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**ORIGINAL RESEARCH**

# A prospective study of the prevalence of various ocular manifestations of diabetes mellitus in the Rural patients reporting at Varun Arjun Medical College & Rohilkhand Hospital Banthra, District: Shahjahanpur, UP, India

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## ABSTRACT

**Background:** Diabetes Mellitus (DM) is a significant global health issue, contributing to various ocular complications. Early detection is crucial to preventing visual impairment, especially in underserved rural populations. This study assesses the prevalence of ocular manifestations in diabetic patients from a rural tertiary care centre. **Methods:** A prospective study was conducted at Varun Arjun Medical College & Rohilkhand Hospital, Shahjahanpur, Uttar Pradesh, India, from April 2021 to March 2024. A total of 5,162 diabetic patients (Type 1 and Type 2) underwent comprehensive ophthalmic evaluations, including visual acuity, intraocular pressure, and fundus examinations. Systemic and laboratory investigations supplemented the findings. Data were analyzed to determine the prevalence of ocular conditions. **Results:** Ocular manifestations were present in 89% of patients, with cataracts (30%), dry eye syndrome (26%), diabetic retinopathy (20%), and glaucoma (12%) being the most common. Other conditions included blepharitis (8%), recurrent chalazion (6%), and anterior ischemic optic neuropathy (2%). Patients aged 25-50 constituted 52%, while 44% were above 50. **Conclusion:** The study highlights a high prevalence of ocular complications in rural diabetic patients, particularly cataracts, dry eye syndrome, and diabetic retinopathy. These findings emphasise the need for early screening and patient education to prevent visual impairment and ensure timely management.



## INTRODUCTION

Diabetes Mellitus (DM) is a global health concern that demands a collaborative global approach. Researchers have found that 10.5% of individuals between the ages of 20 and 79 years are affected by DM, with 50% of them unaware of their condition (1). DM is a multi-systemic disease characterized by hyperglycemia, and its incidence is increasing worldwide (2). It is a chronic condition resulting from the pancreas not producing enough insulin or the body not effectively utilizing the insulin it produces (3). Prevalence is rising more rapidly in low and middle-income group countries than in high-income ones. One in ten adults (10.5%) globally is currently living with diabetes (4). According to the Indian Council of Medical Research (ICMR) INDIAB study published in 2023, the magnitude of diabetes in India is 10.1 crore, affecting 6-7% of the population (5). The increasing prevalence can be attributed to factors such as ageing, diet, obesity, and physical inactivity (6). The rise in Type 2 diabetes in India is also linked to rapid urbanization in rural areas (7).

Diabetes is strongly associated with both microvascular and macrovascular complications, including retinopathy, nephropathy, neuropathy (microvascular), ischemic heart disease, peripheral vascular disease, and cerebrovascular disease (macrovascular), leading to organ and tissue damage

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(8). People with diabetes are approximately 25 times more likely to become blind than those without diabetes (9). It is estimated that 21 million individuals with diabetes in India suffer from vision impairment, of which 2.4 million are blind (10). Complications from DM are progressive, primarily resulting from chronic exposure to high glucose levels, leading to dysfunction in various macromolecules like carbohydrates, lipids, and proteins (11).

Diabetic eye disease encompasses several ocular problems that arise due to diabetes; as the prevalence of diabetes grows, so do the associated ocular disorders (12). Some common conditions include frequent changes in refractive power, dry eye, recurrent sties, chalazia, blepharitis, cataracts, diabetic retinopathy, and various forms of glaucoma (13). Less common manifestations include extra-ocular muscle palsy, orbital cellulitis, and anterior ischemic optic neuropathy (AION). While diabetic retinopathy is well-known, other ocular complications are often overlooked (14).

Cataracts are a significant complication of diabetes and may develop at younger ages (15). Diabetic patients are 2-5 times more likely to develop cataracts and at an earlier age compared to non-diabetics (16,17). The association between diabetes and glaucoma has been thoroughly studied, and diabetes is a major factor in the development of neovascular glaucoma (NVG) (18). Bilateral involvement in normal-tension glaucoma is often observed in diabetic patients due to impaired neurovascular regulation processes (19).

