

# Ein Ausblick auf die Optometrie der Zukunft

---

**Target group:** WVAO  
**Aim:** Sponsoren-Vortrag

---

**Dr. rer. nat. Niklas Domdei**  
ZEISS Vision Care (Abt. Advanced Development)

---

**10 April 2025**

---

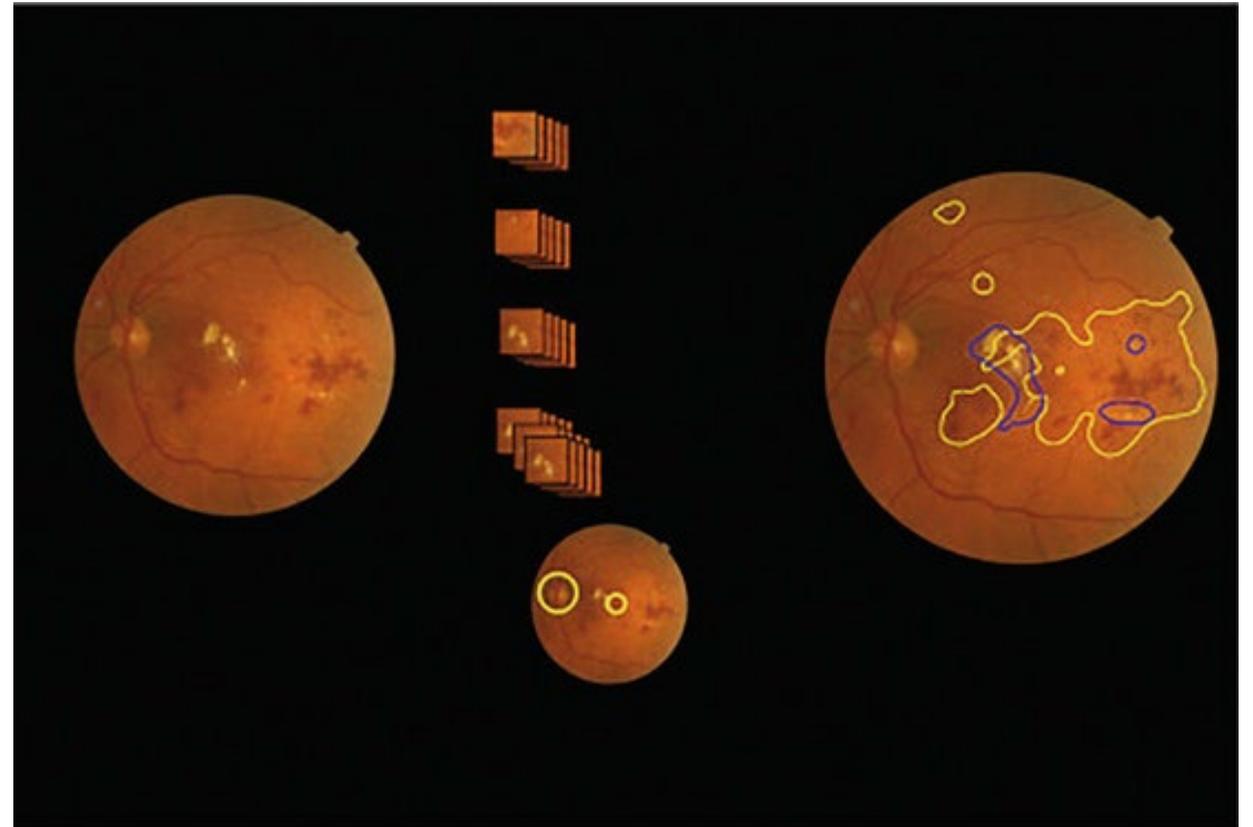
## Die Herausforderungen von heute:

- ❖ Fachkräftemangel
- ❖ Fehlende Termine bei Augenärzten

## Fragen, die in der folgenden Präsentation diskutiert werden:

- Kann KI helfen, diese Probleme in der Optometrie zu überwinden?
- Wie könnte KI das Feld der Optometrie verändern?
- Was müssen wir als Firma bei der Implementierung von KI beachten?

## Idx-DR System: First medical AI application approved by FDA



Mai and Schmidt-Erfurth (2024) - Role of Artificial Intelligence in Retinal Diseases

# Ophthalmology AI devices available in the USA and the



Grzybowski and Brona (2023) Approval and Certification of Ophthalmic AI Devices in the European Union

	Algorithm name	Company	Country of origin	FDA certification	CE mark classification level
1	IDx-DR	Digital diagnostic	USA	Yes	IIA
2	Eyeart	EYENUK	USA	Yes	IIA
3	RetmarkerDR	Retmarker	Portugal	No	IIA
4	SELENA+	cyRIS	Singapore	No	IIA
5	Automated Retinal Disease Assessment (ARDA)	Verily Life Sciences LLC	USA	No	IIA
6	Medios AI	Remidio	India	No	IIA
7	OphtAI	Evolucare	France	No	IIA
8	RetCAD	Thirona	The Netherlands	No	IIA
9	DeepDec AI	DeepDec	The Netherlands/ Belarus	No	I
10	MONA DR	Mona Health	Belgium	No	I
11	Eyetelligence	Eyetelligence Pty Ltd.	Australia	No	I
12	CARA	Diagnos	Canada	No	I
13	Retinalyze	RetinaLyze Nordic ApS	Denmark	No	I

