with high rates of diabetes and cardiovascular disease. Conditions such as diabetic retinopathy and retinal vein occlusion are among the leading causes of visual impairment and blindness worldwide. While hyperglycemia and hypertension are well-established contributors to these disorders, the specific role of lipid abnormalities has gained increasing attention in recent years [1-3].

Lipids play a central role in vascular inflammation and endothelial dysfunction, mechanisms that closely mirror those observed in retinal pathology. Previous studies have suggested that elevated serum lipids, especially low-density lipoprotein (LDL) and triglycerides, may contribute to the formation of hard exudates and retinal vascular leakage. Conversely, high-density lipoprotein (HDL) has been shown to possess antioxidant and anti-inflammatory properties that may protect against microvascular damage [4-6].

Despite these observations, the relationship between serum lipid levels and the severity of retinal vascular disease remains underexplored in many clinical populations, particularly in low-resource settings. Understanding this association could provide valuable insights into prevention and management strategies, including systemic lipid control as a potential approach to slow retinal disease progression.

In many low- and middle-income communities, limited access to ophthalmic care and lack of awareness contribute to unchecked progression of retinal vascular disease. Dyslipidemia is often unmanaged due to socioeconomic barriers, poor health literacy, and limited screening programs.

Given the high prevalence of dyslipidemia in such communities, understanding its role in retinal disease progression has significant public health implications. Targeted awareness, early intervention, and integration of lipid management into primary eye care may help reduce vision impairment.

This study aims not only to assess the association between lipid profiles and retinal vascular disease severity but also to highlight the importance of community-based lipid screening and management as part of ocular health strategies.

METHODOLOGY

This observational, cross-sectional study was carried out from January 2024 to January 2025 at the Department of Ophthalmology, DHQ Teaching Hospital, Dera Ismail Khan. A total of 76 patients were enrolled based on predefined inclusion and exclusion criteria. Participants were recruited from the outpatient and retina clinics, where they were referred for evaluation of diabetic retinopathy, retinal vein occlusions, or other retinal vascular disorders.

Patients aged 40 to 75 years, of either gender, with a confirmed diagnosis of retinal vascular disease based on clinical examination and fluorescein angiography, were included. Exclusion criteria involved individuals with active infections, recent lipid-lowering therapy (within three months), known liver disease, or incomplete biochemical data. All participants gave informed consent prior to enrollment, and the study was approved by the local ethical review board in accordance with the Declaration of Helsinki.

Detailed patient histories, including duration of diabetes or hypertension and smoking habits, were recorded through structured interviews. Clinical evaluation included best-corrected visual acuity using the Snellen chart, slit-lamp examination, fundus photography, and optical coherence tomography (OCT) where required. The severity of retinal vascular disease was placed into classification tiers according to established grading scales like the ETDRS grading system for diabetic retinopathy and the CVOS grading system for vein occlusions.

Blood samples were taken after a period of overnight fasting for the purpose of evaluating the lipid profiles. Serum levels of total cholesterol, low-density lipoprotein (LDL-C), high-density lipoprotein (HDL-C), triglycerides, and non-HDL cholesterol were measured using automated enzymatic methods in the hospital's central laboratory. The atherogenic index was calculated by dividing triglyceride level by HDL-C.

Furthermore, an emphasis was placed on identifying lipid abnormalities not only as clinical parameters but also as potential indicators of broader public health challenges within the local community.

Data were analyzed using SPSS version 26.0. Continuous variables were presented as mean ± standard deviation, and categorical data as frequencies and percentages. Comparisons between disease severity groups were made using the independent t-test or Mann–Whitney U test, depending on normality. Correlations between lipid parameters and retinal disease severity were explored using Pearson or Spearman correlation coefficients. A p-value < 0.05 was considered statistically significant.

RESULTS

The study evaluated 76 patients with varying stages of retinal vascular disease to investigate whether serum lipid abnormalities may correlate with disease progression. Patients ranged in age from 45 to 75 years, with a balanced representation of both sexes. The mean age was approximately 58 years, and half of the participants were women. The average duration of diabetes among the participants was just over eight years, highlighting the chronic nature of disease in this cohort. Most participants had comorbid hypertension, and a smaller but notable proportion had a history of smoking.

Notably, only 38.2% of participants reported regular access to eye care services, highlighting a gap in consistent ophthalmic follow-up that may contribute to delayed detection of lipid-related retinal complications.

