Revista Bioética
Print version ISSN 1983-8042 | On-line version ISSN 1983-8034

Rev. Bioét. vol.34 Brasília 2026

Ethical perspectives on artificial intelligence in ophthalmology: a critical review

Gabrielle Araújo de Melo [1], *Fernando Luiz Westphal* [1], *Thiago Russo* [2], *Silvania Furtado* [1], *Felipe Margem* [2]

1. Universidade Federal do Amazonas, Manaus/AM, Brasil. **2.** Pesquisador autônomo, Manaus/AM, Brasil.

Abstract

The increasing application of artificial intelligence in medicine has led to significant advances in diagnosis, monitoring, and treatment of diseases. However, its use raises important ethical issues involving medical responsibility, confidentiality, and patient autonomy. This review aimed to analyze the main bioethical aspects of the use of artificial intelligence in ophthalmological practice. Articles addressing the interaction between artificial intelligence, ethics, and ophthalmology were included, with emphasis on risk situations and impacts on clinical decision-making. It is concluded that, despite the great potential of artificial intelligence to improve ophthalmic care, final responsibility for diagnosis and patient management remains exclusively with the physician. Furthermore, the implementation of these technologies must be conducted ethically, ensuring transparency, protection of patient privacy, and compliance with regulatory standards, in order to balance technological innovation with safety and respect for individual rights.

Keywords: Artificial intelligence. Bioethics. Ophthalmology. Clinical diagnosis.

Resumo

Perspectivas éticas sobre inteligência artificial em oftalmologia: revisão crítica

O aumento da aplicação da inteligência artificial na medicina tem proporcionado avanços significativos no diagnóstico, monitoramento e tratamento de doenças. No entanto, seu uso levanta questões éticas relevantes envolvendo responsabilidade médica, confidencialidade e autonomia do paciente. Esta revisão teve como objetivo analisar os principais aspectos bioéticos da utilização da inteligência artificial na prática oftalmológica. Foram incluídos artigos que abordam a interação entre inteligência artificial, ética e oftalmologia, com ênfase em situações de risco e impactos na tomada de decisão clínica. Conclui-se que, apesar do grande potencial da inteligência artificial para aprimorar o cuidado oftalmológico, a responsabilidade final pelo diagnóstico e manejo do paciente permanece exclusiva do profissional médico. Além disso, a implementação dessas tecnologias deve ser conduzida de maneira ética, com garantia da transparência, proteção da privacidade dos pacientes e conformidade com normas regulatórias, de modo a equilibrar inovação tecnológica com segurança e respeito aos direitos individuais.

Palavras-chave: Inteligência artificial. Bioética. Oftalmologia. Diagnóstico clínico.

Resumen

Perspectivas éticas sobre la inteligencia artificial en oftalmología: revisión crítica

El aumento de la aplicación de la inteligencia artificial en la medicina ha proporcionado avances significativos en el diagnóstico, monitoreo y tratamiento de enfermedades. Sin embargo, su uso plantea cuestiones éticas relevantes relacionadas con la responsabilidad médica, la confidencialidad y la autonomía del paciente. Esta revisión tuvo como objetivo analizar los principales aspectos bioéticos del uso de la inteligencia artificial en la práctica oftalmológica. Se incluyeron artículos que abordan la interacción entre inteligencia artificial, ética y oftalmología, con énfasis en situaciones de riesgo e impactos en la toma de decisiones clínicas. Se concluye que, a pesar del gran potencial de la inteligencia artificial para mejorar la atención oftalmológica, la responsabilidad final por el diagnóstico y el manejo del paciente sigue siendo exclusiva del profesional médico. Además, la implementación de estas tecnologías debe llevarse a cabo de manera ética, garantizando la transparencia, la protección de la privacidad de los pacientes y el cumplimiento de las normativas regulatorias, con el fin de equilibrar la innovación tecnológica con la seguridad y el respeto a los derechos individuales.