Mai and Schmidt-Erfurth (2024)  
Approved MDR-certified Algorithms

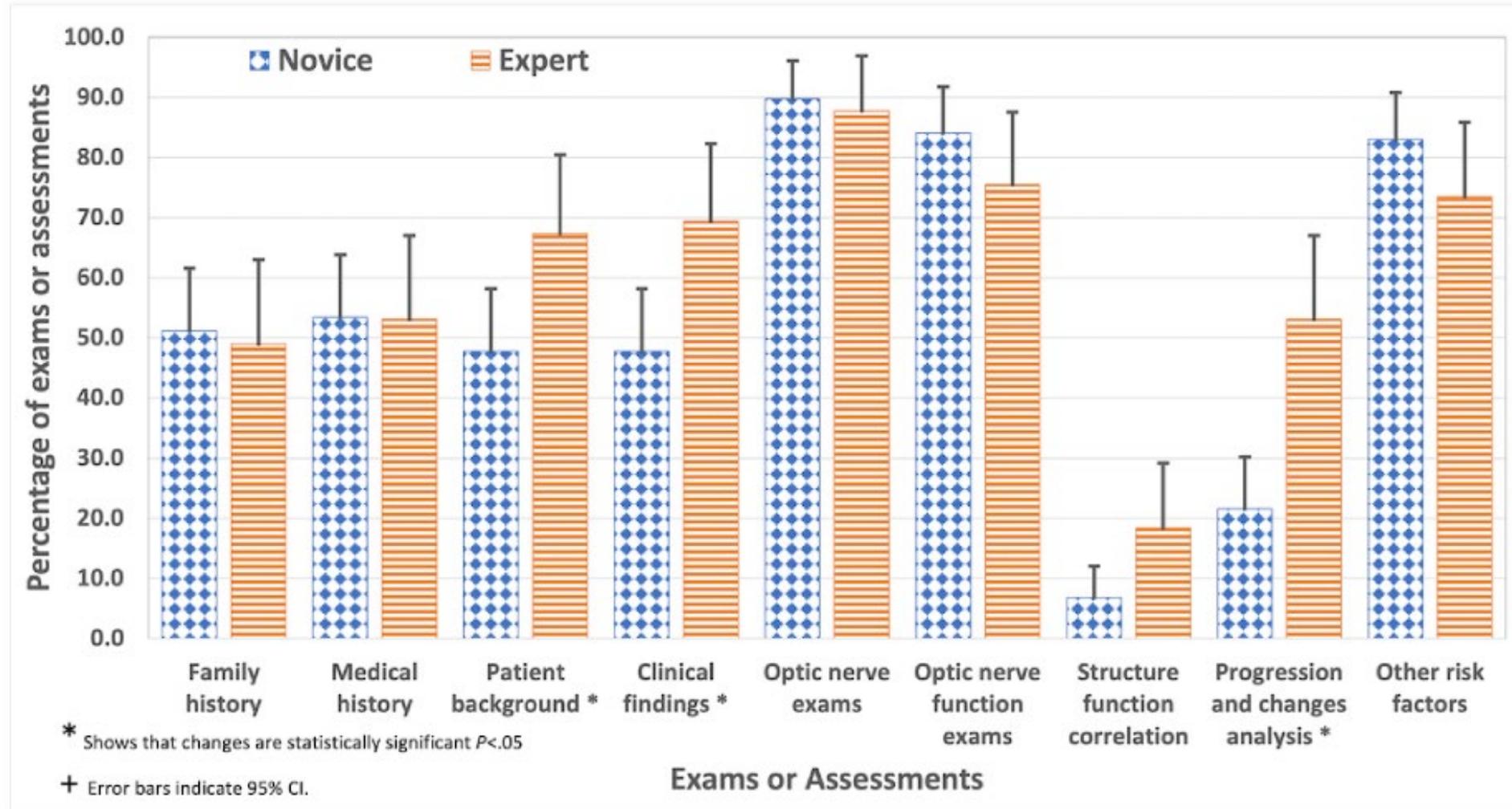
Algorithm	Company	origin
Vienna Fluid Monitor	RetInSight	Austria
GA-Monitor	RetInSight	Austria
RetinAI Discovery	RetinAI Medical AG/ Ikerian	Switzerland
iPredict	iHealthScreen	USA

FDA: US Food and Drug Administration

MDR = Medical Device Regulation

# AI based diagnostic decision assistance based on expertise?

Ghaffar et al. (2025)



# VISUCORE 500

AI assisted “Guided” subjective refraction



## Expert mode

Standard operating procedure for subjective refraction

## Guided mode

AI assisted for inexperienced staff (e.g. returning from parental leave)

## ZEISS VISUCORE 500: all-in-one refraction unit (objective + subjective)

- Optimized for working in small spaces

<b>IOLs</b> 14 studies (2020 - 2025): Calculation & Optimization  1 study (2020): Outcome prediction	<b>Myopia (fundus image)</b> 9 studies (2018 – 2023): Good or very good prediction  3 studies (2020 – 2023): Very good or extremely good diagnosis  1 study (2022): Extremely good classification	<b>Strabismus (gaze images or videos)</b> 9 studies (2015, 2017-2022): Good or extremely good diagnosis/detection  <b>Amblyopia (gaze images)</b> 2 studies (2020-2021): Good detection
<b>Refractive surgery</b> 3 studies (2017, 2020, 2021): good outcome prediction	<b>Myopia (progression prediction)</b> 5 studies (2018, 2020, 2023, 2025): Good or very good prediction	
<b>Ortho-K</b> 1 study (2022): very good curvature estimates  1 study (2025): tear film stability detection	<b>Myopia (personalized treatment)</b> 1 study (2025): factors affecting intraocular pressure	

Acc: >80% (Good), >90% (Very Good), >95% (Extremely Good)

# Smartphone

## AI assisted eye examination comparable to slit-lamp



### Myopia

1 study (2024):  
good detection

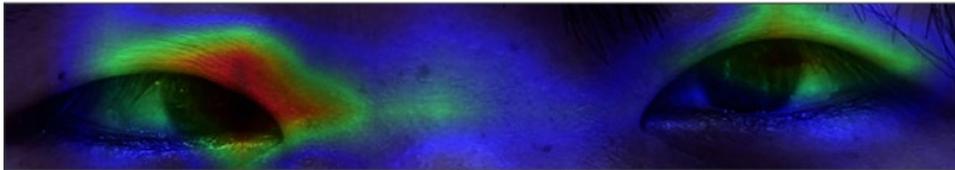
### Strabismus

1 study (2024):  
good detection

A Myopia



B Strabismus



Shu et al., 2024 - Artificial Intelligence for Early Detection of Pediatric Eye Diseases Using Mobile Photos

