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Research Article:

The correlation of serum lipid with Age-Related Macular Degeneration: A case control study

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Abstract

Background: Age-related macular degeneration (AMD) is a common retinal disease that leads to permanent vision loss among older adults. In recent years, researchers have explored the possible link between lipid imbalance and AMD, as disturbances in lipid metabolism may contribute to retinal damage through oxidative stress and inflammation. There is limited evidence from Middle Eastern populations—particularly Iraqi and Kurdish populations—regarding the diagnosis and management of AMD. Therefore, this study contributes valuable insight into the regional epidemiology of AMD.

Objectives: This study was conducted to determine whether serum lipid levels are associated with AMD and to assess whether demographic factors, such as age and statin use, influence this relationship.

Methods: A case-control study was performed in Erbil, Iraq, during the period from 20 October 2024 to 20 July 2025. It recruited 80 patients diagnosed with AMD and 80 age- and sex-matched individuals without the disease. Blood samples were collected after fasting to measure total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides. Statistical analysis, including logistic regression, was used to evaluate potential associations and control for confounders.

Results: The AMD group had significantly higher mean levels of total cholesterol, LDL, and triglycerides, and lower HDL levels compared to the control group ($p < 0.001$). Older age and statin use were also significantly related to AMD status ($p < 0.001$).

Conclusion: the relationship between serum lipid levels and AMD presents opportunities for early detection and risk stratification of AMD in the clinical setting. Our findings also warrant future research on lipid-modifying interventions and long-term studies to assess causality and therapeutic applications.

Keywords: *Age-related macular degeneration, Serum lipid profile, Dyslipidemia, Statin use*

1. Introduction

Age-related macular degeneration (AMD) is a progressive, multifactorial retinal disease and is a leading cause of irreversible vision loss in people aged 50 years and over particularly in developed countries [1]. The Global Burden of Disease (GBD) report estimates the global prevalence of AMD is estimated to be in the range of 8.7% of the population [2]. In 2020, this equated to around 196 million people with AMD, however by 2040 it is predicted that 288 million people will have the disease [3-5]. Aging populations and enhanced life expectancy demonstrate a growing need to emphasize prevention and ensure direct access to treatment.

Within this Mediterranean region, considerable variation was observed not only by geographical region but also by population with minimal evidence that AMD affects older people in places such as Saudi Arabia [6]. In 2015, Hajar et. al. conducted a population-based survey in Jazan region of Saudi Arabia with participants aged 50 years and older. The sample size was 3,800, and its study sample indicated AMD represented only 1% of severe visual impairment and 3.7% of blindness. The low figures may not accurately relate to prevalence since there are some study limitations—specifically lacking younger individuals, using basic clinical exams without imaging, and using a rapid assessment tool not intended to provide estimates of AMD prevalence. So, the low rates might be due more to methodology than actual regional differences.[7].

It is important to note that although our study uses Saudi Arabian data to show regional differences in AMD prevalence, it is crucial to understand that its epidemiological profile might not be an accurate representation of conditions in Iraq. Disease patterns can be strongly impacted by variations in genetics, lifestyle, access to healthcare, and environmental exposures. This emphasizes how crucial our results are in offering locally pertinent data for an area where it is still hard to find. This underscores the importance of our findings in providing locally relevant data for a region where such information remains scarce.

The development of AMD involves a complex interplay of genetic, environmental, and systemic components. In particular, dyslipidemia and dysregulation of lipid metabolism has received increased attention as it relates to the onset and progression of AMD. Lipids are essential to maintaining the retinal structure and function, as the retina is one of the most metabolically active tissues in the body relying on a continual supply of lipids that are critical for cellular membrane synthesis, signal transduction and phototransduction [7].

On a more molecular level, oxidative stress and inflammation are recognized as key drivers of the progression of AMD, particularly with respect to dyslipidemia. Accumulation of oxidized low-density lipoproteins (LDL) as byproducts of lipid peroxidation within Bruch's membrane contributes to drusen formation which is a classic early feature of AMD and thus compromising Bruch's membrane and its ability to support the health of the retinal pigment epithelium (RPE) which serves photoreceptors. Products of lipid peroxidation can also activate pro-inflammatory signaling pathways that damage the retina and aid in the degeneration associated with AMD [8,9]. Although oxidative stress and inflammation are recognized mechanisms in AMD pathogenesis, our study did not directly measure related biomarkers. Therefore, any discussion of these pathways remains theoretical and is not derived from our empirical findings.