Palabras clave: Inteligencia artificial. Bioética. Oftalmología. Diagnóstico clínico.

Research

The authors declare no conflict of interest.

Artificial intelligence (AI) and machine learning (ML) have significant potential to redefine the healthcare landscape, standing out, among other aspects, for their ability to learn from real-world experience and continuously improve their performance [1]. This technology has shown great potential to improve the accuracy of eye diseases identification and diagnosis, thereby making healthcare professionals' work more efficient and reducing treatment costs. These advances facilitate access to healthcare services and contribute to better public health outcomes [2].

The emergence of AI and ML has revolutionized medicine. Despite their high effectiveness, the rapid expansion of these technologies has generated bioethical observations, both anticipated and unforeseen [3]. In ophthalmology, one of the most advanced medical specialties in the application of AI, large amounts of images and data are produced to train and validate intelligent algorithms [4]. The objective of this review is to analyze how artificial intelligence can be used ethically and safely in ophthalmological clinical practice.

Artificial intelligence

AI is the ability of computers or robots to perform tasks normally associated with human intellectual processes and can be classified into different levels. One of them, restricted AI, encompasses most current software and is limited to imitating human intelligence in specific areas. At another level, general AI is designed to operate at a human level, encompassing reasoning, learning, planning, and communication, all integrated.

Ophthalmology is particularly suitable for AI applications due to the widespread use of digital technologies, such as fundus photography, optical coherence tomography (OCT), and computerized visual field testing, which generate extensive databases for training algorithms. FDA-approved AI software, such as IDx-DR, can assist with the automated screening for diabetic retinopathy, especially in regions with a shortage of specialists and limited access to ophthalmological services [5]. While the use of such software requires specific equipment or access to digital platforms, investing in these technological resources in remote regions is more cost-effective than transferring ophthalmologists, which would entail relocation costs, family relocation, salary increases, and upgrades to local infrastructure. Thus, technology does not eliminate the need for specialists, but expands the reach of diagnoses to scenarios where continuous human presence is logistically more complex.

Within the field of AI, one of the most relevant sub-areas is machine learning, which enables machines to learn from data rather than relying on explicit programming to perform tasks. ML algorithms are designed to identify patterns in data and automatically improve their performance over time, making them fundamental to practical AI applications across various areas, including medicine. Chart 1 describes some types of AI and their applications in medicine.

Chart 1. Types of artificial intelligence in the medical field

Types of artificial intelligence	Applications in medicine
Neural networks	Interpretation of exam images
	Signal analysis (ECG, EEG)
	Genetic pattern detection
Deep learning	Diagnostic imaging
	Language processing (medical records)
Natural language processing	Virtual assistants for physicians (automation of administrative tasks)
	Information extraction from literature
Expert systems	Decision support systems (DSS)
	Generation of diagnostic and treatment guidelines
	Creation of treatment plans based on clinical guidelines
Medical robotics	Robot-assisted surgery
	Robots for rehabilitation
	Assistance robots for the care of patients with limitations

continues...

Research

Rev. bioét. 2026; 34: e4166EN 1-10 http://dx.doi.org/10.1590/1983-803420264166EN

Chart 1. Continuation

Types of artificial intelligence	Applications in medicine
Artificial intelligence for personalized medicine	Personalization of treatments based on generic data Prediction of drug response Identification of biomarkers
Computer vision algorithms	Diagnostic imaging Analysis of histopathological images
Intelligent virtual assistants	Monitoring of symptoms and medication records for patients Interaction with patients to collect information prior to consultations Medical assistance in administrative tasks and quick consultations
Optimization and planning algorithms	Scheduling of operating room hours and resources Management of medication supply
Predictive models	Prediction of pandemic progression Predictive models for the evolution of chronic diseases Prediction of postoperative complications

Source: Albisua and Pacheco [6]

The development and implementation of AI technologies must follow national strategic guidelines. In Brazil, the Brazilian Artificial Intelligence Plan (PBIA) [7], developed within the scope of the National Council for Science and Technology, under the coordination of the Ministry of Science, Technology, and Innovation, and with technical support from the Center for Strategic Studies and Management, constituted a strategic initiative for the country. By establishing guidelines for the development of artificial intelligence, PBIA [7] emphasizes that this technology be conducted in an ethical, safe, and sustainable manner, in line with fundamental principles of social responsibility and respect for human rights.