### Keratitis

2 studies (2021):  
Very good detection

### Keratoconus

1 study (2025):  
Extremely good detection

### Amblyopia

2 studies (2020, 2021):  
(Good) diagnosis

### Pterygium

1 study (2023):  
Very good detection

### Cataract

2 studies (2020, 2023):  
Very good detection/grading

### Various diseases (based on gaze behavior)

1 study (2023):  
good detection in visually impaired children

### Ptosis

1 study (2022):  
Good detection

Acc: >80% (Good), >90% (Very Good), >95% (Extremely Good)

# Anterior chamber (AS\_OCT / slit lamp)

Eyelid Tumors, Keratoconus, cataract



## Eyelid tumors

Study 1 (2017):

Basal cell carcinoma excisions

Good prediction of preoperative complexity assessment, surgical delays, and tumor size

Study 2 (2020):

Pathological slides

Very good detection of malignant samples

## Keratoconus (Mainly AS-OCT images)

30 Studies (2018 - 2023):

Extremely good diagnosis

Very/Extremely good detection

Very good classification

(Very) good prediction

## Infectious Keratitis

20 studies (2017 - 2023):

(Very) good detection

## Cataract

5 Slit lamp studies (2013, 2015, 2019, 2021, 2022):

Grading of nuclear cataracts,

Good detection of referable cataracts

7 fundus images studies (2017 - 2022):

(Very) Good detection and grading of cataracts

Supporting Cataract Surgery (2022)

## Pediatric Cataract

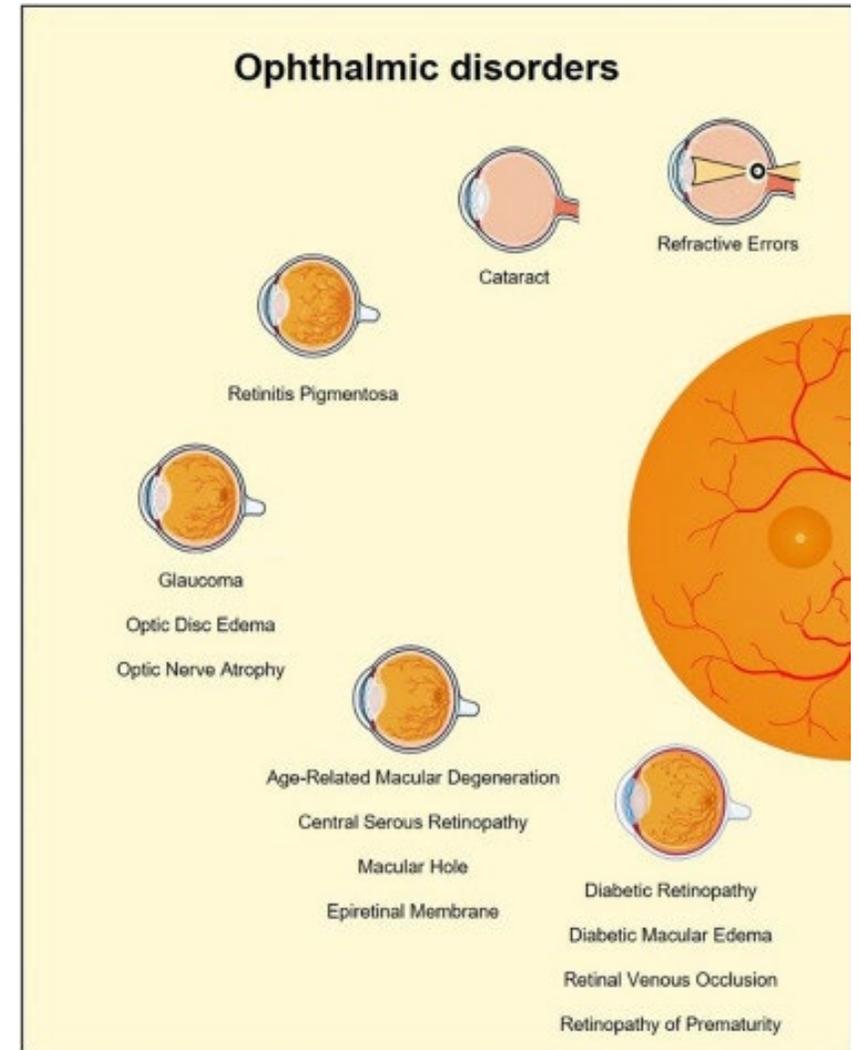
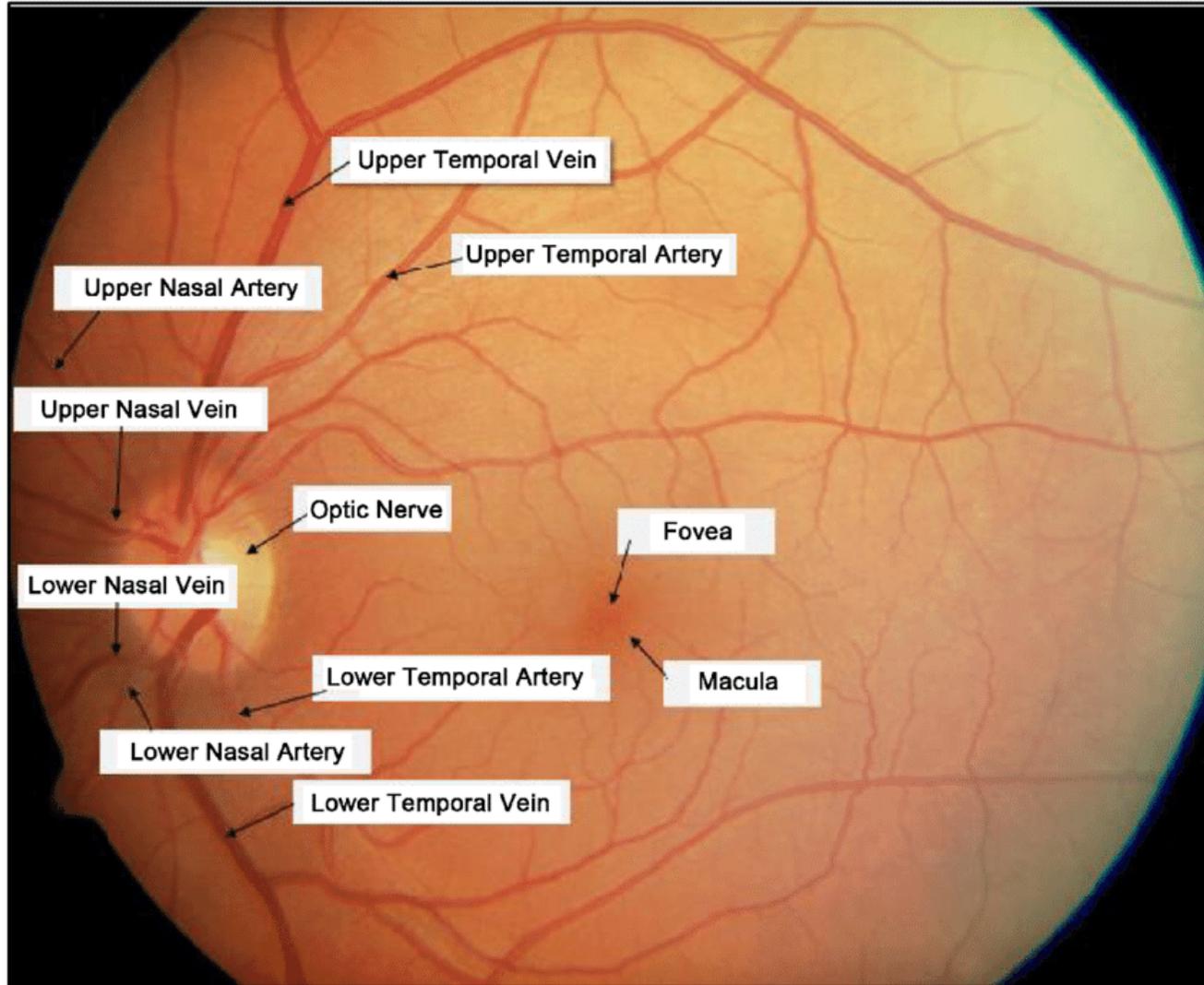
Slit lamp images