Educating diabetic patients about their condition is crucial for promoting positive healthcare behaviors. Awareness levels in rural areas tend to be lower compared to urban regions due to disparities in education and healthcare infrastructure. Despite the high risk of blindness, studies show that most diabetic patients do not seek the recommended ocular examinations (20). It is essential to assess patients' knowledge of diabetes-related ocular manifestations to identify barriers to seeking proper eye care and treatment (21).

There is no recent study on the prevalence of various ocular manifestations of diabetes mellitus across rural geographical divisions of India (22). This could also impact identifying where diabetic retinopathy (DR) screening and treatment programs are needed in rural populations. Therefore, the objective of the current study is to assess the prevalence of various ocular manifestations of diabetes mellitus in the patients reporting at Rohilkhand Hospital, which can also help assess the lacunae in the health awareness of the patients by generating awareness and promoting health education, making it a step towards preventing and managing ocular complications of diabetes (23). There is a significant difference between urban and rural populations in terms of health awareness, education, and availability of health infrastructure (24)

## MATERIAL AND METHODS

This prospective study was conducted at Varun Arjun Medical College and Rohilkhand Hospital Banthra, Shahjahanpur, Uttar Pradesh, India PIN 242307, a tertiary care hospital located in a rural area. We evaluated all diabetic patients (Type 1+Type 2) visiting eye OPD, Department of Ophthalmology and Diabetic Clinic. The Study period was of 3 years from 01/04/2021 to 31/03/24. We registered all new patients and followed up with old patients during this period and willing patients of all age groups and ethnicities were incorporated in this study. A total of 5162 diabetic patients, both Type 1 and Type 2, were included. A detailed ophthalmic workup was performed for each patient.

Over three years, we thoroughly examined ocular manifestations in these patients. Initial data included the registration number, name, age, sex, and occupation. We also recorded contact details to facilitate necessary follow-up. The patient‘s primary ocular complaints like discomfort, watering, vision loss, floaters, flashes, ocular pain, and metamorphopsia were noted. We gathered information about the type of DM, duration, current treatment as well as treatment history for any associated systemic condition. We followed DM's definition as “fasting blood sugar level 126mg/dl and or postprandial 200 mg/dl or more” (25). A thorough assessment including other systemic diseases, and a history of past hospitalizations were also done. Visual acuity was recorded using a Snellen’s chart, and intraocular pressure was assessed with an Applanation tonometer before dilating the pupil. Both eyes underwent colour vision tests and detailed examination with a torch light/ slit lamp evaluation. Fundus examination of both eyes was done using tropicamide plus phenylephrine eye drops, by both direct and indirect ophthalmoscopes to assess the media, optic disc, blood vessels, macula, and peripheral retina.

Basic investigations, including fasting blood sugar, postprandial blood sugar, Hba1c, urine analysis, and complete blood count, were performed and documented. In certain patients renal function tests, lipid profile and liver function tests were also done. All patients’ data was recorded according to the Performa in physical and electronic form for the study. The main division of ocular manifestations of DM such as Ocular Surface Disorder (OSD), Glaucoma, Cataract and Diabetic Retinopathy (DR) were recorded separately with age and sex distribution.

## RESULTS

Over a period of three years, 5162 diabetic patients were included in this study, in them 182 patients aged 0-25 years, 2694 patients aged 25-50 years, and 2286 patients over 50 years. The gender distribution was 55% maleand 45% female. Type 2 diabetes was present in 60% of patients, while 40% had Type 1 diabetes. We did not find any ocular manifestation in

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11% patients. The remaining 89% patients displayed a variety of conditions, with cataracts being the most prevalent that is 30%, followed by dry eye (26%), diabetic retinopathy (20%), and glaucoma (12%) and other complications.

**Table 1: Age and Sex Distribution**

| Age group | Female | Male | Subtotal |
|---|---|---|---|
| 0-25 Years | 81 | 101 | 182 |
| 25-50 Years | 1205 | 1489 | 2694 |
| >50 Years | 1028 | 1258 | 2286 |
| Grand Total | 2314 | 2848 | 5162 |

In this study, 89% of the patients (4,595 individuals) presented with various ocular manifestations. On the other hand, 11% of the patients (567 individuals) had no ocular manifestations.It is important to note that a single patient may have more than one type of ocular manifestation. Therefore, the totals in Table 2 reflect the occurrences of specific conditions, not the total number of patients.