These demographic and clinical characteristics help provide context for interpreting lipid deviations and their potential link to retinal damage.

Table 1: Baseline Demographic and Clinical Characteristics (n = 76)

Variable	Mean ± SD / n (%)
Age (years)	58.4 ± 8.9
Sex (Male/Female)	38 (50%) / 38 (50%)
BMI (kg/m²)	27.3 ± 4.1
Duration of Diabetes (years)	8.2 ± 3.6
Smoking Status (Never/Former/Current)	46 (60.5%) / 18 (23.7%) / 12 (15.8%)
Hypertension (Yes/No)	48 (63.2%) / 28 (36.8%)
Access to Eye Care (Regular/Irregular)	**29 (38.2%) / 47 (61.8%)**

The following stage centered on evaluating serum lipid concentrations throughout the obtained sample. Total cholesterol averaged close to 196 mg/dL, while LDL levels averaged above 120 mg/dL. Many participants had HDL, the cardioprotective lipid, at levels that were suboptimal. Triglycerides were also increased on average, falling into the borderline normal to mildly elevated category. The atherogenic index (triglycerides/HDL ratio) was also quite elevated, indicating a likely harmful lipid profile that may lead to microvascular alterations in the retina.

Table 2: Serum Lipid Profile in Study Subjects

Parameter	Mean ± SD (mg/dL)
Total Cholesterol	195.6 ± 36.9
LDL-C	124.3 ± 29.7
HDL-C	41.5 ± 8.3
Triglycerides	158.4 ± 55.2
Non-HDL Cholesterol	154.1 ± 35.6
Atherogenic Index (TG/HDL)	3.87 ± 1.64

To assess if lipid abnormalities are associated with the retinal vascular disease severity, the sample was split based on the clinical classification into mild, and moderate-to-severe classes. An apparent pattern was noticed: patients with more advanced retinal pathology had higher total cholesterol, LDL, and triglycerides. Simultaneously, those with moderate or severe disease had decreased HDL levels. These trends were statistically significant, suggesting a substantial association between the disease progression and dyslipidemia.

Table 3: Correlation of Lipid Profile with Severity of Retinal Vascular Disease

Lipid Parameter	Mild Disease (n=34)	Moderate/Severe (n=42)	P-value
Total Cholesterol	183.8 ± 30.5	204.2 ± 39.3	0.042*
LDL-C	117.2 ± 26.1	130.3 ± 29.9	0.038*
HDL-C	44.8 ± 9.1	38.6 ± 6.9	0.004**
Triglycerides	138.6 ± 48.1	174.8 ± 58.3	0.028*
Atherogenic Index	3.18 ± 1.34	4.41 ± 1.58	0.011*

* Significant at $p < 0.05$
** Significant at $p < 0.01$

After controlling for confounding variables, regression analyses investigated the impact lipid variables had on the severity of the disease. Of the lipid variables investigated, both LDL cholesterol and triglycerides had a positive association with the presence of more severe and advanced retinal changes. Conversely, HDL cholesterol had a negative association, highlighting its protective effect. The atherogenic index also demonstrated a positive association which was significant and consistent with what was seen in the comparative analyses.

Table 4: Regression Analysis between Lipid Levels and Retinal Disease Progression

Variable	Beta Coefficient	p-value
LDL-C	0.42	0.021*
HDL-C	-0.39	0.008**
Triglycerides	0.31	0.043*
Atherogenic Index	0.35	0.025*

This particular pattern indicates that there might be an unusual pattern of lipid metabolism that is an under-acknowledged factor in the development of damage to the retina and the systemic damage of peripheral vascular circulation. Notably, the present study makes no claims of causation; the nature of the associations, being consistent, indicates the necessity of implementing control of these lipids, in the population of patients with the highest chances of experiencing the negative consequences in the form of progressing retinal disease.