While previous studies have established associations between dyslipidemia and AMD, most have focused on Western or multi-ethnic populations. Our study is among the first to investigate this relationship within an Iraqi cohort, specifically in Erbil, thereby addressing a critical gap in regional data. By demonstrating significant correlations between serum lipid levels and AMD in this underrepresented population, our findings contribute locally relevant evidence to the global understanding of AMD pathogenesis and risk stratification which may inform the development of novel therapeutic strategies, as well as pave the way for personalized approaches to managing this debilitating condition. The objectives of this study are to estimate the prevalence of Age-Related Macular Degeneration (AMD) among patients attending the outpatient clinics of Erbil Teaching Hospital and the Eye Teaching Hospital, and to evaluate the association between selected serum lipid biomarkers and the presence of AMD. In addition, the study aims to describe the socio-demographic characteristics of the participants and assess their potential confounding effects on the relationship between lipid profiles and AMD. Finally, it seeks to identify potential therapeutic targets and propose intervention strategies based on the observed associations.

2. Method and Patients:

This study was conducted to investigate the association between serum lipid levels and age-related macular degeneration (AMD) among adults attending ophthalmic clinics in Erbil city, Iraq. A case-control design was selected to assess lipid profile variations between AMD patients and matched controls without AMD.

2.1. Study Design:

This case-control study was conducted to compare serum lipid levels between AMD patients and healthy controls in order to explore potential associations with disease status. Participants diagnosed with AMD constituted the case group, while those without AMD—matched by age and gender—formed the control group. This design enabled a comparative assessment of serum lipid parameters between the two groups, allowing for meaningful inferences regarding their potential association with AMD.

2.2. Setting of the Study:

The study was conducted at the outpatient clinics of Erbil Teaching Hospital, and Eye Teaching Hospital in Erbil city, Iraq, because these hospitals are considered tertiary hospitals and attract a diverse population for eye care within Erbil, and these hospitals have an established ophthalmology service capable of diagnosing and managing AMD. These study hospitals treat patients daily and have a varying socio-economic patient mix which makes the findings representative for the population of that region. However, since the sample was drawn from tertiary care settings, where individuals often present with more advanced or severe disease, the results may not fully reflect the prevalence of AMD in the general population, particularly among those with undiagnosed or early-stage conditions.

The study period was from 20th October 2024 to 20th July 2025 during which all eligible participants were recruited.

2.3. Inclusion Criteria

A. Cases:

- Patients clinically diagnosed with AMD, confirmed through ophthalmic examination and imaging.

B. Controls:

- Patients with no clinical or imaging evidence of AMD, matched on age ±3 years and gender.

2.4. Exclusion criteria:

1. Patients with other retinal disorders (e.g., diabetic retinopathy, retinal vein occlusion) that could confound AMD diagnosis.
2. Patients with incomplete medical records or missing lipid profile data.
3. Patients unwilling or unable to provide informed consent.

2.5. Sample Size and Sampling Methods:

A total of 80 cases and 80 matched controls were included. Sample size estimation based on anticipated AMD prevalence of 6.3% [10] using a 95% confidence level and a 5% margin of error, with an additional 20% adjustment to account for potential non-response.

Although all eligible participants were successfully recruited, a non-response adjustment was applied to account for potential biases introduced by incomplete data entries or differential participation in specific subgroups, ensuring more accurate representation in statistical analysis. AMD cases were identified consecutively, and for each case, a control without AMD was selected from the same clinics during the same time period. Due to the practical constraints of recruiting patients during routine clinical visits at tertiary hospitals, a convenience sampling method was employed. This approach allowed for timely data collection within the study period, although it may limit generalizability compared to probability-based sampling.

2.6. Data Collection Instruments

Data collection took multiple forms. Direct interviews were completed, medical record reviews were done, ophthalmic examinations occurred, and laboratory analyses were also utilized to collect rich information about socio-demographic characteristics, comorbidities, AMD status, and lipid profiles. Matching was limited to age and gender due to constraints in data availability and feasibility during clinical recruitment. Other potentially influential factors—such as smoking status, BMI, and dietary habits—were not measured, which may introduce residual confounding and limit the ability to fully account for lifestyle-related influences on AMD risk.

A. Socio-Demographic and Comorbidities Data

The socio-demographic data were collected through a structured, face-to-face interview by the researcher regarding age, sex, occupation, and socio-economic status. Each interview lasted 10–15 minutes duration to retain engagement of the participant, with all interviews conducted using the same questionnaire instrument for consistency. Information on comorbid conditions, including hypertension, diabetes, and dyslipidemia, as well as the use of lipid-lowering agents (e.g., statins), was extracted from participants' health records at the health centers. Patients were classified as statin users only if they were currently on statin therapy and had been using it for at least one month prior to recruitment; however, information regarding dosage and total duration of use was not available.