**Chart 1: PIE chart representation of the distribution of Diabetic patients with and without ocular manifestation**

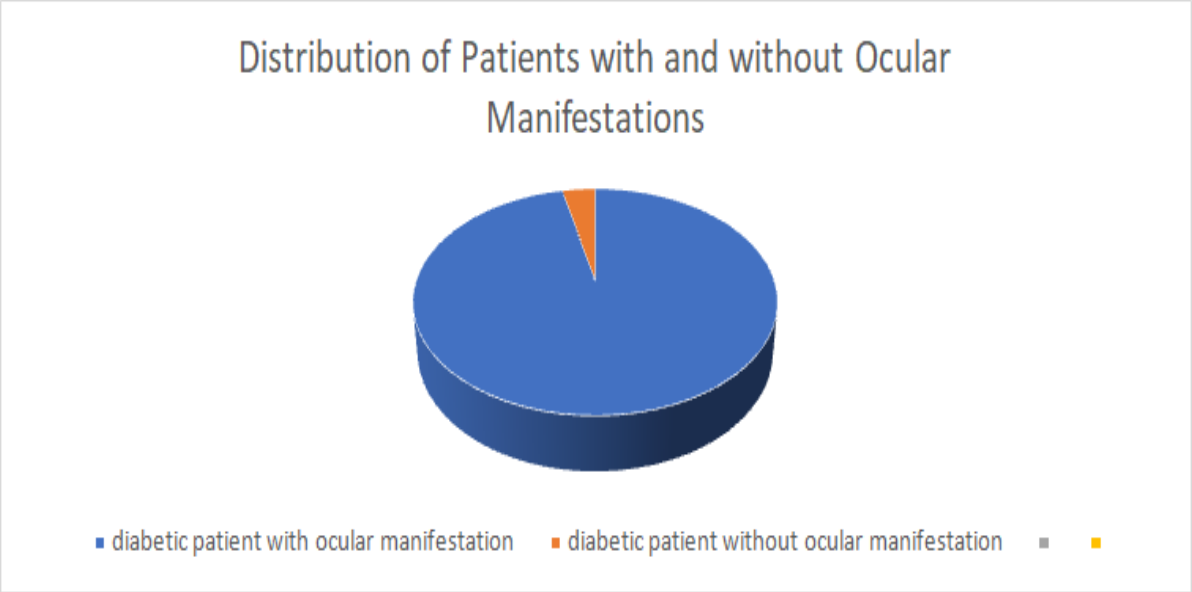


**Table 2: Distribution of Ocular Manifestations and Their *Percentage* of Occurrence in the Total Study Population (N=5,162)**

| Sno. | Ocular manifestations | No. Of patients | Percentage |
|---|---|---|---|
| 1 | Recurrent stye | 258 | 5 |
| 2 | Recurrent chalazion | 309 | 6 |
| 3 | Blepharitis | 413 | 8 |
| 4 | Dry Eye | 1342 | 26 |
| 5 | Cataract | 1549 | 30 |
| 6 | Glaucoma | 619 | 12 |
| 7 | Diabetic Retinopathy | 1032 | 20 |
| 8 | Anterior Ischemic optic neuropathy | 103 | 2 |
| 9 | Extra Ocular Muscle Palsy | 103 | 2 |

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**Chart 2: Bar chart representation of the distribution of Ocular Manifestations and Their Percentage of Occurrence in the Total Study Population**