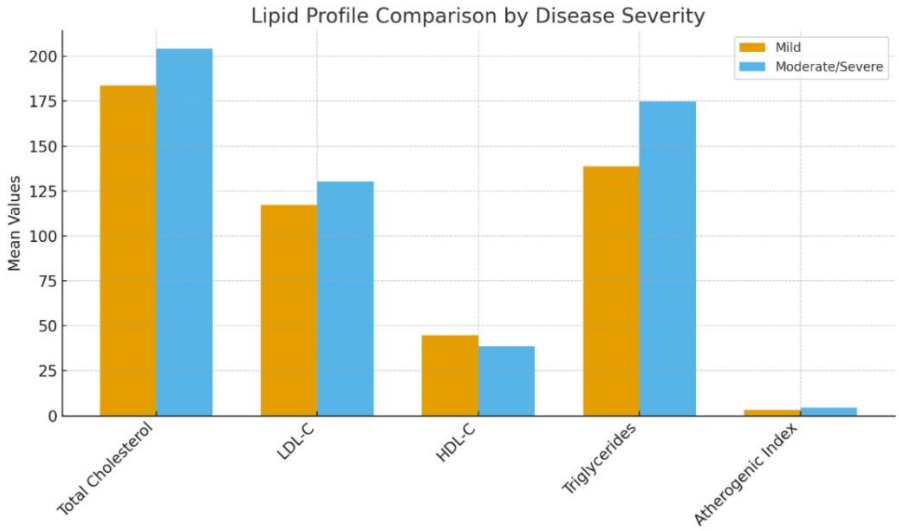

Figure 1: Lipid Profile Comparison by Disease Severity

The bar graph presents average serum lipid values across two cohorts: individuals diagnosed with mild retinal vascular disease versus those suffering with moderate to severe disease. Differences in means for total cholesterol, LDL-C, triglycerides, and atherogenic index are greater in the moderate/severe group than in the mild group. Moreover, the means for HDL-C are lower in the moderate/severe group than in the mild group, confirming a statistically significant relationship between dyslipidemia and the retinal vascular disease severity.

DISCUSSION

This research exhibited a definitive trend among heightened serum lipid concentrations and the augmented severity of retinal vascular disease. Patients whom displayed moderate to severe retinal involvement displayed greater quantities of total cholesterol, LDL-C, triglycerides, and atherogenic index, as well as markedly decreased quantities of HDL-C. The data corroborate the plausibility of dyslipidemia as a contributing factor to retinal microvessel damage [7-9].

The relationship between retinal pathology and lipid metabolism continues to be documented in expanding literature. For instance, one of the cross-sectional studies documented the association of high levels of LDL and triglycerides to increased risk of diabetic retinopathy progression, and to having greater changes in retinal vascular caliber [10-12]. Equally, research similarly recognized oxidative stress and lipid peroxidation as constituents of dysfunctional retinal endothelial cells which supports the hypothesized lipid involvement in the pathogenesis of retinal diseases. The aforementioned research findings reflect and expand on the considerations for clinical practice [13, 14].

The study's findings demonstrating an inverse relationship between the HDL-C and the severity of the disease conforms to the findings that studied the protective role of HDL in vascular health. HDL particles provide anti-inflammation and oxidation to the microenvironment of the retina. Therefore, decreased HDL may weaken the vascular resilience of the retina, deterioration of the eye to ischemic and inflammatory damage a phenomenon also observed from the study by Cheung et al., who indicated the role of HDL in predicting retinopathy [15-17].

The findings from this study’s lipid profile provide evidence for the importance of complete lipid management for patients with retinal vascular disease. Medications like statin, which can lower LDL, and triglycerides, and increase HDL, may have cadioprotective secondary benefits. Managing lipids along with the retinal disease may improve clinical outcomes for patients, especially for those with obesity or diabetes [18, 19]. This becomes particularly critical in underserved communities where screening for dyslipidemia and retinal disease is limited, often resulting in late presentations and accelerated disease progression.

The existing findings correspond with previous studies such as those who reported that lipid-lowering strategies may decelerate the progression of retinal vascular lesions. However, there have been some studies with discrepancies in findings which may be caused by differences in the design of the studies, characteristics of the populations, as well as the methods utilized for measuring lipids [20]. The modest sample size here, although indicative of real-world settings, may limit the generalizability of the findings. Larger, longitudinal studies are warranted for deeper insights, especially in diverse populations.

The community-level implications of these results suggest the need for integrating retinal screening with lipid profiling into primary healthcare services, especially in rural and underserved regions. Accessible and affordable preventive strategies could reduce the burden of retinal vascular diseases at the population level.

This observation highlights how even small changes in lipid values triggered changes in the retina at a striking magnitude, suggesting an importance balance in retial homeostasis. Since the eyes are a part of the system, the observation speaks to the complexity of disease in the system.