The protection of personal data and the right to privacy have also been treated as fundamental human rights by the United Nations (UN) [8]. In this context, the UN General Assembly emphasized the need to safeguard privacy in the digital age.

These recommendations serve as an international framework, encouraging governments and organizations to implement ethical, safe, and compatible data protection policies and practices that respect individuals' fundamental rights.

Artificial intelligence in ophthalmology

Anatomically, the eyeball is divided into two main segments: anterior and posterior. The anterior segment consists of the cornea, iris, anterior chamber, lens, and ciliary body, while the posterior segment consists of the sclera, choroid, retina, and vitreous body. Among these structures, the retina has stood out for arousing greater interest in AI applications [9]. The scientific literature has documented several AI tools in ophthalmology. Some of them are described in Chart 2.

Chart 2. Artificial intelligence technologies applied in ophthalmology

Type of artificial intelligence	Applications in ophthalmology
RetinaLyze [10]	Rapid retinal investigation, including: glaucoma, diabetic retinopathy, macular degeneration
Retina.AI [11]	Helps identify signs of diabetic retinopathy and diabetic macular edema in fundus photographs Helps determine the stage of diabetic retinopathy according to the international classification
SELENA+ [12]	Implicitly recognizes characteristics of diabetic retinopathy, possible suspicion of glaucoma, and age-related macular degeneration based on appearance in retinal images

continues...

Research

Chart 2. Continuation

Type of artificial intelligence	Applications in ophthalmology
EyeArt AI [13]	Autonomous detection of diabetic retinopathy
EyeScreen [14]	Assessment of diabetic retinopathy Classification by human experts and artificial intelligence assessment

The use of AI in ophthalmology focuses on retinal diseases, but also encompasses conditions such as cataracts and glaucoma. Furthermore, AI is increasingly being incorporated into the diagnosis of corneal diseases [15]. The widespread prevalence of these diseases, along with the availability of images, makes these areas attractive for AI-based analyses.

In cataract care, AI assists with diagnosis, classification, surgical referral, and prediction of postoperative refractive outcomes, including more accurate intraocular lens calculations. In glaucoma, machine learning algorithms analyze retinal nerve fiber layer thickness, visual fields, and optic nerve changes in fundus photographs, enabling early diagnosis and detection of disease progression. Furthermore, AI has also been applied to corneal diseases, such as keratoconus and Fuchs' endothelial dystrophy, using Scheimpflug tomography and high-definition OCT for automated diagnosis [16].

The pioneering use of machine learning algorithms for the recognition of corneal patterns based on topographies obtained with a Placido disk occurred in 1994 [17]. However, subsequent research has focused on the use of ML in corneal tomographs [18]. A review of topic [19] found that most studies aimed at detecting keratoconus used tomographic devices such as Orbscan, Pentacam, and Galilei's Scheimpflug rotary tomography.

In addition to clinical applications, the retina has attracted interest in biometrics for individual identification. Among the different types of biometrics, such as face, iris, fingerprint, retina, signature, and voice, the human retina is the most reliable for recognition and verification. This is due to its unique vascular pattern, which allows for accurate identification with minimal risk of misidentification, as well as its location within a protected organ of the body and its limited variation over time [20].