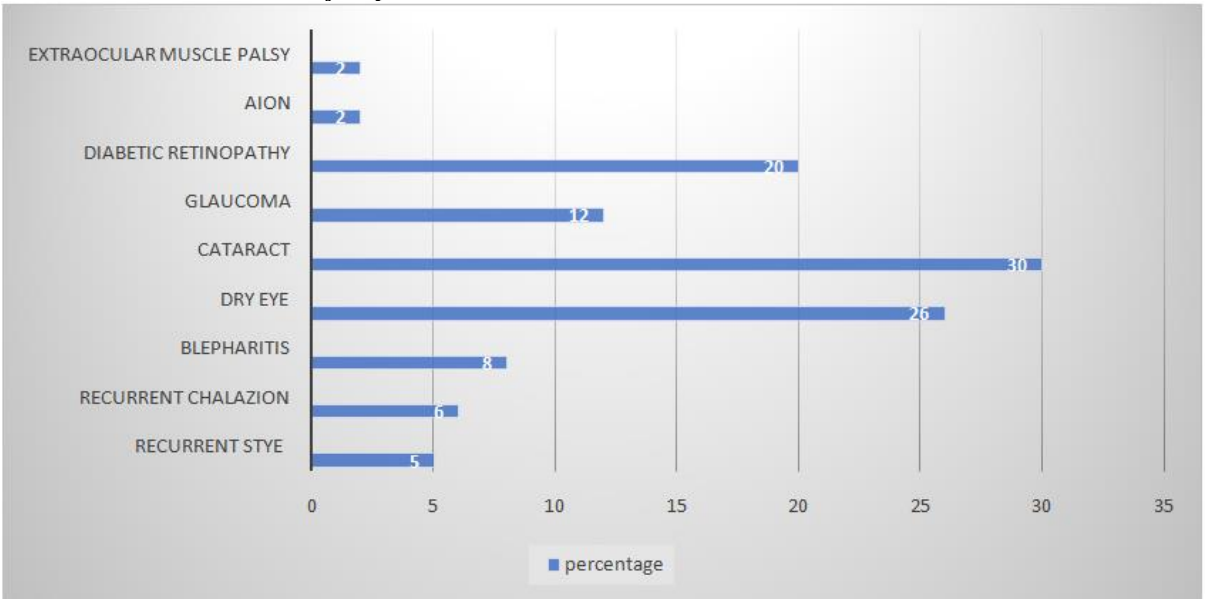


**Table 3: Summary of Observations**

| Age Group in Years | Female | Male | Total Male-Female | Adnexal and Ocular Surface Manifestations | Glaucoma | Cataract | Diabetic Retinopathy | Neurological &Vascular Manifestations |
|---|---|---|---|---|---|---|---|---|
| 0-25 | 81 | 101 | 182 | 91 | 13 | 23 | 19 | 3 |
| 25-50 | 1205 | 1489 | 2694 | 1347 | 323 | 808 | 539 | 135 |
| >50 | 1028 | 1258 | 2286 | 1142 | 283 | 718 | 474 | 120 |
| Grand Total | 2314 | 2848 | 5162 | 2580 | 619 | 1549 | 1032 | 258 |

## DISCUSSION

The updated study with 5162 diabetic patients highlights the significant prevalence of various ocular manifestations, including cataracts, diabetic retinopathy, glaucoma, dry eye, and more. The findings have been compared with other prominent Indian studies to provide a comprehensive understanding of the burden of these conditions in diabetic populations.

### Cataracts

Cataracts were the most common ocular manifestation in our study, affecting 30% of patients. This prevalence aligns closely with the findings from the Beaver Dam Eye Study, which reported a 33% prevalence of cataracts among older-onset diabetic patients(15). The Aravind Comprehensive Eye Study also observed a high prevalence of cataracts, ranging from 35-40%, due to delayed healthcare access in rural areas(28). Our results are also comparable to the Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR), which found an incidence rate of 30-35%(16).

### Diabetic Retinopathy (DR)

In our study, 20% of patients had Diabetic Retinopathy (DR), a figure lower than the WESDR findings of 40%(27). However, this is consistent with the Andhra Pradesh Eye Disease Study, which reported a DR prevalence of 25%(22). Factors such as lower rates of routine eye exams and healthcare access may explain this discrepancy in rural populations.

### Glaucoma

Glaucoma was observed in 12% of patients in this study, which is consistent with the results from the Aravind Comprehensive Eye Study, where the prevalence of glaucoma in diabetic populations ranged between 10-15%(28). Similar results were reported by George R et al., who found a glaucoma prevalence of 12-15% in diabetic patients(32). The high prevalence underscores the need for screening programs targeting diabetic populations.