CONCLUSION

This study suggests a strong association between dyslipidemia and the progression of retinal vascular disease. Elevated total cholesterol, LDL, triglycerides, and atherogenic index, paired with reduced HDL, appear to align with more advanced retinal pathology. These findings are consistent with evidence from prior literature and emphasize the importance of systemic lipid control. Integrating lipid management strategies in at-risk patients may offer a dual benefit of cardiovascular and ocular protection.

Given the high prevalence of dyslipidemia in underserved populations, implementing community-based screening and lipid management programs could play a crucial role in preventing vision loss. Integrating such strategies into primary care frameworks may offer dual benefits of cardiovascular and ocular protection, particularly in low-resource settings.

REFERENCES

1. Zhang, X., et al., *Dysregulated serum lipid metabolism promotes the occurrence and development of diabetic retinopathy associated with upregulated circulating levels of VEGF-A, VEGF-D, and PlGF.* 2021. **8**: p. 779413.
2. Liu, Z., et al., *Association between increased lipid profiles and risk of diabetic retinopathy in a population-based case-control study.* 2022: p. 3433-3446.
3. Zheng, C., et al., *Plasma lipid levels and risk of retinal vascular occlusion: A genetic study using Mendelian randomization.* 2022. **13**: p. 954453.
4. Gabrielle, P.h., *Lipid metabolism and retinal diseases*. 2022, Wiley Online Library.
5. Park, S.J., D.H.J.J.o.L. Park, and Atherosclerosis, *Revisiting lipids in retinal diseases: a focused review on age-related macular degeneration and diabetic retinopathy.* 2020. **9**(3): p. 406.
6. Chen, X., et al., *Circulating level of homocysteine contributes to diabetic retinopathy associated with dysregulated lipid profile and impaired kidney function in patients with type 2 diabetes mellitus.* 2023. **37**(7): p. 1383-1389.
7. Alattas, K., et al., *Relation between lipid profile, blood pressure and retinopathy in diabetic patients in King Abdulaziz University hospital: a retrospective record review study.* 2022. **8**(1): p. 20.
8. Chen, X., et al., *The link between diabetic retinal and renal microvasculopathy is associated with dyslipidemia and upregulated circulating level of cytokines.* 2023. **10**: p. 1040319.
9. Behera, R., et al., *Association of Serum Lipid Profile and Body Mass Index with Diabetic Retinopathy in Type II Diabetes Mellitus–A Cross Sectional Study.* 2023. **13**(4).
10. Abu-Yaghi, N.E., et al., *Relationship between serum vascular endothelial growth factor levels and stages of diabetic retinopathy and other biomarkers.* 2020. **2020**(1): p. 8480193.
11. Chou, Y., et al., *Emerging insights into the relationship between hyperlipidemia and the risk of diabetic retinopathy.* 2020. **19**(1): p. 241.
12. Pavlovschi, E., et al., *Biomarkers of lipid status and metabolism in retinal hypertensive disorder.* 2021. **9**(4): p. 77-89.
13. Lei, C., et al., *The Association Between Lipid Profile and Subfoveal Choroidal Thickness in Chinese Patients with Proliferative Diabetic Retinopathy Secondary to Type 2 Diabetes.* 2023: p. 2477-2489.
14. Mondal, L.K., et al., *Do different lipid components accelerate the pathogenesis and severity of Diabetic Retinopathy?* 2022. **8**(1): p. 39.
15. Joshi, R.S. and V.H.J.I.J.o.O. Adatiya, *Study of the relationship between serum lipid levels and primary open-angle glaucoma.* 2023. **71**(5): p. 1948-1952.
16. Shokr, H., et al., *Dry eye disease is associated with retinal microvascular dysfunction and possible risk for cardiovascular disease.* 2021. **99**(7): p. e1236-e1242.
17. Bryl, A., et al., *The effect of hyperlipidemia on the course of diabetic retinopathy—literature review.* 2022. **11**(10): p. 2761.

18. Rauscher, F.G., et al., *Renal function and lipid metabolism are major predictors of circumpapillary retinal nerve fiber layer thickness—the LIFE-Adult Study.* 2021. **19**(1): p. 202.
19. Li, F.-F., et al., *Causal effects of serum lipid biomarkers on early age-related macular degeneration using Mendelian randomization.* 2023. **18**(1): p. 11.
20. Umetsu, A., et al., *Fatty acid metabolism is involved in both retinal physiology and the pathology of retinal vascular diseases.* 2022. **183**: p. 102473.