https://doi.org/10.34883/PI.2024.14.3.031

Muataz Hasan Jaaz
University of Thi-Qar, Thi-Qar, Iraq

Correlating Cataract Occurrence with Diabetes Type and Duration: A Comprehensive Study

Conflict of interest: nothing to declare.

Submitted: 27.08.2024
Accepted: 09.09.2024
Contacts: Medicalreseach11@yahoo.com

Abstract

Background. The global prevalence of diabetes mellitus, projected to affect over 439 million people by 2030, presents significant challenges, particularly in relation to ocular health. Among the various complications associated with diabetes, cataracts are a leading cause of visual impairment, largely due to metabolic and oxidative stressors induced by chronic hyperglycemia.
Purpose. This study purposed to explore the relationship between cataract formation and the type and duration of diabetes, focusing on the impact of prolonged diabetes and associated risk factors on cataract development.
Materials and methods. A cross-sectional observational study was conducted from October 2022 to December 2023, involving 60 diabetic patients with and without cataracts, recruited from a specialized outpatient clinic. Participants were categorized by diabetes type, duration, and cataract presence.
Results. The study found that longer diabetes duration (≥20 years) was significantly associated with a higher prevalence of cataracts (OR=4.579, p=0.037). Age was also a significant factor, with cataract patients being older on average (p<0.001). No significant differences were observed regarding gender (p=0.628), type of diabetes (p=0.89), or diabetes treatment (p=0.146). The study also found no significant association between smoking or hypertension and
Conclusion. Prolonged diabetes duration and advanced age are significant risk factors for cataract development in diabetic patients. These findings highlight the importance of early and sustained glycemic control to mitigate the risk of cataract formation and the necessity of regular ophthalmic evaluations, especially for long-term diabetics.
Keywords: diabetes mellitus, cataract formation, diabetes duration, ocular complications, glycemic control

Муатаз Хасан Джааз
Университет Ти-Кар, Ти-Кар, Ирак

Корреляция возникновения катаракты с типом и продолжительностью диабета: комплексное исследование

Конфликт интересов: не заявлен.

Подана: 27.08.2024
Принята: 09.09.2024
Контакты: Medicalreseach11@yahoo.com

Резюме

Введение. Глобальная распространенность сахарного диабета, которая, по прогнозам, затронет более 439 миллионов человек к 2030 г., влечет за собой значительные проблемы, особенно в отношении здоровья глаз. Среди различных осложнений, связанных с диабетом, катаракта является основной причиной нарушения зрения, в основном из-за метаболических и окислительных стрессоров, вызванных хронической гипергликемией.

Цель. Изучение связи между образованием катаракты и типом и продолжительностью диабета с упором на влияние длительного диабета и связанных с ним факторов риска на развитие катаракты.

Материалы и методы. Кросс-секционное наблюдение проводилось с октября 2022 г. по декабрь 2023 г. с участием 60 пациентов с диабетом и катарактой и без нее, набранных в специализированной амбулаторной клинике. Участники были распределены по типу диабета, продолжительности и наличию катаракты.

Результаты. Исследование показало, что более длительная продолжительность диабета (≥20 лет) была значительно связана с более высокой распространенностью катаракты (OR=4,579, p=0,037). Возраст также был значимым фактором, при этом пациенты с катарактой были в среднем старше (p<0,001). Не было выявлено значимых различий в отношении пола (p=0,628), типа диабета (p=0,89) или его лечения (p=0,146). Исследование также не обнаружило значимой связи между курением или гипертонией.

Заключение. Длительная продолжительность диабета и пожилой возраст являются значимыми факторами риска развития катаракты у пациентов с диабетом. Эти результаты подчеркивают важность раннего и постоянного контроля гликемии для снижения риска образования катаракты и необходимость регулярных офтальмологических обследований, особенно для пациентов с диабетом длительной продолжительности.