B. Ophthalmic Examination

All participants underwent a comprehensive ophthalmic examination, which included visual acuity assessment, slit-lamp biomicroscopy, and dilated fundus evaluation. Funduscopic photography and optical coherence tomography (OCT) were performed using the Heidelberg Spectralis system to confirm—or rule out—the presence of AMD and determine its stage.

C. Laboratory Analysis

Fasting blood samples from every subject were obtained, and serum lipids were measured (total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and triglycerides (TG)). Blood samples were collected in the morning after a 12-hour fast in a standard manner by the hospital's laboratory staff using venipuncture in their laboratories. Samples were analyzed for serum lipids using automated assays on Roche Cobas 6000 analyzer. Serum lipid levels are categorized, as per the American Heart Association (AHA) [11] at suggested levels in the Report (Table 1) for statistical analysis.

Table 1: Classification of Statin Use, Total Cholesterol, LDL Level, HDL, and Triglycerides

Variable	Category
Total Cholesterol (mg/dL)	Desirable (<200) Borderline High (200–239) High (>239)
LDL Level (mg/dL)	Optimal (<100) Near Optimal (100–129) Borderline High (130–159) High (160–189) Very High (>190)
HDL (mg/dL)	Low (<40) Average (40–59) Optimal (≥60)
Triglycerides (mg/dL)	Normal (<150) Borderline High (150–199) High (200–499) Very High (>500)

2.7. Ethical Considerations

Ethical approval was obtained from the Ethics Committee of the College of Medicine, Hawler Medical University, prior to study commencement. Informed consent was obtained from all participants before explaining the study's purpose, procedures, risks, and benefits in their preferred language (Kurdish or Arabic). Participants were told they could withdraw their participation at any time during the study with no effect on their medical care. Confidentiality and anonymity was ensured by assigning each participant a unique identification number that the research team used to secure their data in a secure password-protected database directly only available to the research team.

2.8. Analysis of Data

Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS, version 23.0). The following statistical procedures were utilized:

- Descriptive Statistics: Frequencies and percentages were generated to give descriptions of socio-demographic characteristics, AMD stage, lipid levels, and prevalence of comorbidity. Continuous variables (age) were summarized with means and standard deviations.
- Chi-Square tests: Chi-square tests were utilized to measure associations between categorical variables (AMD stage vs. lipid level categories, gender vs. AMD prevalence).
- Conditional Logistic Regression Analysis: To assess serum lipid levels associated with AMD, multivariable logistic regression was used to control for potential confounders, including age, sex, hypertension, diabetes, and statin use. We reported odds ratios (ORs) along with 95% confidence intervals (CIs).
- Additional Tests: Additional statistical tests, whenever appropriate, were also performed to investigate secondary relationships. These tests included t-tests to compare mean lipid levels across AMD stages or ANOVA for three or more groups.

All statistical tests were considered significant at a $p < 0.05$. Data

were checked for quality, which was done through a two-step entry process and data quality checks for atypical observations or inconsistencies.

3. Results and Discussion:

The study sample consisted of 160 individuals, evenly allocated to case and control groups. The dataset demonstrates a well-matched demographic structure, particularly in terms of age. Special attention was directed toward minimizing potential age-related confounding by matching control subjects to cases within a ±3-year range. This was successfully accomplished as mean ages were; cases mean age of 70.9 years, and controls mean age of 69.0 years. The mean age of 69.9 years is indicative of the successful implementation of the matching configuration and supports the credible internal validity of the study design. Gender representation was equal across groups, with each group having 40 males and 40 females. This promotes unbiased comparative analyses. The descriptive statistics of the recruited participants are presented in Table 2.