### Dry Eye Syndrome

Our study found that 26% of patients suffered from dry eye syndrome, a figure closely resembling Patil M et al. (2020), who reported 27% prevalence in rural diabetic populations(34). Another study, conducted by Naik K et al. (2022), found a similar prevalence, indicating a strong correlation between diabetes and dry eye syndrome(33).

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**Recurrent Stye**

In this study, a prevalence of 5% was noted for recurrent styes among diabetic patients. While limited studies specifically focus on the prevalence of recurrent styes in diabetic populations, the link between diabetes and conditions like meibomian gland dysfunction (MGD) and blepharitis is well-established, both of which increase the likelihood of developing styes. According to sources such as All About Vision and the American Academy of Ophthalmology, diabetes can lead to frequent occurrences of blocked oil glands (MGD), which significantly contributes to the formation of styes. Furthermore, the study by Nivedha S. Raman et al. (2018) found that ocular surface diseases, including MGD and blepharitis, were more common among diabetics, suggesting a higher risk for related complications like styes(35). Another study by Prasad T et al. (2020) found a prevalence of 12% in diabetic populations, particularly in rural settings (37).

**Anterior Ischemic Optic Neuropathy (AION)**

Anterior ischemic optic neuropathy (AION) was observed in 2% of patients. While Chen T et al. (2013) did not provide a specific prevalence percentage, their meta-analysis found that diabetes mellitus is associated with a 1.64 times increased risk of AION compared to non-diabetic individuals, emphasizing the heightened risk for diabetic patients. (37).

**Other Ocular Manifestations**

Other ocular manifestations, including recurrent chalazion and blepharitis, were observed in smaller proportions in our study. Chalazion had a prevalence of 6%, which is consistent with other findings in studies of rural diabetic population. Research has shown that diabetics are more prone to lid disorders, including chalazion, due to increased inflammation and meibomian gland dysfunction (MGD), which commonly affects diabetic patients. Blepharitis was present in 8% of the patients in our study, aligning with data from Lemp MA et al. (2009), who highlighted that diabetic patients have a higher risk of developing blepharitis, often linked to MGD. These lid conditions, exacerbated by diabetes, are frequently associated with tear film instability and chronic lid inflammation.(35,39)

**Extra-ocular Muscle Palsy**

Extra-ocular muscle palsy affected 2% of patients in our study, consistent with a prevalence of 2-4% reported by Harris RA et al. (2019), which linked cranial nerve palsies with diabetic patients (41).

## CONCLUSION

This study highlights the significant burden of ocular complications in diabetic patients, particularly in rural areas. Cataracts, diabetic retinopathy, and glaucoma are the most common manifestations, and their prevalence is consistent with findings from both rural and urban studies. The study underscores the urgent need for early detection and management of these conditions to prevent visual impairment in diabetic populations. The higher prevalence of ocular surface diseases like dry eye syndrome and recurrent stye in rural populations further emphasizes the need for improved healthcare infrastructure in these areas.

**Abbreviations Used**

- DM – Diabetes Mellitus
- DR – Diabetic Retinopathy
- AION – Anterior Ischemic Optic Neuropathy
- OSD – Ocular Surface Disease
- POAG – Primary Open-Angle Glaucoma
- DED – Dry Eye Disease
- MGD – Meibomian Gland Dysfunction
- NVG – Neovascular Glaucoma
- IOP – Intraocular Pressure
- BCVA – Best Corrected Visual Acuity
- FBS – Fasting Blood Sugar
- HbA1c – Hemoglobin A1c

