OCULAR RAMIFICATIONS OF DIABETES

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ABSTRACT

Diabetes mellitus (aka "diabetes") is a disease in which the body's ability to **produce** or **respond to** the hormone insulin is impaired, resulting in abnormal metabolism of carbohydrates and elevated levels of glucose in the blood and urine.

When diabetes (specifically blood sugar level) is <u>not</u> properly managed, elevated sugar in the bloodstream causes systemic damage- particularly to the kidneys, heart, and eyes.

This damage affects every major component of the eyes, from the tear film back to the retina.

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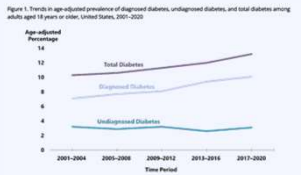
DIABETES IN THE UNITED STATES

An estimated **38.4 million** Americans have diabetes (as of 2021). This represents **11.6%** of the population.[1]

This includes an estimated 8.7 million diabetic Americans who are currently *undiagnosed* (almost 1 in 4 US adults with diabetes).[2]

A diagnosis of diabetes is usually based on measurement of blood sugar levels.

- Fasting blood sugar level of 99 milligrams per deciliter (mg/dL) or lower is normal.
- Blood sugar between 100-125 mg/dL is considered pre-diabetic.
- Blood sugars of 126 or higher indicates diabetes.



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[1,2] https://www.niddk.nih.gov/health-information/health-statistics/diabetes-statistics

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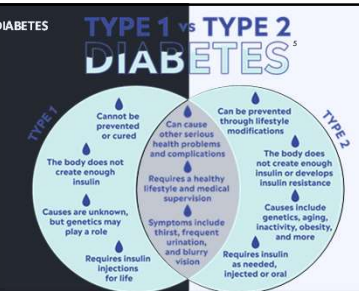
TYPES OF DIABETES



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[5] https://www.prevention.com/health/health-conditions/a20764231/type-2-diabetes-definition/

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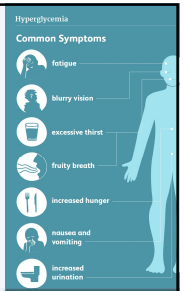
DIABETES SYMPTOMS

Elevated blood sugar (hyperglycemia) produces several symptoms (see illustration)…

In Type 1, onset of symptoms are usually fairly sudden. (Sudden occurrence of bedwetting in a formerly potty-trained child is a definite warning sign.)

In Type 2, they may increase slowly over time.[6]



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[6] https://www.verywellhealth.com/type-2-diabetes-symptoms-4158457

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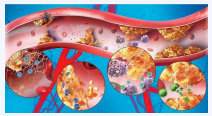
DIABETES SYSTEMIC COMPLICATIONS

Elevated blood sugar (hyperglycemia) decreases the elasticity of blood vessels- causing them to narrow.

This results in a decreased supply of blood and oxygen, and can result in high blood pressure.

74% of adults with diabetes have hypertension.[7,8]



Macrovascular complications include:
- heart attack
- stroke
- peripheral arterial disease

Microvascular issues can damage the:
- eyes
- kidneys
- nervous system

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[7] https://www.medicalnewstoday.com/articles/317483#cardiovascular-system
[8] Arsalan U. Syed et al, cAMP controls cerebral vascular reactivity during diabetic hyperglycemia, Journal of Clinical Investigation (2019).

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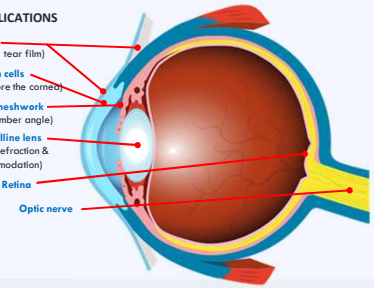
DIABETES OCULAR COMPLICATIONS



Diabetes (or more specifically hyperglycemia) has negative impacts on virtually every component of the eye.

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DIABETES OCULAR COMPLICATIONS – LACRIMAL SYSTEM

Diabetes has been identified as one of the leading systemic risk factors for Dry Eye Syndrome (DES).