→ Cloud based identification and grading "CC-Cruiser"

Acc: >80% (Good), >90% (Very Good), >95% (Extremely Good)

# Fundus Imaging

Focus on blood vessels, microvasculature, and optic nerve head



# Fundus Imaging

## DR, AMD



Focus on blood vessel structure and integrity, microvasculature, optic nerve head

### Diabetic Retinopathy

1<sup>st</sup> commercial camera with FDA & EU approved AI based DR detection (since 2018):

IDx-DR by Digital Diagnostics

13 studies (2013, 2015 - 2023):  
Extremely good and Very good detection

12 studies (2017 – 2022):  
(Very) good Grading of DR

1 study (2023):  
Extremely good classification after DL image enhancement

1 study (2023):  
Good segmentation of DR in eyes with cataract

1 study (2021)  
Very good classification of healthy, **AMD**, **DR**, high **myopia**, and **Retinal vein occlusion**

1 study (2022)  
Extremely good grading of **AMD** and **DR** on the same image

### Age-related macular degeneration

2 studies (2017, 2019)  
Very good detection of (early) AMD

2 studies (2021)  
Good grading of AMD

3 studies (2018, 2019)  
Extremely good classification into dry and wet AMD

3 studies (2018, 2020)  
(Very) good progression prediction

1 study (2022)  
Good prediction of late AMD

Acc: >80% (Good), >90% (Very Good), >95% (Extremely Good)

### Glaucoma

3 studies (2017, 2022):

Very good detection of critical cup/disc ratios

24 studies (2018 - 2023):

Very good glaucoma detection (4 with additional OCT data)

3 studies (2020, 2021):

Differentiation of glaucoma from other diseases affecting the optic disk

6 studies (2018 - 2023):

(Very good) forecast of progression

### Axial length

1 study (2023):

good prediction with ultrawide field

### Ocular refraction

1 study (2022):

Very good identification of sphere, cylinder and axis

### Visual Acuity

1 study (2025):

Within 1 to 1.5 lines - BCVA estimate

### Risk of high myopia

2 studies (2021, 2023):

Extremely good prediction of high myopia development in children

### Myopic Maculopathy

1 study (2022):

Extremely good detection and classification

1 study (2023):

Very good grading

### Pathological Myopia

17 studies (2010, 2013, 2015, 2021 - 2022):

Extremely/Very good detection

Acc: >80% (Good), >90% (Very Good), >95% (Extremely Good)