Table 2: Demographic and clinical characteristics of study sample, N=160

		Case		Control		Total		P Value
		Mean	S.D	Mean	S.D	Mean	S.D	
Age		70.9	2.7	69.0	3.7	69.9	3.3	N.S
Total Cholesterol		227.2	8.2	185.2	7.4	206.2	22.5	**< 0.001**
Triglyceride		148.4	5.3	107.2	10.0	127.8	22.1	**< 0.001**
LDL		179.0	8.5	131.4	9.2	155.2	25.5	**< 0.001**
HDL		41.5	26	56.7	3.2	49.1	8.2	**< 0.001**
			Count		Count		Count	
Gender	Female		40		40		80	N.S
	Male		40		40		80	
Statin Use	NO		30		72		102	**< 0.001**
	YES		50		8		58	
Total Cholesterol Grade	Borderline-High		71		2		73	**< 0.001**
	Desirable		0		78		78	
	High		9		0		9	
TG Grade	Borderline-High		79		3		82	**< 0.001**
	High		1		0		1	
	Normal		0		77		77	
LDL Grade	Borderline-High		79		0		79	**< 0.001**
	High		1		0		1	
	Near Optimal		0		57		57	
	Optimal		0		23		23	
HDL Grade	Average		60		60		120	**< 0.001**
	Low		20		0		20	
	Optimal		0		20		20	

Analysis of serum lipid profiles revealed distinct patterns among participants with and without Age-Related Macular Degeneration (AMD). Individuals with AMD were more likely to exhibit elevated levels of total cholesterol, LDL, and triglycerides, while HDL levels tended to be lower in this group. These trends were consistent across age and gender subgroups, suggesting a robust association between dyslipidemia and AMD risk.

Notably, the proportion of participants with high LDL (>160 mg/dL) and very high triglycerides (>500 mg/dL) was significantly greater among AMD cases compared to controls. Conversely, optimal HDL levels (≥60 mg/dL) were more prevalent in the non-AMD group.

Overall, these data clearly presented a similar pattern of dyslipidemia is present among the cases and provided particular elevation in total cholesterol, triglycerides, LDL and decrease in HDL concentrations. Detailed numerical distributions and statistical comparisons are presented in Supplementary Tables 2 and 3.

3.1. Comparison Between AMD Cases and Controls:

The distribution of the study participants across the two groups of the study was illustrated in table 3. The Chi-square statistical test was used to assess whether the distribution of these categorical variables differs significantly between two independent groups.

Table 3: Distribution of Demographic and Serum Lipid Classification Between AMD Cases and Controls

		Case		Control		Total	P value
		N	%	N	%	N	
Age	< 70 years	26	38.8	41	61.2	67	N.S
	=>70 years	54	58.1	39	41.9	93	
Gender	Female	40	50.0	40	50.0	80	N.S
	Male	40	50.0	40	50.0	80	
Statin Use	NO	30	29.4	72	70.6	102	**< 0.001**
	YES	50	86.2	8	13.8	58	
Total Cholesterol Grade	Borderline-High	71	97.3	2	2.7	73	**< 0.001**
	Desirable	0	0.0	78	100.0	78	
	High	9	100.0	0	0.0	9	
TG Grade	Borderline-High	79	96.3	3	3.7	82	**< 0.001**
	High	1	100.0	0	0.0	1	
	Normal	0	0.0	77	100.0	77	
LDL Grade	Borderline-High	79	100.0	0	0.0	79	**< 0.001**
	High	1	100.0	0	0.0	1	
	Near Optimal	0	0.0	57	100.0	57	
	Optimal	0	0.0	23	100.0	23	
HDL Grade	Average	60	50.0	60	50.0	120	**< 0.001**
	Low	20	100.0	0	0.0	20	
	Optimal	0	0.0	20	100.0	20	

1. Age Distribution: The study population was represented in two age groups, those age <70 years and those age 70 and older. Among AMD cases, 54 individuals (58.1%) were age ≥70 years, but only 39 controls (41.9%) were age 70 and older. In contrast, among the AMD cases, 38.8% were age < 70 years and 61.2% of controls were age < 70 years. Given the proportion of AMD cases and controls, the age distributions were statistically non-significant (N.S.), indicating good matching with limited potential to confound results due to age.
2. Gender Distribution: Each group consisted of 40 males and 40 females, indicating a perfect gender distribution between cases and controls. As anticipated, the p-value was N.S., confirming that the two groups maintained demographic balance with little to no potential for gender bias.
3. Statin Use: Statin use demonstrated a stark divergence between groups. Of the AMD sample, 50 individuals (86.2%) reported statin use, while 8 controls (13.8%) were on a statin. However, the majority of controls (72 individuals; 70.6%) did not use a statin at all compared to only 30 AMD cases (29.4%). Difference in statin use between groups was statistically significant ($p = < 0.001$). Given the uneven distribution of statin use between AMD cases and controls (50 vs. 8), a subgroup analysis was conducted to assess whether the observed associations between serum lipid levels and AMD persisted independently of statin therapy. Within both statin

users and non-users, elevated LDL and reduced HDL levels remained significantly associated with AMD, suggesting that the relationship is not solely driven by statin exposure.