The reported prevalence of DES in diabetics is 15–33% in those > 65 years of age and increases with age and is 50% more common in women than in men[9]. The incidence of dry eye is correlated with the level of glycated hemoglobin: the higher the level of glycated hemoglobin, the higher the incidence of dry eye[10]. Up to 54% of diabetic patients will have at least one *symptom* of DES.[11]

[9] Dry eye syndrome, NICE CKS, September 2012
[10] Seifart U., Strempel I. The dry eye and diabetes mellitus. Ophthalmologe. 1994;91(2):235–239.
[11] Manaviat M. R., Rashidi M., Afkhami-Ardekani M., Shoja M. R. Prevalence of dry eye syndrome and diabetic retinopathy in type 2, diabetic patients. BMC Ophthalmology. 2008;8, article 10 doi: 10.1186/1471-2415-8-10.

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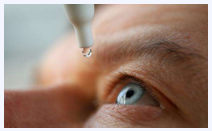
DIABETES OCULAR COMPLICATIONS – LACRIMAL SYSTEM RAMIFICATIONS

It's important to note that not everyone with diabetes will develop dry eye, just like not everyone will develop other diabetes complications. Other factors may increase your risk for dry eyes, including:



- Environmental factors (like living in a dry climate)
- Wearing contact lenses
- Having another medical condition (for example, rheumatoid arthritis)
- Taking certain medications, such as antidepressants or blood pressure medication[14].

[14] https://diatribe.org/understanding-diabetes/dry-eye-syndrome-and-diabetes-what-know

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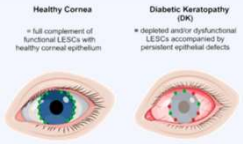
DIABETES OCULAR COMPLICATIONS – CORNEA

Continuous replenishment of the corneal epithelium is crucial for maintaining optical transparency and achieving optimal visual perception.

In patients afflicted with diabetes, hyperglycemia-induced impairments in corneal epithelial regeneration results in persistent epithelial and other defects on the ocular surface, termed diabetic keratopathy (DK), which progressively diminish vision and quality of life[16].



[16] Nureen L, Di Girolamo N. Limbal Epithelial Stem Cells in the Diabetic Cornea. Cells. 2023 Oct 16;12(20):2458. doi: 10.3390/cells12202458.

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DIABETES OCULAR COMPLICATIONS – CORNEAL RAMIFICATIONS

"Non-compliant" contact lens wearers often escape serious problems because the epithelial layer of the cornea normally regenerates very quickly.

This is **NOT** necessarily the case with diabetic contact lens wearers.

It is IMPERATIVE to monitor the diabetic lens wearer!

DIABETES
+ non-compliance
SERIOUS ISSUES

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DIABETES OCULAR COMPLICATIONS – CORNEAL RAMIFICATIONS

Dry eye, an age-related condition, is a multifactorial disease of the tears and ocular surface that results in symptoms of discomfort, visual disturbance and tear film instability. Environmental factors are also often implicated in dry eye including exposure to pollutants, **ultraviolet (UV)** radiation and ozone. These factors increase oxidative stress and ocular surface inflammation[17].

ALL diabetic patients should be wearing sunwear when spending time outdoors during the day!

[17] Seen S, Tong L. Dry eye disease and oxidative stress. Acta Ophthalmol. 2018 Jun;96(4):e412-e420. doi: 10.1111/aos.13526. Epub 2017 Aug 21. PMID: 28834388.

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DIABETES OCULAR COMPLICATIONS – ANTERIOR CHAMBER ANGLE

Multiple studies have found that people with diabetes risk developing glaucoma more than the general population. **Adults with diabetes are twice as likely to get glaucoma.** The risk increases with the amount of time someone has had diabetes. The link appears to be the strongest for open-angle glaucoma, the most common form. People with diabetes are 48% more likely to develop open-angle glaucoma over 20 years than non-diabetics[18].

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[18] https://glaucoma.org/articles/the-relationship-between-diabetes-and-glaucoma

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DIABETES OCULAR COMPLICATIONS – GLAUCOMA RAMIFICATIONS

Understanding the potential connection between diabetes and glaucoma emphasizes the importance of early detection and treatment:

Regular Eye Check-ups: Diabetic patients should undergo comprehensive eye exams annually or as recommended by their optometrist or ophthalmologist.
MANAGE BLOOD SUGAR: Consistent blood sugar management can reduce the risk of complications, including eye conditions.
Glaucoma Medications: Several medications can help reduce intraocular pressure for those diagnosed with glaucoma.
Glaucoma Laser and Surgery: In advanced cases or when medication isn't effective, your doctor might recommend surgical interventions like laser trabeculoplasty, micro-invasive glaucoma surgery (MIGS), or more traditional options.[20]