# VISUREF 1000 & EyeCare Network

Objective refraction with fundus imaging → Telemedicine



## ZEISS EyeCare | Ocumeda platform

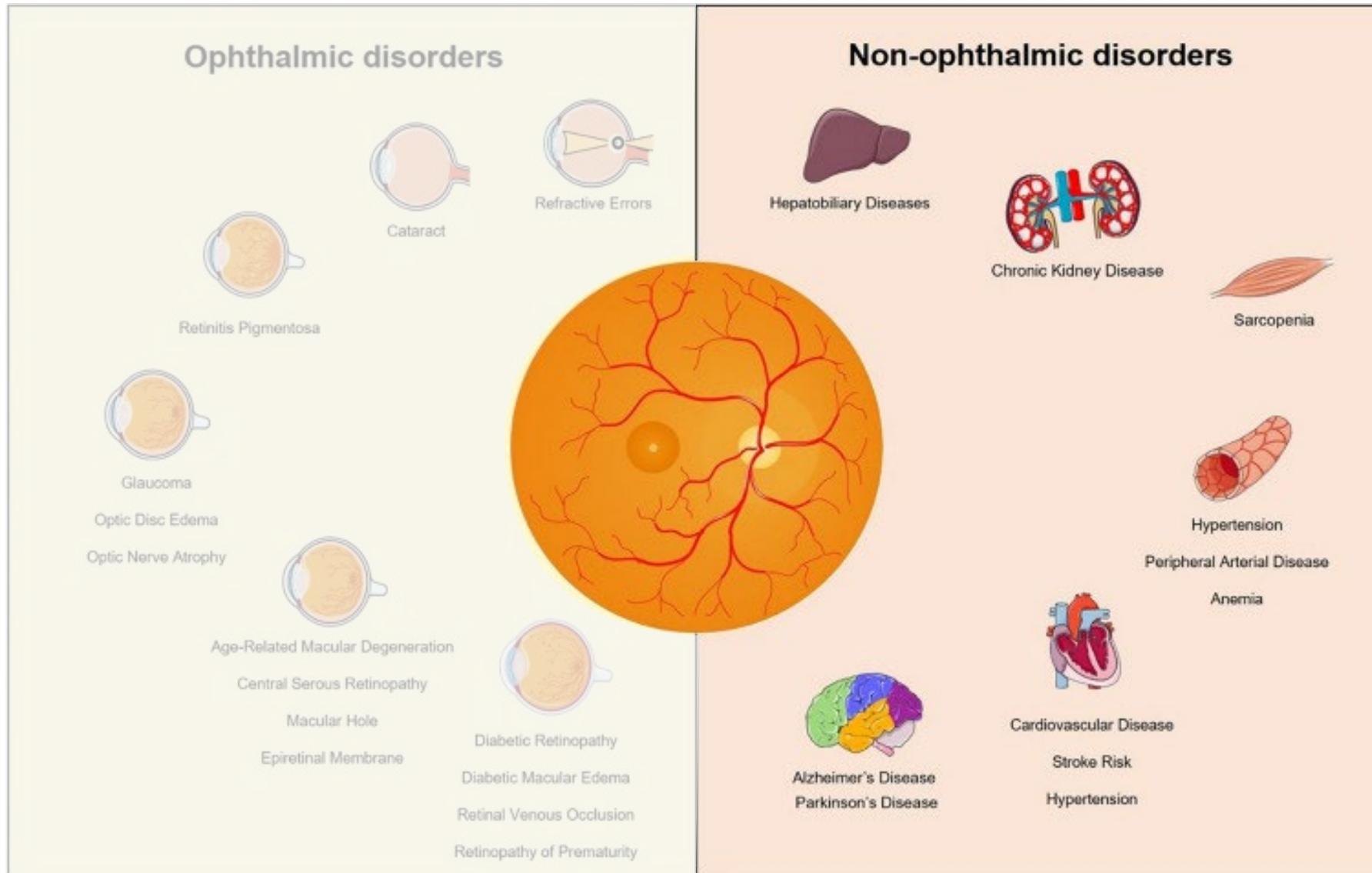
- bridging the gap between optical retail and ophthalmology.
- Transmits data to authorized ophthalmologists
- Ophthalmological report via email or postal mail to the consumer including individual recommendations for action.

## ZEISS VISUREF 1000

- Precise and detailed examination of both anterior and posterior segments
- Early detection of, for example, keratoconus, cataracts, and glaucoma.

# Oculomics

## Systemic diseases detectable from fundus images



Grzybowski et al.,  
2024 - Retina Fundus  
Photograph-Based  
Artificial Intelligence  
Algorithms in Medicine