Ключевые слова: сахарный диабет, образование катаракты, длительность диабета, глазные осложнения, гликемический контроль

■ INTRODUCTION

The universal prevalence of diabetes mellitus signifies the need for comprehensive medical research to address its multifaceted impact on global health, as more than 285 million people are estimated to be affected by this disease. The estimation is expected to surpass the to 439 million by 2030 [1]. Diabetes is fundamentally characterized by the body's inability to produce or effectively use insulin. It is categorized into two types depending on the mechanism of development. However, the lack of effective insulin action in both types prevents the body from properly processing glucose, leading to elevated blood glucose levels and subsequent complications [2]. Diabetes has emerged as a global challenge, as the numbers of people suffering from diabetes are increasing consistently with the Western Pacific regions hosting the higher prevalence [3]. Due to rapid economic development and nutritional transition, Asia is considered the epicenter of the global diabetes epidemic, along with the Gulf region and the Middle East which are gradually exhibiting an increase in the prevalence of diabetes [3, 4].

Ocular conditions associated with diabetes are well-recognized globally due to the potential progression to serious ophthalmic complications and vision loss, and one of the main causes of visual impairment in diabetic patients is cataracts [5]. Diabetic cataracts originate from a defect in the polyol pathway, where the enzyme aldose reductase converts glucose to sorbitol, leading to potential sorbitol accumulation within the lens. Subsequently, osmotic changes take place resulting in lens fiber degeneration and cataract formation [6, 7]. The osmotic stress contributes to apoptosis in lens epithelial cells which adds to the progression of cataracts. Moreover, the elevated glucose in diabetic patients signifying glycation of lens proteins, along with the oxidative stress resulted from the polyol pathway can play an important role in progression of cataracts and the exacerbation of lens damage [8].

It was demonstrated that cataracts are three to four times more prevalent in patients with diabetes than healthy individuals [9]. Diabetes was also linked to cortical cataracts and the need for cataract surgery in relation to age-related eye conditions [10]. Some ophthalmic investigations presented a three to four times higher occurrence of cataracts in diabetic individuals below the age of 65, and a twofold increased occurrence in those aged 65 and above [11]. A Hospital-based comparative study conducted in Karachi, found a strong relationship between age advancement and cataracts development in diabetic patients, particularly among men [12].

This comprehensive study aims to delve into the intricate correlation between cataract occurrence and type and duration of diabetes. Understating this relationship is important for early detection, development of prevention strategies and tailoring treatment approaches. A differentiation between type 1 and type 2 diabetes will be presented along with their duration, exploring how both factors contribute to the development progression of cataracts.

■ MATERIALS AND METHODS

Study Design

This study is a cross-sectional observational analysis aimed at exploring the correlation between cataract occurrence and various types and durations of diabetes. By examining a cohort of 60 patients with diabetes, both with and without cataracts, this research seeks to understand the nuanced relationships between these conditions.

Setting and Population

The study was conducted between October 2022 and December 2023. Participants were selected from an outpatient clinic specializing in diabetes and ophthalmology care, ensuring a relevant population for the research question. All participants were diagnosed with diabetes and were further categorized based on the presence or absence of cataracts, as diagnosed through clinical assessment.

Inclusion Criteria

- Individuals diagnosed with any type of diabetes.
- Age 18 years or older.

Exclusion Criteria

- Patients with a history of ocular surgery, including previous cataract surgery.
- Diagnoses of other major ocular diseases that could influence cataract development (e.g., glaucoma, retinopathy not related to diabetes).
- Inability to undergo slit-lamp examination due to physical or psychological reasons.
- Patients with uncontrolled systemic diseases that could influence ocular health, such as uncontrolled hypertension or autoimmune diseases, to minimize confounding effects on cataract development.
- Individuals with a history of ocular trauma or injury.
- Patients using systemic or ocular corticosteroids within the last 12 months.
- correction surgery.
- Patients with significant visual impairment from causes other than cataracts.

Data Collection and Evaluation

Data collection involved a detailed review of patient medical records for diabetes type, duration, and management history. Cataract diagnosis was confirmed through slit-lamp examination by experienced ophthalmologists.

Ethical Approval

Written informed consent was obtained from all participants prior to inclusion in the study, ensuring their awareness and voluntary participation.