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[20] https://glaucoma.org/articles/the-relationship-between-diabetes-and-glaucoma

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DIABETES OCULAR COMPLICATIONS – CRYSTALLINE LENS

The crystalline lens is thus named because it is composed of α-, β-, and γ-crystallin proteins. Through mechanisms that are not totally understood, hyperglycemia induces changes in protein linking and lens hydration. Additionally, reactive oxygen species (ROS) contribute to oxidation of the lens.
This results in: refractive changes, loss of accommodation, and cataract formation.[22]

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[22] Samson Darnah, OD, Dorothy Hitchmoth, OD. PRESBYOPIA PHYSICIAN. DECEMBER 1, 2023 VOL 3, PAGE(S): 33-36.

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DIABETES OCULAR COMPLICATIONS – CRYSTALLINE LENS RAMIFICATIONS

1. Refractive changes in the crystalline lens depend on changes in glycaemia (i.e., changes are usually non-permanent).

2. Type 1 diabetic patients are known to lose accommodative ability earlier than non-diabetics (i.e., they become presbyopic earlier in life)[23].

3. Cataract is one of the major causes of visual impairment in diabetic patients.
Diabetics are up to ***five times more likely*** to develop cataract, in particular at an early age.[24]

Diabetes
+ UV exposure
CATARACTS

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[23] Adnan, Efron N, Mathur A, Edwards K, Pritchard N, Suheimat M, Atchison DA. Amplitude of accommodation in type 1 diabetes. Invest Ophthalmol Vis Sci. 2014 Oct 8;55(10):7014-8. doi: 10.1167/iovs.14-15376. PMID: 25298413.
[24] Klein BE, Klein R, Lee KE. Diabetes, cardiovascular disease, selected cardiovascular disease risk factors, and the 5-year incidence of age-related cataract and progression of lens opacities: the Beaver Dam Eye Study. Am J Ophthalmol. 1998;126:782–790.

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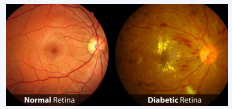
DIABETES OCULAR COMPLICATIONS – RETINA

Diabetic retinopathy is an eye condition that can cause vision loss and blindness (DR is the leading cause of blindness in American adults age 20-64). 4 million Americans have DR, and 1 million have reduced vision/blindness as a result. Issues associated with diabetic retinopathy include:

- **Diabetic macular edema (DME).** Over time, about 1 in 15 people with diabetes will develop DME. DME happens when blood vessels in the retina leak fluid into the macula. This causes blurry vision.
- **Neovascular glaucoma.** Diabetic retinopathy can cause abnormal blood vessels to grow out of the retina and block fluid from draining out of the eye. This causes a type of glaucoma (a group of eye diseases that can cause vision loss and blindness).[25]



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[25] https://www.nei.nih.gov/learn-about-eye-health/eye-conditions-and-diseases/diabetic-retinopathy

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DIABETES OCULAR COMPLICATIONS – RETINA RAMIFICATIONS

The risk of diabetic retinopathy was **2.66 times higher** with ≥5 h of daily sunlight exposure than in the group with less exposure after adjusting for risk factors such as duration of diabetes, serum hemoglobin A1c level, hypertension, and dyslipidemia (P = 0.023).

- risk of non-proliferative diabetic retinopathy was **3.13 times higher** (P = 0.009).
- risk in individuals with diabetes <10 years was **4.82 times higher** (P < 0.05)[30].

ALL diabetic patients should be wearing sunwear when spending time outdoors during the day!

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[30] Lee HJ, Kim CO, Lee DC. Association between daily sunlight exposure duration and diabetic retinopathy in Korean adults with diabetes: A nationwide population-based cross-sectional study. PLoS One. 2020 Aug 7;15(8):e0237149.

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DIABETES OCULAR COMPLICATIONS – OCULAR NERVE

Anterior ischemic optic neuropathy (AION) is essentially a stroke of the optic nerve. Studies suggest that up to 25% of patients with AION have a history of diabetes[31].

Patients with AION usually present with moderate loss of vision upon awakening, presumably related to nocturnal systemic hypotension. Visual acuity is better than 20/200 in 60% of cases at presentation[32].

Healthy Retina

AION Retina

[31] Characteristics of patients with nonarteritic anterior ischemic optic neuropathy eligible for the Ischemic Optic Neuropathy Decompression Trial. Arch Ophthalmol 114:1366–1374. 1996
[32] Arnold AC: Pathogenesis of nonarteritic anterior ischemic optic neuropathy. J Neuroophthalmol 23:157–163, 2003.