# Future outlook

Triage system for anterior segment diseases obtained using smartphone images

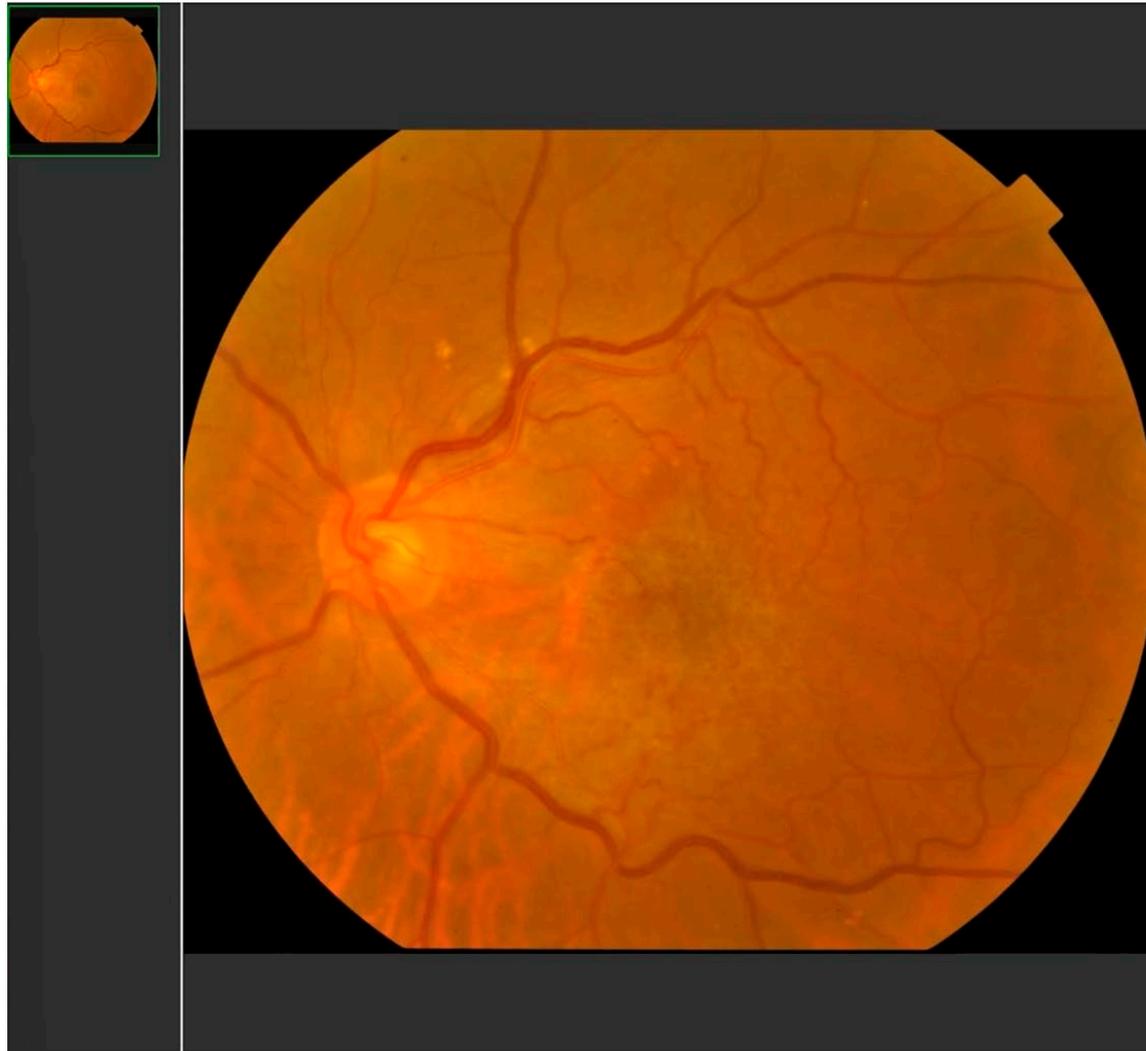


	<b>Urgent</b> Infectious keratitis Acute glaucoma
	<b>Semi-urgent</b> Immunological keratitis Ocular surface tumor
	<b>Routine</b> Corneal scar Corneal deposits Bullous keratopathy Cataract/IOL opacity
	<b>Observation</b> Normal

Oshika (2025) - Artificial Intelligence Applications in Ophthalmology

# Future outlook

AI application for the differential diagnosis of 11 retinal diseases



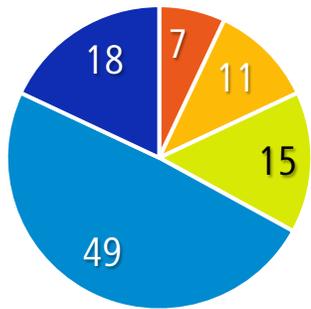
Diagnosis	Likelihood
Normal	0.000
AMD	0.000
CSC	0.000
BRVO-CRVO	0.000
Macular hole	0.000
<b>ERM</b>	<b>0.995</b>
Diabetic retinopathy	0.000
Glaucoma	0.000
Myopic chorioretinopathy	0.000
Papilledema	0.005
Retinal pigment streak	0.000
Optic atrophy	0.000

Oshika (2025) - Artificial Intelligence Applications in Ophthalmology

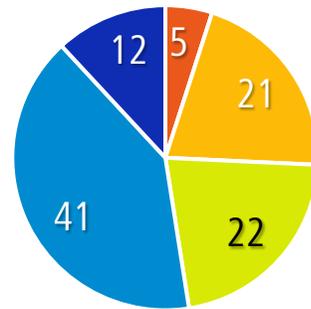
# Attitudes of optometrists towards AI



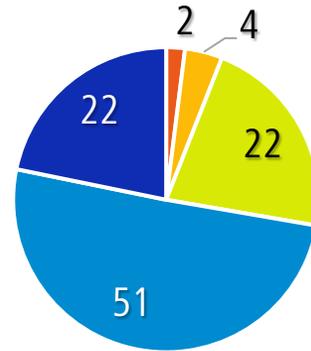
I am familiar with the use of artificial intelligence in eye care



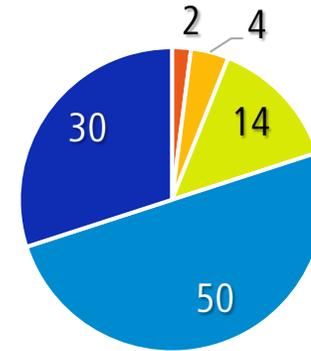
I am concerned about the diagnostic accuracy of AI in eye care



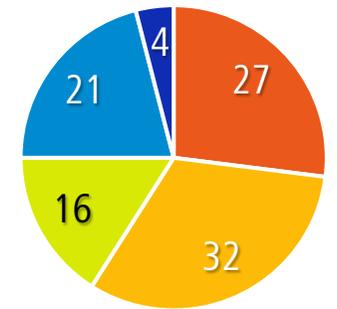
Artificial intelligence will improve the practice of optometry



AI should be incorporated into the optometry school curriculum

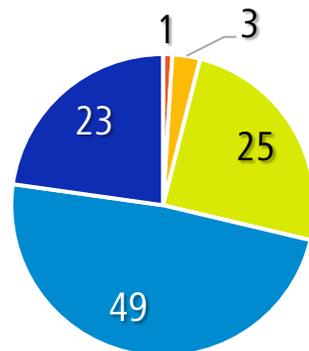


I am concerned that AI will replace optometrists/ doctors

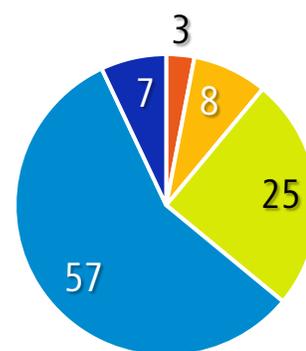


- strongly disagree
- somewhat disagree
- neutral
- somewhat agree
- strongly agree

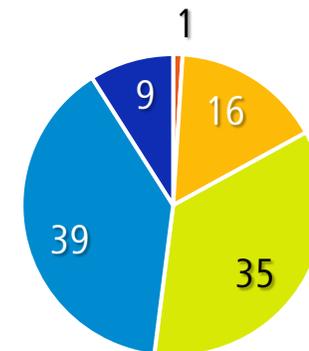
I see myself using AI as its increased use excites me



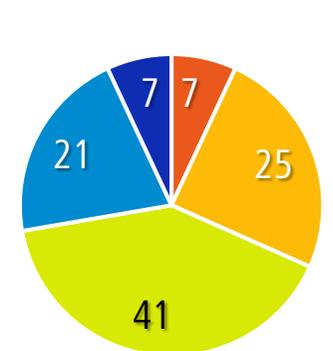
In the future, I see myself using AI if most of my peers are using it