Statistical Analysis

Statistical analyses were performed using SPSS software, version 26. The chi-square test was utilized to examine the association between categorical variables, such as the presence of cataracts and types of diabetes. The Mann-Whitney U test was employed for comparing the duration of diabetes between patients with and without cataracts. Logistic regression analysis was conducted to identify potential predictors of cataract occurrence within the diabetic population, adjusting for relevant confounders. A p-value of <0.05 was considered statistically significant for all test.

RESULTS

The analysis reveals a significant age difference between cataract and non-cataract groups, with the former being older ($P<0.001$), indicating age as a key factor in cataract development. Gender shows no significant impact on cataract occurrence ($P=0.628$). This

Table 1
The demographical data distribution between the two groups

Variables		Cataract Group (No. 28)	Non-Cataract Group (No. 32)	P-value
Age (years) (mean±SD)		62.21–14.34	49.41–12.15	<0.001
Sex	Male	14 (50.0%)	14 (43.8%)	0.628
	Female	14 (50.0%)	18 (56.3%)	
Side of cataract	Unilateral	8 (28.6%)	–	–
	Bilateral	20 (71.4%)		

Table 2
Diabetes-related data distribution between the two groups

Variables		Cataract Group (No. 28)	Non-Cataract Group (No. 32)	P-value
Duration of Diabetes	<20 years	19 (67.9%)	29 (90.6%)	0.028
	≥20 years	9 (32.1%)	3 (9.4%)	
Type of Diabetes	Type I	2 (7.1%)	2 (6.3%)	0.89
	Type II	26 (92.9%)	30 (93.8%)	
Type of treatment	Insulin	8 (28.6)	15 (46.9)	0.146
	Oral medication	20 (71.4)	17 (53.1)	

Table 3
Logistic Regression analysis of the duration of diabetes factor

Variables	Coefficient regression	Odd ratio	Standard error	P-Value	95% CI
Duration of DM ≥20 years	1.521	4.579	0.729	0.037	1.097–19.11

summary underscores age as a crucial determinant in the development of cataracts, while gender appears unrelated.

The dataset reveals a significant association between the duration of diabetes and cataract development, with longer diabetes duration linked to higher cataract prevalence (P=0.028). No significant differences are noted in diabetes type (P=0.89) or treatment methods (P=0.146) between cataract and non-cataract groups.

The logistic regression analysis indicates a significant relationship between the duration of diabetes (≥20 years) and the likelihood of developing cataracts. With a coefficient of 1.521 and an odds ratio (OR) of 4.579, individuals with diabetes for 20 years or more are approximately 4.6 times more likely to develop cataracts compared to those with a shorter duration. The P-value of 0.037 confirms the statistical significance of this finding. The 95% confidence interval (CI) for the OR ranges from 1.097 to 19.11.

■ DISCUSSION

This study has demonstrated a significant correlation between the duration of diabetes and cataracts formation. It is shown that individuals who had diabetes for 20 years or more are approximately 4.6 times more likely to develop cataracts compared to those with shorter durations (P=0.037). This finding is consistent with previous research

which indicates that chronic hyperglycemia in long-term diabetes and poor glycemic control contribute to cataract formation, alongside other risk factors such as anemia, macroalbuminuria, high triglyceride level, diabetic retinopathy and lower socioeconomic status [13, 14]. Aldose reductase converts glucose into sorbitol, initiating a hyperosmotic gradient within lens fibers. This gradient results in the collapse and liquefaction of lens fibers, contributing to the development of cataracts. This process is known as the polyol pathway [15]. Furthermore, osmotic and oxidative stress are implicated in the development of diabetic cataracts. The accumulation of sorbitol, leading to increased free radical production and osmotic stress within the endoplasmic reticulum of the lens, results in damage to lens fibers, apoptosis of lens epithelial cells, and the formation of cataracts [16, 17]. Additionally, research indicates a reduction in the antioxidant enzyme superoxide dismutase (SOD) levels in the eyes of diabetic individuals. Conversely, levels of oxidative radicals such as hydrogen peroxide (H2O2), hydroxyl radicals (OH-), and nitric oxide (NO) are found to be elevated [18, 19].