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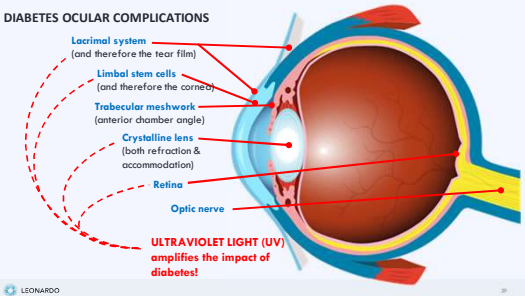
DIABETES OCULAR COMPLICATIONS



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ROLE OF OPTICIANS AS HEALTH CARE PROVIDERS

According to the National Institute of Health, "MEDICAL CARE" is defined as:

"The provision of what is necessary for a person's health and well-being by a doctor, nurse, or other healthcare professional."[35]

Opticians are HEALTH CARE PROVIDERS- so provide health care!

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[35] https://www.nlm.nih.gov/exhibition/outsideinside/materials/LP-Handout-What-is-Medical-Care.pdf

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ROLE OF OPTICIANS AS HEALTH CARE PROVIDERS

When providing opticianry care to a diabetic patient:

1. **Recognize the reason for most refractive shifts (changes in the crystalline lens).**
   - Work with the OD/OMD to manage expectations when Rx changes occur. (Because Rx changes may likely not be permanent.)
2. **The use of dark lenses when outside during daylight hours cannot be overstressed!**
   - UV is an aggravating factor in most ocular ramifications of diabetes.
   - Photochromic lenses provide *automatic* protection from UV and HEV.
   - *"No really,* ***you NEED sunglasses and/or photochromic lenses.****"* (You and the OD/OMD *should* be singing a duet here.)
3. **If you are managing contact lens wear, pay extra attention to diabetic patients.**
   - Follow-up visits are mandatory for ALL CL wearers- but especially diabetics.
   - Non-compliance is likely grounds for discontinuation of contact lens use.
   - Refer ***ANY and ALL*** CL related corneal issues to an OD/OMD immediately!
4. **Listen for symptoms of presbyopia- even in a patient in their 20s or 30s.** Pass these symptoms on to the OD/OMD.

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CONCLUSIONS

Diabetes affects over 11% of the US population (you probably see a diabetic patient every day).

Complications of diabetes impact virtually every structure of the eye.

Management of blood glucose levels is the BEST preventative against ocular & systemic damage.

The eyes of a diabetic patient MUST be protected from UV light.

Non-compliance in a diabetic contact lens wearer can be catastrophic.

Living with diabetes:

1. Manage blood glucose levels.
2. **Manage Blood Glucose Levels.**
3. **MANAGE BLOOD GLUCOSE LEVELS !!!!**
4. Visit your primary care physician, endocrinologist, and optometrist regularly.
5. Always wear dark lenses when outside during the day.
6. Manage blood glucose levels.

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CITATIONS

[1,2] https://www.niddk.nih.gov/health-information/health-statistics/diabetes-statistics
[3,4] https://www.cdc.gov/diabetes/
[5] https://www.prevention.com/health/health-conditions/a21764231/type-2-diabetes-definition/
[6] https://www.verywellhealth.com/type-2-diabetes-symptoms-4158457
[7] https://www.medicalnewstoday.com/articles/317483#cardiovascular-system
[8] Arsalan U. Syed et al, cAMP controls cerebral vascular reactivity during diabetic hyperglycemia, Journal of Clinical Investigation (2019).
[9] Dry eye syndrome, NICE CKS, September 2012
[10] Seifart U., Strempel I. The dry eye and diabetes mellitus. Ophthalmologe. 1994;91(2):235–239.
[11] Manaviat M. R., Rashidi M., Afkhami-Ardekani M., Shoja M. R. Prevalence of dry eye syndrome and diabetic retinopathy in type 2 diabetic patients. BMC Ophthalmology. 2008;8, article 10 doi: 10.1186/1471-2415-8-10.
[12] Stevenson W. Dry eye disease. Archives of Ophthalmology. 2012;130(1):90–100. doi: 10.1001/archophthalmol.2011.364.
[13] Zhang X, Zhao L, Deng S, Sun X, Wang N. Dry Eye Syndrome in Patients with DM: Prevalence, Etiology, and Clinical Characteristics. J Ophthalmol. 2016;2016:8201053.
[14] https://diatribe.org/understanding-diabetes/dry-eye-syndrome-and-diabetes-what-know
[15] Lubniewski A. J., Houchin K. W., Holland E. J., et al. Posterior infectious crystalline keratopathy with Staphylococcus epidermidis . Ophthalmology. 1990;97(11):1454–1459.
[16] Nureen L, Di Girolamo N. Limbal Epithelial Stem Cells in the Diabetic Cornea. Cells. 2023 Oct 16;12(20):2458.
[17] Seen S, Tong L. Dry eye disease and oxidative stress. Acta Ophthalmol. 2018 Jun;96(4):e412-e420.
[18] https://glaucoma.org/articles/the-relationship-between-diabetes-and-glaucoma
[19,20] ibid.
[21] Bron AJ, Sparrow J, Brown NA, Harding JJ, Blakitny R. The lens in diabetes. Eye (Lond). 1993;7 (Pt 2):260-75.
[22] Samson Darrah, OD, Dorothy Hitchmoth, OD. PRESBYOPIA PHYSICIAN. December 1, 2023 Vol 3, Page(s): 33-36.