Several companies have developed biometric solutions based on different ocular, facial, and/or fingerprint attributes. NEUROtechnology [21] provides biometric solutions that include fingerprint, palm print, facial, iris, and voice recognition. IrisGuard [22] focuses on iris recognition, while Eyecool [23] adopts a multimodal model that combines facial, iris, and fingerprint scanning.

Despite the technological sophistication presented, none of these companies explicitly state clear data security policies or ethical guidelines for the use of such tools on their official websites, highlighting a worrying gap given the sensitivity of the biometric information handled.

Method

This is a critical literature review aimed at analyzing the possible ethical and safety considerations of AI use in ophthalmology. The search for studies was conducted in the PubMed, Lilacs, SciELO, Elsevier, and IEEE Xplore databases, using the descriptors "inteligência artificial," "oftalmologia," and "ética". Only bibliographic materials detailing content related to AI, ethical issues, and the intersection of these two themes in the ophthalmological field were selected to ensure coherence with the objective of the review.

Discussion

While ocular images are often considered less identifiable than facial photos, their unique vascular patterns can, in theory, allow for patient re-identification when cross-referenced with an external database [24]. Hence, the importance of discussing ethical issues in the use of AI.

Privacy and data security

Patient safety is fundamental in healthcare and involves protecting against events that pose

Research

danger, risk, or injury. While security concerns avoid dangers or threats, privacy refers to protection against unauthorized access to or use of patient information [25].

To preserve the privacy of patient data in AI-based systems, several strategies have been proposed in digital health, emphasizing privacy-preserving AI techniques that minimize the risk of data leaks and unauthorized access to sensitive information. These approaches include decentralizing data on local servers, making it harder to intercept data in large centralized databases; adding "noise" to datasets, making it harder to trace the original information; and fragmenting data across different servers and encoding systems, separating demographic, financial, and clinical information to increase security.

Another promising strategy is homomorphic encryption, which enables AI algorithms to process data without decrypting it, thereby preserving the confidentiality of the information. The importance of multifactor authentication, robust data governance policies, anonymization and pseudonymization of information, as well as greater transparency and patient control over the use of their data in AI research and applications, is highlighted [26].

RetinAI [27], a Swiss artificial intelligence company in ophthalmology, obtained CE-MDR certification – the mandatory conformity indication for selling medical devices in the European Union – for LuxIA, a diabetic retinopathy screening algorithm developed in partnership with the Fundación Ver Salud. Classified as a Class IIb medical device (equipment that requires rigorous safety and efficacy assessment), which indicates moderate to high risk and requires compliance with the European Union (EU) Medical Device Regulations, LuxIA processes fundus images and integrates with existing clinical workflows, ensuring regulatory compliance, accelerating diagnoses, and improving the management of patients with diabetes.

Concerns about confidentiality in the context of AI applications focus on the obtaining and use of information, which is also observed in Brazil, where there is the General Data Protection Law [28], whose main provisions are Articles 1 and 7, which establish the objectives of the law and the hypotheses for the processing of personal data.

Article 1. This Law provides for the processing of personal data, including by digital means, by a natural person or a legal entity of either public or private law, with the purpose of protecting the fundamental rights of freedom and privacy and the free development of the personality of the natural person. (...)

Article 7. Processing of personal data shall only be carried out under the following circumstances:

I – with the consent of the data subject; (...)

IV – for the conduction of studies by research bodies, ensuring, whenever possible, the anonymization of personal data.

Other countries also have regulations to ensure the secure use of data. In the EU, for example, there are the Cybersecurity Guidelines [29] and the Medical Device Regulations and the General Data Protection Regulation [30], whose main articles state that:

Article 1 GDPR. Subject-matter and objectives:

1. This Regulation lays down rules relating to the protection of natural persons with regard to the processing of personal data and rules relating to the free movement of personal data.

2. This Regulation protects the fundamental rights and freedoms of natural persons and in particular their right to the protection of personal data. (...)