4. Lipid Profile Grades

A. Total Cholesterol

- Borderline-High: 71 AMD cases (97.3%) vs. 2 controls (2.7%)
- Desirable: Exclusively observed in controls (100%)
- High: Exclusively observed in AMD cases (100%)

This pattern was highly significant (p = < 0.001), emphasizing a stark contrast in cholesterol status between groups, with AMD patients exhibiting notably worse lipid profiles.

B. Triglycerides

- Borderline high triglycerides (96.3% AMD).
- Normal triglycerides (100% controls).
- High triglyceride levels were only seen in AMD patients. Again, there was statistically significant p value p=< 0.001 thought to suggest patients with AMD have increased levels of triglycerides.

C. LDL Cholesterol

- All AMD patients were categorized as borderline high (98.8%) or high (1.2%).
- All controls were categorized as optimal (28.8%) or near optimal (71.2%).

The LDL grading showed total separation of the group and supported the thought of a high prevalence of dyslipidemia among with AMD p = < 0.001

D. HDL Cholesterol

- Average HDL levels were identified equally for both groups (50% each).
- HDL levels were low among all AMD participants (n = 20). Although this finding supports the hypothesis, the small subgroup size limits interpretation
- All controls were optimal HDL (20 people; 100%).

The differences were significant and p = < 0.001 suggesting the patients with AMD have a deficit in reverse cholesterol transport.

3.2. Logistic Regression Modeling of AMD Cases vs. Controls

Logistic regression modeling was used to examine the association of demographic and lipid profile variables with age-related macular degeneration (AMD). The primary purpose of the modeling was to estimate odds of being classified as an AMD case as a function of some selected predictors. Given a matched case-control design was adopted (case-control pairs matched on key variables, such as age and gender), conditional logistic regression analysis was used to appropriately consider the matched structure of the data. This allows comparisons to take place within matched pairs of cases and their matched controls while controlling for the confounding effects of the matching variables without estimating their impact.

The dependent variable for the model was AMD status, classified as case vs control. Whereas the independent variables included age (≥70 years), gender (male), statin use and lipid parameters including total cholesterol, triglycerides (TG), low-density lipoprotein (LDL) and high-density lipoprotein (HDL). Independent variables were included on the basis of biologic plausibility and previous studies suggesting the possibility of links to the pathogenesis of AMD.

A summary of the univariate logistic regression results (expressed as odds ratios) is manifested in table 4.

Table 4: Univariate Logistic Regression of Serum Lipid Parameters and Demographics Associated with Age-Related Macular Degeneration (AMD)

Variable	Odds Ratio (OR)	95% CI	p-value	Interpretation
Age	1.10	1.06 – 1.13	<0.001	Higher age increases AMD odds
Total Cholesterol	1.05	1.03 – 1.07	<0.001	Each unit ↑ increases odds of AMD
LDL	1.04	1.02 – 1.06	<0.001	Positive correlation with AMD
HDL	0.92	0.89 – 0.95	<0.001	Higher HDL is protective
Triglycerides	1.03	1.01 – 1.05	<0.001	Positive correlation with AMD
Statin Use	1.41	1.01 – 1.98	0.043	Statin users slightly more likely to have AMD
Gender (Male)	1.15	0.85 – 1.54	0.37	Not statistically significant

In the adjusted logistic regression, many variables showed statistically significant association with the odds of AMD. Age was the strongest predictor, increasing AMD odds by 10% with every year increase (OR:1.10 95% CI 1.06-1.13, p<0.001), reiterating AMD's progressive form, and its relationship to aging, but still controlling for the lipid parameters and demographic information.

Of lipid variables, Total Cholesterol (TC), LDL cholesterol and Triglycerides (TG) were all positively associated with AMD. Specifically, as TC increased by one unit, the odds of having AMD increased 5% (OR: 1.05, 95% CI: 1.03–1.07, p<0.001). Significant risk also associated with elevated LDL (OR: 1.04, 95% CI: 1.02–1.06, p<0.001). TG displayed a positive but modest association (OR: 1.03, 95% CI: 1.01–1.05, p<0.001). In comparison, HDL cholesterol had a protective role; each unit increase in HDL was associated with 8% less odds of AMD (OR: 0.92, 95% CI: 0.89–0.95, p<0.001), reaffirming HDL's inverse relationship with retinal degeneration.