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[39] https://www.news-medical.net/health/Trailblazing-Discoveries-The-Top-5-Diabetes-Research-Breakthroughs-of-2023.aspx

39

CITATIONS

[23] Adnan, Elfron N, Mathur A, Edwards K, Pritchard N, Suheimat M, Atchison DA. Amplitude of accommodation in type 1 diabetes. Invest Ophthalmol Vis Sci. 2014 Oct 8;55(10):7014-8. doi: 10.1167/iovs.14-15376. PMID: 25298413.
[24] Klein BE, Klein R, Lee KE. Diabetes, cardiovascular disease, selected cardiovascular disease risk factors, and the 5-year incidence of age-related cataract and progression of lens opacities: the Beaver Dam Eye Study. Am J Ophthalmol. 1998;126:782–790.
[25] https://www.nei.nih.gov/learn-about-eye-health/eye-conditions-and-diseases/diabetic-retinopathy
[26] https://www.elitecarehc.com/blog/understanding-diabetic-retinopathy-symptoms-treatment-and-prevention/
[27] Ferrara N, Henzel WJ. Pituitary follicular cells secrete a novel heparin-binding growth factor specific for vascular endothelial cells. Biochem Biophys Res Commun. 1989;161:851–8.
[28] Agarwal P, Jindal A, Saini VK, Jindal S. Advances in diabetic retinopathy. Indian J Endocrinol Metab. 2014 Nov;18(6):772-7.
[29] https://www.aao.org/education/topic-detail/diabetic-retinopathy--asia-pacific
[30] Lee HJ, Kim CO, Lee DC. Association between daily sunlight exposure duration and diabetic retinopathy in Korean adults with diabetes: A nationwide population-based cross-sectional study. PLoS One. 2020 Aug 7;15(8):e0237149.
[31] Characteristics of patients with nonarteritic anterior ischemic optic neuropathy eligible for the Ischemic Optic Neuropathy Decompression Trial. Arch Ophthalmol 114:1366–1374, 1996
[32] Arnold AC: Pathogenesis of nonarteritic anterior ischemic optic neuropathy. J Neuroophthalmol 23:157–163, 2003.
[33] https://www.careersineyecare.org.uk/2023/04/28/five-reasons-why-becoming-a-dispensing-optician-is-a-great-career-choice/
[34] https://my.clevelandclinic.org/health/articles/24404-optician
[35] https://www.nlm.nih.gov/exhibition/outsideinside/materials/LP-Handout-What-is-Medical-Care.pdf
[36] https://www.mayoclinic.org/diseases-conditions/diabetes/in-depth/diabetes-management/
[37] Park, W., Seo, H., Kim, J. et al. In-depth correlation analysis between tear glucose and blood glucose using a wireless smart contact lens. Nat Commun 15, 2828 (2024).
[38] Geon-Hui Lee, et.al. Smart Wireless Near-Infrared Light Emitting Contact Lens for the Treatment of Diabetic Retinopathy. Advanced Science: Volume9, Issue9, March 25, 2022.
[39] https://www.news-medical.net/health/Trailblazing-Discoveries-The-Top-5-Diabetes-Research-Breakthroughs-of-2023.aspx