For me to use AI in the future, it is necessary to inform patients about its use



I see myself using AI if it will not result in a relative neglect of my skills



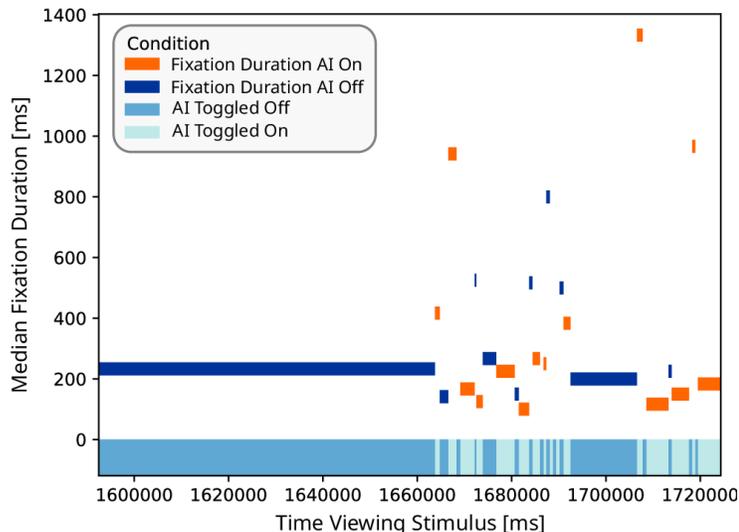
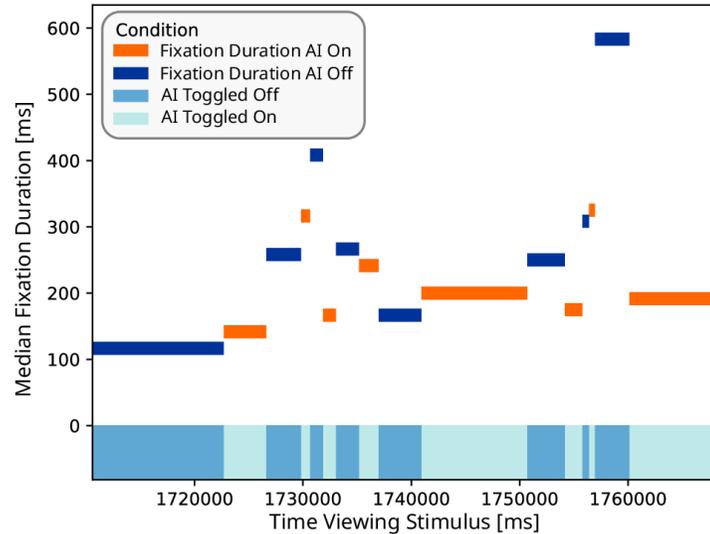
Scanzera et al. (2022) Optometrist's perspectives of AI in eye care. *J Optom.* 15:S91-S97

Ho S et al. (2022) Attitudes of optometrists towards AI for the diagnosis of retinal disease. *Ophthalmic Physiol Opt.* 42(6):1170-1179

# ZEISS Vision Science Lab: AI as an assistant tool for experts



Castner & Arsiwala-Scheppach et al. (2024)



“[...] **collaborative** systems are becoming the preferred choice for clinical workflows”

## Aim

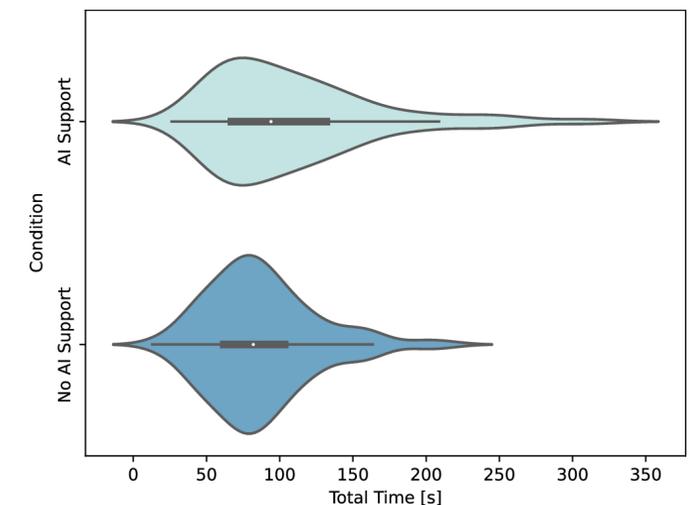
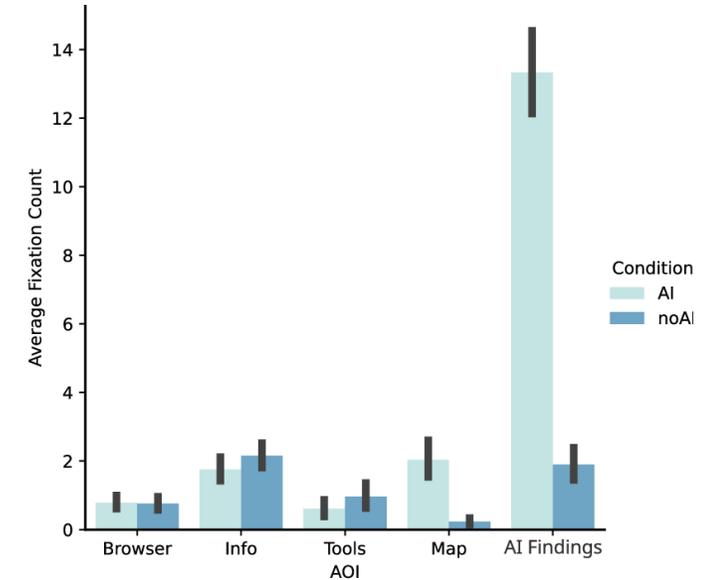
Experts' interaction with an AI software for diagnosis

## Methods

Analysis of gaze behavior

## Outcome

- Experts turned the AI on for roughly 25% of the total inspection task
- With AI, more attention was dedicated to user interface elements related to the AI support
- Interruptions in attention can lead to increased assessment time



Steigende Anzahl von optometrischen und ophthalmologischen System mit immer leistungsfähigerer KI-Assistenz

## Vielseitige Chancen für Optometristen und Augenoptiker:

- Abfedern des Fachkräftemangels (→ VISUCORE 500)
- Erweiterung des Serviceangebotes (→ VISUREF 1000 & EyeCare Network)
- Telemedizin (→ Oculomics)

## Für uns Geräte-Herstellende:

Implementierung einer sinnvollen KI Assistenz gemeinsam mit Experten!