## REFERENCES

1. International Diabetes Federation. Diabetes Facts and Figures. International Diabetes Federation. May 7, 2024. Available from: https://idf.org/about-diabetes/diabetes-facts-figures/
2. International Diabetes Federation. IDF Diabetes Atlas, 10th Edition. 2021. Available from: https://diabetesatlas.org
3. American Diabetes Association. Standards of Medical Care in Diabetes—2023. Diabetes Care. 2023;46(Suppl. 1):S1–S254. DOI: 10.2337/dc23-SINT
4. World Health Organization. Global report on diabetes. WHO. 2016. Available from: https://www.who.int/publications/i/item/9789241565257
5. Anjana RM, Unnikrishnan R, Deepa M, Pradeepa R, Tandon N, Das AK, Joshi S, Bajaj S, Jabbar PK, Das HK, Kumar A, Dhandhania VK, Bhansali A, Rao PV, Desai A, Kalra S, Gupta A, Lakshmy R, Madhu SV, Elangovan N, Chowdhury S, Venkatesan U, Subashini R, Kaur T, Dhaliwal RS, Mohan V. Metabolic non-communicable disease health report of India: the ICMR-INDIAB national cross-sectional study (ICMR-INDIAB-17). Lancet Diabetes Endocrinol. 2023 Jul;11(7):474-489. DOI: 10.1016/S2213-8587(23)00119-5. Epub 2023 Jun 7. PMID: 37301218.
6. Kahn SE, Cooper ME, Del Prato S. Pathophysiology and treatment of type 2 diabetes: perspectives on the past, present, and future. Lancet. 2014;383(9922):1068-83. DOI: 10.1016/S0140-6736(13)62154-6
7. Leese GP, Wang J, Broomhall J, et al. Frequency of severe hypoglycemia requiring emergency treatment in type 1 and type 2 diabetes: a population-based study of health service resource use. Diabetes Care. 2003;26(4):1176-80. DOI: 10.2337/diacare.26.4.1176
8. Gurudas S, Vasconcelos JC, Prevost AT, et al. National prevalence of vision impairment and blindness and associated risk factors in adults aged 40 years and older with known or undiagnosed diabetes: results from the

SMART-India cross-sectional study. Lancet Glob Health. 2024;12(5):e838-e847. DOI: 10.1016/S2214-109X(24)00035-4