Age was another significant factor influencing cataract development in this study. Participants with cataracts were notably older than those without ($P<0.001$), this shows that age-related degenerative processes in the lens contribute to cataractogenesis. This observation aligns with existing literature that identified age as one of the major risk factors for cataracts development [13, 20]. Song et al. reported that by the age of 60, 15% of individuals develop age-related cataracts, while by the age of 80, this prevalence increases to 50% [21]. The three primary types of age-related cataracts are nuclear, cortical, and subcapsular cataracts. There is an overlap in the mechanisms and clinical presentations of these types, however, the precise biological mechanisms underlying their formation remaining unclear, as highlighted by Sinha et al. [22]. Generally, as individuals age, there is a simultaneous increase in lenticular protein oxidation and protein disulfide cross-linking, accompanied by a decrease in lens elasticity. These factors collectively with ocular oxidative stress, alterations in lenticular ion transport, and changes in lens epithelial cells (LECs), such as aberrant LEC-to-fiber differentiation, contribute to cataract development [23].

Interestingly, the findings of this study indicated no significant differences in cataract occurrence related to gender or type of diabetes treatment, which suggests that the pathophysiology of cataracts in diabetic patients might be more influenced by metabolic control and diabetes duration rather than treatment type per se or gender-based physiological differences. This contrasts with the findings of the Wisconsin Epidemiological Study of Diabetic Retinopathy, which concluded that the use of insulin is linked to an increased incidence of cataract development and the need for surgery among individuals with type 2 diabetes [16]. Becker et al. also observed an increased risk of cataract in insulin users, which they explained by the higher percentage of poor glycemic control in insulin users compared with diabetics without insulin therapy [24]. Regarding gender, Janghorbani et al. [25] reported a higher risk of cataracts among diabetic women when compared to diabetic men. A previous study by Harding et al. [26], also documented the same finding. Both of these studies contradict the findings of the present study.

The study's limitations include its cross-sectional design, which can only infer associations rather than causality. Furthermore, the study's sample size and demographic might limit the generalizability of the findings. Future longitudinal studies are needed to confirm these observations and explore the mechanisms underlying the observed associations.

■ CONCLUSION

This study highlights a strong correlation between diabetes duration and cataract formation, emphasizing the impact of chronic hyperglycemia and poor glycemic control. Age also emerged as a significant factor in cataract development. Interestingly, no significant differences were found based on gender or type of diabetes treatment, suggesting that metabolic control and duration of diabetes may be more influential factors.