Article 2 GDPR. Material scope

1. This Regulation applies to the processing of personal data wholly or partly by automated means and to the processing other than by automated means of personal data which form part of a filing system or are intended to form part of a filing system.

In the United States, the Health Insurance Portability and Accountability Act (HIPAA) [31] stands out, establishing accountability rules for healthcare entities, including hospitals, clinics, and health plans, ensuring that they protect

Research

the confidentiality, integrity, and availability of identifiable medical information. The law imposes civil and criminal penalties for misuse or unauthorized disclosure of this data. In addition, it defines strict privacy and security standards for protected health information, regulating how it can be collected, stored, transmitted, and shared, including guidelines on patient consent, data access, breach notification, and the implementation of technical and administrative protection measures [31].

Several public databases of ocular images have been used in ophthalmological research and vary in re-identification risk. The Ocular Disease Intelligent Recognition (ODIR-5K) [32], with fundus images labeled by pathologies, presents a low risk; T\the Optical Coherence Tomography Dataset for Image-Based Deep Learning Methods (OCTDL) [33], containing optical coherence tomography images, presents a moderate risk due to the uniqueness of retinal structures; the UHB Eye Image Dataset [34], which includes clinical and demographic information, presents a high risk, requiring rigorous anonymization protocols; finally, TEyeD [35], with detailed images of the pupil, iris, and eye movements, presents a high risk, especially if associated with facial data or eye fixation pattern.

Professional responsibility

According to the United Nations Educational, Scientific, and Cultural Organization (UNESCO), ethical responsibility and liability for decisions or actions taken using AI systems should ultimately be assigned to the people who use or develop this technology [36].

Concerns have been raised regarding medical liability for failures in AI-driven decisions, especially in the diagnosis and management of serious eye diseases. For example, errors in AI systems can lead to incorrect diagnoses of diabetic retinopathy, inadequate interpretation of glaucoma, failures in the early detection of age-related macular degeneration, or inaccurate assessments of cataracts, compromising therapeutic and surgical interventions. These risks reinforce the need for rigorous medical supervision and robust validation protocols to ensure safety and efficacy in ophthalmological practice.

Despite these concerns, AI has transformative potential to expand access to eye care for underserved populations, enabling decentralized screening and delegating tasks to non-specialist professionals [24]. Teleophthalmology, supported by AI, has expanded access to eye care in remote regions. Basic examinations, such as fundus images, are analyzed by algorithms to identify signs of ocular pathology, enabling the prioritization of higher-risk patients. Furthermore, non-specialist professionals, such as nursing technicians or imaging technicians, can capture the data. At the same time, AI evaluates patterns indicative of the need for intervention, an approach that optimizes resources, increases care coverage, and democratizes access to eye health [24].

On the other hand, the fear of medical negligence, defined as carelessness or omission in providing adequate care that results in harm to the patient, constitutes a significant obstacle to the adoption of AI in clinical practice, even considering its potential to improve diagnostic accuracy and efficiency [37]. Training and education for professionals are essential to reduce the fear of medical negligence when adopting AI. Training ophthalmologists on the limits, accuracy, and interpretation of algorithms ensures they can validate diagnoses previously suggested by AI, make safer clinical decisions, and consciously integrate the technology into medical practice, reducing the sense of exclusive responsibility for the results generated by automated systems.

Autonomy and informed consent

Patient-related ethics are based on the principles of beneficence (doing what is best for the person), non-maleficence (not causing harm to the patient), autonomy (respecting the individual's values and opinions through informed consent), and justice [38].

The ethical principle of autonomy was upheld in a court decision by Judge Cardozo in New York in 1914, with the succinct statement that *every human being of adult years and sound mind has a right to determine what shall be done with his own body, except in cases of emergency* [39], such as when the patient is unconscious. It is necessary to operate before consent can be obtained.