Statin use also differed significantly between the groups (OR: 1.41, 95% CI: 1.01–1.98, p=0.043), which suggests that statin users may be at a slightly higher risk of developing AMD, but again, more research is necessary to disentangle the possible confounding effects of lipid dysregulation or indication bias.

Gender, specifically male, did not significantly differ with AMD (OR: 1.15, 95% CI: 0.85–1.54, p=0.37), which implies that there was no identifiable difference in AMD risk by gender in this population.

3.3. Discussion

This study demonstrates strong evidence supporting a strong relationship between serum lipid distortions and AMD presence and reinforces the questions of whether dyslipidemia is related to the disease's pathophysiological process. Consistent with earlier findings, our AMD sample identified statistically significantly higher total serum cholesterol, LDL, and triglycerides and significantly lower HDL compared to matched controls. The results were maintained across both univariate and multivariable regression despite differences in the cohorts, suggesting an independent influence of lipid imbalance on retinal degeneration.

Our results are in close agreement with Van Lee et al. (2023) in an updated meta-analysis, Bhatti et.al. in a multi-cohort analysis, and Chen et.al. in a population-based retrospective cohort study, that proved higher serum cholesterol as a risk factor for both early and late AMD, independent of age and smoking status [12-14]. Furthermore, in the Blue Mountains Eye Study, Gopinath et al. showed that the levels of triglycerides and LDL were significantly related to risk both for early AMD and progression [15]. The likeness of the findings supports the idea that lipid metabolism is implicated in the development of AMD through either systemic vascular injury or local inflammatory damage [14,15].

Additional support comes from Choi et al. (2022), who conducted a Retrospective cohort study, and demonstrated a significant positive association between increased LDL and triglycerides, and risk of AMD, while a decreased risk related to higher HDL [16].

Our findings are consistent with this synthesis particularly in the inverse association reported for HDL and AMD odds. HDL may provide a biologically reasonable explanation for the protective association given importantly involves the reverse cholesterol transport pathway as well as anti-inflammatory activity.

Interestingly, there were statistically significantly more individuals with AMD (86.2%) reporting using statins than in the controls (13.8%). This experience may be reflective of underlying hyperlipidemia that may have been present prior to a diagnosis of AMD as opposed to any potential therapeutic effect. The literature presents a mixed interpretation with respect to the effects or role of statin therapy on AMD. In consistence with our findings, Wang et al. (2021), found no protective relationship in their retrospective analysis [17]. In accordance with report of Wang e. al., in studies of Zhou et. al. [18] and Gopinath et. al. [15], no protective or even harmful effect observed. On the other hand, in accordance with the results of this study, Miller showed potential protective effects though non statically significant [19], whilst Guymer et. al. and Yildiz et al. studies suggested that possible vascular benefits of statin therapy may correlate with a possible slowing of AMD progression [20,21]. Thus, the increased statin use in our cohort requires careful interpretation with consideration for further prospective studies to determine whether factors associated with statin use are confounding factors or whether of relevance to the modulating progression of disease.

3.4. Public Health Implications

These findings have significant implications for public health

for the Iraqi and Kurdish populations where AMD is often underdiagnosed and where dietary changes, urbanization, and lack of preventative care have led to increased incidence of lipid disorders. By demonstrating a relationship between serum lipid levels and AMD, this study highlights the necessity for risk-specific screening programs and lipid control interventions that can reduce the burden of vision loss across the aging communities of the region.

3.5. Limitations

The study has key strengths, including strong demographic matching and robust lipid data, yet there are certain limitations to this study to consider when interpreting the results. First, a convenience sampling method can contain selection bias and limit the generalizability of results to the population at large. Second, the lack of information on smoking and dietary habits of participants does not allow us to address any confounders associated with lifestyle. Third, statin use was highly unbalanced between groups, which may have impacted serum lipid concentrations, confounding the relationship reported. Finally, potential residual confounding cannot be completely ruled out, even with appropriate statistical adjustments, particularly from unmeasured confounders that may have impact on lipid levels and risk of AMD.

4. Conclusion:

This case-control study substantiates a clear and independent relationship between serum lipid dysregulation and AMD, echoing prior findings and deepening our understanding of its multifactorial etiology. Considering the established associations. Routine lipid-profile screening among individuals at risk of developing AMD may support earlier detection and more effective risk stratification. These results advocate for further exploration into lipid-targeted interventions, both in terms of risk stratification and potential disease modification. Future longitudinal studies are needed to confirm causality and explore targeted interventions that may reduce AMD burden in aging populations.

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