■ REFERENCES

1. Pollreisz A, Schmidt-Erfurth U. Diabetic cataract – pathogenesis, epidemiology and treatment. *Journal of ophthalmology.* 2010;2010(1):608751.
2. Shivashankar M, Mani D. A brief overview of diabetes. *International Journal of Pharmacy and Pharmaceutical Sciences.* 2011;3(4):22–7.
3. Yang W, Lu J, Weng J, Jia W, Ji L, et al. Prevalence of diabetes among men and women in China. *New England journal of medicine.* 2010;362(12):1090–101.
4. Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes research and clinical practice.* 2010;87(1):4–14.
5. Jingi AM, Nansseu JRN, Noubiap JJN, Bilong Y, Ellong A, et al. Diabetes and visual impairment in sub-Saharan Africa: evidence from Cameroon. *Journal of Diabetes & Metabolic Disorders.* 2015;14:1–8.
6. Thorne CA, Grey AC, Lim JC, Donaldson PJ. The Synergistic Effects of Polyol Pathway-Induced Oxidative and Osmotic Stress in the Aetiology of Diabetic Cataracts. *International Journal of Molecular Sciences.* 2024;25(16):9042.
7. Mathebula SD. Polyol pathway: A possible mechanism of diabetes complications in the eye. *African vision and eye health.* 2015;74(1):5.
8. Guo Z, Ma X, Zhang RX, Yan H. *Oxidative stress, epigenetic regulation and pathological processes of lens epithelial cells underlying diabetic cataract. Advances in ophthalmology practice and research.* 2023.
9. Kiziltoprak H, Tekin K, Inanc M, Goker YS. Cataract in diabetes mellitus. *World journal of diabetes.* 2019;10(3):140.
10. Mamatha BS, Nidhi B, Padmaprabhu CA, Pallavi P, Vallikannan B. Risk factors for nuclear and cortical cataracts: A hospital based study. *Journal of Ophthalmic & Vision Research.* 2015;10(3):243.
11. Haddad NMN, Sun JK, Abujaber S, Schlossman DK, Silva PS, editors. *Cataract surgery and its complications in diabetic patients. Seminars in ophthalmology.* 2014: Taylor & Francis.
12. Memon AF, Mahar PS, Memon MS, Mumtaz SN, Shaikh SA, et al. Age-related cataract and its types in patients with and without type 2 diabetes mellitus: A Hospital-based comparative study. *J Pak Med Assoc.* 2016;66(10):1272–6.
13. Raman R, Pal SS, Adams JSK, Rani PK, Vaitheeswaran K, et al. Prevalence and risk factors for cataract in diabetes: Sankara Nethralaya Diabetic Retinopathy Epidemiology and Molecular Genetics Study, report no. 17. *Investigative Ophthalmology & Visual Science.* 2010;51(12):6253-61.
14. Chen S-J, Liu J-H, Shih H-C, Chou P, Tsai C-Y, et al. Prevalence and associated factors of lens opacities among Chinese type 2 diabetics in Kinmen, Taiwan. *Acta diabetologica.* 2008;45:7–13.
15. Kador PF, Wyman M, Oates PJ. Aldose reductase, ocular diabetic complications and the development of topical Kinostat®. *Progress in retinal and eye research.* 2016;54:1–29.
16. Klein BE, Klein R, Moss SE. Incidence of cataract surgery in the Wisconsin Epidemiologic Study of Diabetic Retinopathy. *American journal of ophthalmology.* 1995;119(3):295–300.
17. Bayraktar Bilen N, Sarıcaoğlu MS. Assessment of cataract forming effect of diabetes in young adults by lens densitometer. *International Ophthalmology.* 2020;40(12):3357–62.
18. Olofsson EM, Marklund SL, Behndig A. Enhanced diabetes-induced cataract in copper-zinc superoxide dismutase – null mice. *Investigative Ophthalmology & Visual Science.* 2009;50(6):2913–8.
19. Olofsson EM, Marklund SL, Karlsson K, Brännström T, Behndig A. In vitro glucose-induced cataract in copper – zinc superoxide dismutase null mice. *Experimental eye research.* 2005;81(6):639–46.
20. Zhang X, Zhao J, Zhao T, Liu H. Effects of intensive glycemic control in ocular complications in patients with type 2 diabetes: a meta-analysis of randomized clinical trials. *Endocrine.* 2015;49:78–89.
21. Song P, Wang H, Theodoratou E, Chan KY, Rudan I. The national and subnational prevalence of cataract and cataract blindness in China: a systematic review and meta-analysis. *Journal of global health.* 2018;8(1).
22. Sinha R, Kumar C, Titiyal JS. Etiopathogenesis of cataract. *Journal review. Indian journal of ophthalmology.* 2009;57(3):245–9.
23. Richardson RB, Ainsbury EA, Prescott CR, Lovicu FJ. Etiology of posterior subcapsular cataracts based on a review of risk factors including aging, diabetes, and ionizing radiation. *International journal of radiation biology.* 2020;96(11):1339–61.
24. Becker C, Schneider C, Aballéa S, Bailey C, Bourne R, et al. Cataract in patients with diabetes mellitus – incidence rates in the UK and risk factors. *Eye.* 2018;32(6):1028–35.
25. Janghorbani M, Jones RB, Allison SP. Incidence of and risk factors for cataract among diabetes clinic attenders. *Ophthalmic epidemiology.* 2000;7(1):13–25.
26. Harding JJ, Egerton M, Van Heyningen R, Harding R. Diabetes, glaucoma, sex, and cataract: analysis of combined data from two case control studies. *British Journal of Ophthalmology.* 1993;77(1):2–6.