Seeing beyond

Ghaffar F, Furtado NM, Ali I, Burns C. (2025) Diagnostic Decision-Making Variability Between Novice and Expert Optometrists for Glaucoma: Comparative Analysis to Inform AI System Design. *JMIR Med Inform.* 13:e63109.

Oshika T. (2025) Artificial Intelligence Applications in Ophthalmology. *JMA J.* 8(1):66-75

Akpinar MH, Sengur A, Faust O, Tong L, Molinari F, Acharya UR. (2024) Artificial intelligence in retinal screening using OCT images: A review of the last decade (2013-2023). *Comput Methods Programs Biomed.* 254:108253.

Castner N, Arsiwala-Scheppach L, Mertens S, Krois J, Thaqi E, Kasneci E, Wahl S, Schwendicke F. (2024) Expert gaze as a usability indicator of medical AI decision support systems: a preliminary study. *NPJ Digit Med.* 7(1):199

Grzybowski A, Jin K, Zhou J, Pan X, Wang M, Ye J, Wong TY. (2024) Retina Fundus Photograph-Based Artificial Intelligence Algorithms in Medicine: A Systematic Review. *Ophthalmol Ther.* 13(8):2125-2149.

Hashemian H, Peto T, Ambrósio R Jr, Lengyel I, Kafieh R, Muhammed Noori A, Khorrami-Nejad M. (2024) Application of Artificial Intelligence in Ophthalmology: An Updated Comprehensive Review. *J Ophthalmic Vis Res.* 19(3):354-367

Jin K, Li Y, Wu H, Tham YC, Koh V, Zhao Y, Kawasaki R, Grzybowski A, Ye J. (2024) Integration of smartphone technology and artificial intelligence for advanced ophthalmic care: A systematic review. *Adv Ophthalmol Pract Res.* 25;4(3):120-127.

Linde G, Rodrigues de Souza W Jr, Chalakkal R, Danesh-Meyer HV, O'Keefe B, Chiong Hong S. (2024) A comparative evaluation of deep learning approaches for ophthalmology. 14(1):21829.

Mai J, Schmidt-Erfurth U. (2024) Role of Artificial Intelligence in Retinal Diseases. *Klin Monbl Augenheilkd.* 241(9):1023-1031

- Morey J, Schupbach J, Jones D, Walker L, Lindor R, Loufek B, Mullan A, Cabrera D. (2024) FDA reviewed artificial intelligence-enabled products applicable to emergency medicine. *Am J Emerg Med.* 89:241-246.
- Parmar UPS, Surico PL, Singh RB, Romano F, Salati C, Spadea L, Musa M, Gagliano C, Mori T, Zeppieri M. (2024) Artificial Intelligence (AI) for Early Diagnosis of Retinal Diseases. *Medicina (Kaunas).* 60(4):527
- Stuermer L, Braga S, Martin R, Wolffsohn JS. (2024) Artificial intelligence virtual assistants in primary eye care practice. *Ophthalmic Physiol Opt.* doi: 10.1111/opo.13435.
- Anandi L, Budihardja BM, Anggraini E, Badjrai RA, Nusanti S. (2023) The use of artificial intelligence in detecting papilledema from fundus photographs. *Taiwan J Ophthalmol.* 13(2):184-190.
- Chaitanu Wong P, Singhanetr P, Chainakul M, Arjkongharn N, Ruamviboonsuk P, Grzybowski A. (2023) Potential Ocular Biomarkers for Early Detection of Alzheimer's Disease and Their Roles in Artificial Intelligence Studies. *Neurol Ther.*
- Daich Varela M, Sen S, De Guimaraes TAC, Kabiri N, Pontikos N, Balaskas K, Michaelides M. (2023) Artificial intelligence in retinal disease: clinical application, challenges, and future directions. *Graefes Arch Clin Exp Ophthalmol.* 1–15.
- Du HQ, Dai Q, Zhang ZH, Wang CC, Zhai J, Yang WH, Zhu TP. (2023) Artificial intelligence-aided diagnosis and treatment in the field of optometry. *Int J Ophthalmol.* 16(9):1406-1416.
- Prashar J, Tay N. (2023) Performance of artificial intelligence for the detection of pathological myopia from colour fundus images: a systematic review and meta-analysis. *Eye (Lond).* 2023 Aug 7.
- Wang S, Ji Y, Bai W, Ji Y, Li J, Yao Y, Zhang Z, Jiang Q, Li K. (2023) Advances in artificial intelligence models and algorithms in the field of optometry. *Front Cell Dev Biol.* 11:1170068.

# General Overview – AI in Ophthalmology

Olawade et al. (2025)



Service Area	AI Technology	Key Systems/Programs	Clinical Application	Advantages	Challenges
Screening Programs	AI-powered screening tools	EyeArt, IDx-DR, mobile AI apps	Early detection of eye diseases, such as DR and glaucoma	Increased access, early detection, reduced workload	Data privacy, ensuring accuracy in diverse settings
Teleophthalmology	AI in telemedicine platforms	Retina-AI, telehealth initiatives	Remote diagnosis and monitoring of eye conditions	Access to care in remote areas, timely referrals	Technology access, maintaining data security
Workflow Optimization	AI for task automation	AI-driven triage and scheduling	Automating image analysis, patient triage, and scheduling	Improved efficiency, allowing for focus on complex cases	Interoperability with existing systems, user acceptance
Patient Monitoring	AI in wearable devices	Smart contact lenses, AI apps	Continuous monitoring of eye conditions	Real-time data, proactive management	Data management, patient adherence
Decision Support Systems	Clinical decision support AI	IBM Watson, Google Health AI	Assisting in diagnosis and treatment planning	Enhanced decision-making, personalized care	Trust in AI recommendations, integration into workflow
Resource Allocation	AI for resource management	Hospital management AI tools	Optimizing use of medical resources and staff scheduling	Cost savings, improved resource utilization	Implementation costs, training staff
Patient Engagement	AI chatbots and virtual assistants	Chatbots for appointment scheduling, symptom checking	Enhancing patient communication and education	Improved patient satisfaction, reduced administrative burden	Accuracy of AI responses, patient data privacy