9. Early Treatment Diabetic Retinopathy Study design and baseline patient characteristics. ETDRS report number 7. Ophthalmology. 1991 May;98(5 Suppl):741-56. DOI: 10.1016/s0161-6420(13)38009-9. PMID: 2062510.
10. Sabanayagam C, Banu R, Chee ML, Lee R, Wang YX, Tan G, Jonas JB, Lamoureux EL, Cheng CY, Klein BEK, Mitchell P, Klein R, Cheung CMG, Wong TY. Incidence and progression of diabetic retinopathy: a systematic review. Lancet Diabetes Endocrinol. 2019 Feb;7(2):140-149. DOI: 10.1016/S2213-8587(18)30128-1. Epub 2018 Jul 11. PMID: 30005958.
11. Calderon GD, Juarez OH, Hernandez GE, Punzo SM, De la Cruz ZD. Oxidative stress and diabetic retinopathy: development and treatment. Eye (Lond). 2017 Aug;31(8):1122-1130. DOI: 10.1038/eye.2017.64. Epub 2017 Apr 28. PMID: 28452994; PMCID: PMC5558229.
12. Ahmed KR, Jebunessa F, Hossain S, Chowdhury HA. Ocular knowledge and practice among type 2 diabetic patients in a tertiary care hospital in Bangladesh. BMC Ophthalmol. 2017 Sep 19;17(1):171. DOI: 10.1186/s12886-017-0560-x. PMID: 28927398; PMCID: PMC5605995.
13. Teo ZL, Tham YC, Yu M, Chee ML, Rim TH, Cheung N, Bikbov MM, Wang YX, Tang Y, Lu Y, Wong IY, Ting DSW, Tan GSW, Jonas JB, Sabanayagam C, Wong TY, Cheng CY. Global Prevalence of Diabetic Retinopathy and Projection of Burden through 2045: Systematic Review and Meta-analysis. Ophthalmology. 2021 Nov;128(11):1580-1591. DOI: 10.1016/j.ophtha.2021.04.027. Epub 2021 May 1. PMID: 33940045.
14. Brar AS, Sahoo J, Behera UC, Jonas JB, Sivaprasad S, Das T. Prevalence of diabetic retinopathy in urban and rural India: a systematic review and meta-analysis. Indian J Ophthalmol. 2022 Jun;70(6):1945-1955. DOI: 10.4103/ijo.IJO_2206_21.
15. Falck A, Laatikainen L. Diabetic cataract in children. Acta Ophthalmol Scand. 1998;76:238-240. DOI: 10.1034/j.1600-0420.1998.760220.x
16. Klein BEK, Klein R, Moss SE. Incidence of cataract surgery in the Wisconsin Epidemiologic Study of Diabetic Retinopathy. Am J Ophthalmol. 1995 Mar;119(3):295-300. DOI: 10.1016/s0002-9394(14)71170-5. PMID: 7872389.
17. Klein BEK, Klein R, Wang Q, Moss SE. Older-onset diabetes and lens opacities: The Beaver Dam Eye Study. Ophthalmic Epidemiol. 1995;2(1):49-55. DOI: 10.3109/09286589509071451.
18. Al-Shamsi HN, Dueker DK, Nowilaty SR, Al-Shahwan SA. Neovascular glaucoma at King Khaled Eye Specialist Hospital: etiologic considerations. Middle East Afr J Ophthalmol. 2009 Jan;16(1):15-9. DOI: 10.4103/0974-9233.48860. PMID: 20142954; PMCID: PMC2813576.
19. Kim C, Kim TW. Comparison of risk factors for bilateral and unilateral eye involvement in normal-tension glaucoma. Invest Ophthalmol Vis Sci. 2009;50:1215-1220. DOI: 10.1167/iovs.08-1886.
20. Srinivasan NK, John D, Rebekah G, Kujur ES, Paul P, John SS. Diabetes and Diabetic Retinopathy: Knowledge, Attitude, Practice (KAP) among Diabetic Patients in A Tertiary Eye Care Centre. J Clin Diagn Res. 2017 Jul;11(7):NC01-NC07. DOI: 10.7860/JCDR/2017/27027.10174. Epub 2017 Jul 1. PMID: 28892947; PMCID: PMC5583928.
21. Vujosevic S, Aldington SJ, Silva P, Hernández C, Scanlon P, Peto T, Simó R. Screening for diabetic retinopathy: new perspectives and challenges. Lancet Diabetes Endocrinol. 2020 Apr;8(4):337-347. DOI: 10.1016/S2213-8587(19)30411-5. Epub 2020 Feb 27. PMID: 32113513.
22. Dandona R, Dandona L, Srinivas M, Giridhar P, Prasad MN, Vilas K, McCarty CA, Rao GN. Moderate visual impairment in India: the Andhra Pradesh Eye Disease Study. Br J Ophthalmol. 2002 Apr;86(4):373-7. DOI: 10.1136/bjo.86.4.373. PMID: 11914201; PMCID: PMC1771093.
23. Zimmet PZ, Alberti KGMM. Diabetes and its complications in the developing world. Globalization and Health. 2016;12(1):1-4. DOI: 10.1186/s12992-016-0187-9
24. Pradeepa R, Rema M, Vignesh J, Deepa M, Deepa R, Mohan V. Prevalence and risk factors for diabetic neuropathy in an urban south Indian population: the Chennai Urban Rural Epidemiology Study (CURES-55). Diabet Med. 2008 Apr;25(4):407-12. DOI: 10.1111/j.1464-5491.2008.02397.x.Epub 2008 Feb 19. PMID: 18294224.
25. Wong TY, et al. Global burden of visual impairment and blindness due to diabetic retinopathy: A review. Lancet Diabetes Endocrinol. 2016;4(1):20-27. DOI: 10.1016/S2213-8587(15)00556-6.
26. Ashwin PT, Shah S, Anderson DF. Cataract formation in diabetes: Mechanisms and management. Br J Ophthalmol. 2020;104(6):726-734. DOI: 10.1136/bjophthalmol-2019-313016.
27. Klein R, Klein BE, Moss SE, et al. The Wisconsin Epidemiologic Study of Diabetic Retinopathy. III. Prevalence and risk of diabetic retinopathy when age at diagnosis is 30 or more years. Arch Ophthalmol. 1984;102:527-532. DOI: 10.1001/archopht.1984.01040030405011.
28. Nirmalan PK, Krishnadas R, Ramakrishnan R, Thulasiraj RD, Katz J, Tielsch JM, Robin AL. Lens opacities in a rural population of Southern India: The Aravind Comprehensive Eye Study. Invest Ophthalmol Vis Sci. 2003 Nov;44:4639-4643. DOI: 10.1167/iovs.03-0011.
29. Sunita M, Singh AK, Rogye A, Sonawane M, Gaonkar R, Srinivasan R, Natarajan S, Stevens FCJ, Scherpbier AJJA, Kumaramanickavel G, McCarty C. Prevalence of Diabetic Retinopathy in Urban Slums: The Aditya Jyot Diabetic Retinopathy in Urban Mumbai Slums Study-Report 2. Ophthalmic Epidemiol. 2017 Oct;24(5):303-310. DOI: 10.1080/09286586.2017.1290258. Epub 2017 Apr 12. PMID: 28402722.
30. Klein R, Klein BE, Moss SE, et al. The Wisconsin Epidemiologic Study of Diabetic Retinopathy. III. Prevalence and risk of diabetic retinopathy when age at diagnosis is 30 or more years. Arch Ophthalmol. 1984;102:527-532. DOI: 10.1001/archopht.1984.01040030405011.
31. Dandona R, Dandona L, Srinivas M, Giridhar P, Prasad MN, Vilas K, McCarty CA, Rao GN. Moderate visual impairment in India: the Andhra Pradesh Eye Disease Study. Br J Ophthalmol. 2002 Apr;86(4):373-7. DOI:

10.1136/bjo.86.4.373. PMID: 11914201; PMCID: PMC1771093.

32. George R, Ve RS, Vijaya L. Glaucoma in India: estimated burden of disease. J Glaucoma. 2010 Aug;19(6):391-7. DOI: 10.1097/IJG.0b013e3181c4ac5b. PMID: 20711029.
33. Naik K, Magdum R, Ahuja A, Kaul S, SJ, Mishra A, Patil M, Dhore DN, Alapati A. Ocular Surface Diseases in Patients With Diabetes. Cureus. 2022 Mar 22;14(3):e23401. DOI: 10.7759/cureus.23401. PMID: 35495002; PMCID: PMC9045461.
34. Mansuri F, Bhole PK, Parmar D. Study of dry eye disease in type 2 diabetes mellitus and its association with diabetic retinopathy in Western India. Indian J Ophthalmol. 2023 Apr;71(4):1463-1467. DOI: 10.4103/IJO.IJO_2770_22. PMID: 37026283; PMCID: PMC10276693.
35. Nivedha S, Raman S, Kumar M. Prevalence of chalazion and blepharitis in diabetic populations. Indian J Clin Exp Ophthalmol. 2018;4(3):367-372.
36. Naik K, Magdum R, Ahuja A, Kaul S, SJ, Mishra A, Patil M, Dhore DN, Alapati A. Ocular Surface Diseases in Patients With Diabetes. Cureus. 2022 Mar 22;14(3):e23401. DOI: 10.7759/cureus.23401. PMID: 35495002; PMCID: PMC9045461.
37. Chen T, Song D, Shan G, Wang K, Wang Y, Ma J, Zhong Y. The association between diabetes mellitus and nonarteritic anterior ischemic optic neuropathy: a systematic review and meta-analysis. PLoS One. 2013 Sep 30;8(9):e76653. DOI: 10.1371/journal.pone.0076653. PMID: 24098798; PMCID: PMC3786911.
38. Morya AK, Ramesh PV, Kaur K, Gurnani B, Heda A, Bhatia K, Sinha A. Diabetes more than retinopathy, it's effect on the anterior segment of eye. World J Clin Cases. 2023 Jun 6;11(16):3736-3749. DOI: 10.12998/wjcc.v11.i16.3736. PMID: 37383113; PMCID: PMC10294174.
39. Lemp MA, Bron AJ, Baudouin C, et al. Blepharitis: Current strategies for management. Indian J Ophthalmol. 2019;67(7):933-944.
40. Bell DSH. Diabetic Mononeuropathies and Diabetic Amyotrophy. Diabetes Ther. 2022 Oct;13(10):1715-1722. DOI: 10.1007/s13300-022-01308-x. Epub 2022 Aug 15. PMID: 35969368; PMCID: PMC9500121.
41. Harris RA, Galetta SL, Peng L, Balcer LJ. Cranial nerve palsies associated with diabetes: A review. J Clin Endocrinol Metab. 2019;104(4):1205-1215. DOI: 10.1210/jc.2018-01455.