Research

It is up to the physician to clearly explain the details of the procedures to be performed, and to the patient to decide whether to authorize the processing and/or sharing of their data. In this regard, the informed consent form is a fundamental ethical and legal requirement in ophthalmology, particularly for surgical procedures. He ensures that the patient understands the risks, benefits, alternatives, and purpose of the treatment, respecting their autonomy and promoting informed decision-making. In surgical and/or non-surgical procedures, it is a legal and ethical requirement that the patient knows what will be done to their body and that informed consent is obtained before any procedure [40]. This includes a clear explanation of the procedure's objectives, potential risks (such as infection, hemorrhage, and decreased visual acuity), available alternatives, and, when necessary, postoperative care. Furthermore, the possibility of complications and the need for ongoing follow-up must be explained.

Beneficence

Brazilian ethical and legal guidelines, aimed at protecting the integrity of participants in scientific research, are standardized in Law 14,874/2024 [41] and CNS Resolution 466/2012 [42], which determine that studies with human beings must have as a fundamental principle the promotion of the well-being of participants, whether individual or collective, real or potential, and must include strategies for the identification, prevention and mitigation of risks and harm, as well as guarantee the right of access to the benefits arising from their results.

Research in ophthalmology is conducted to provide information that serves as a basis for diagnostic, prognostic, or therapeutic decisions and/or to improve understanding of pathogenesis when information is insufficient. *In emerging areas of ophthalmological treatment in which no established guidelines exist, it is up to the ophthalmologist to exercise particularly careful clinical judgment and implement the necessary precautions to safeguard the patient's well-being* [43].

Non-maleficence

It expresses the commitment to avoid harm, whether physical, psychological, moral, or ethical, by adopting preventive measures against identified risks and by implementing reparative strategies in the face of possible damage [41].

While the risks are relatively low, it is the physician's duty to minimize them, which includes a thorough assessment of the patient's eligibility for procedures, clear communication about the risks involved, and adherence to ethical advertising and marketing practices. Such measures enable patients to make more informed decisions about whether to undergo ophthalmic surgical interventions [44].

Final considerations

While artificial intelligence offers a promising resource for advancing ophthalmology, the ultimate responsibility for analyzing, validating, or modifying reports, as well as for defining the patient's diagnosis, must remain exclusively with the physician to ensure ethical and safe clinical practice.

Many of these AI technologies store personal information, which can generate risks if legal requirements are not observed. To a large extent, these difficulties stem from a lack of technical and legal knowledge among professionals who use these tools, including the need to obtain explicit consent for data use. Given this, it becomes essential to invest in the training of these professionals and ensure that the application of AI occurs responsibly, transparently, and in accordance with current regulations.

To guarantee transparency and scientific integrity, DeepSeek AI was used exclusively for linguistic support and to adapt the tone to an academic style, limiting textual improvements to the authors' original ideas, which were critically reviewed and validated point by point. The tool was not used to generate data, analyze results, or draw conclusions. ChatGPT was used in a preliminary stage of reference formatting, but all citations were subsequently verified, corrected, and manually validated by the authors against the sources. Therefore, the authors assume full responsibility for the accuracy and adequacy of all references and for the article's entire content.

References

1. Abramoff MD, Cunningham B, Patel B, Eydelman MB, Leng T, Sakamoto T *et al*. Foundational considerations for artificial intelligence using ophthalmic images. Ophthalmology [Internet]. 2021 [acesso 23 set 2025];129(2):14-32. DOI: 10.1016/j.ophtha.2021.08.023
2. Rajavi Z, Hatami F, Mirzaei SK, Lateef M, Khorrami Z, Jaldian HB *et al*. Advancements in strabismus diagnosis: a comprehensive systematic review of artificial intelligence and digital health applications. Exp Eye Res [Internet]. 2025 [acesso 23 set 2025];258:110501. DOI: 10.1016/j.exer.2025.110501
3. Paladugu PS, Ong J, Nelson N, Kamran SA, Waisberg E, Zaman N e*t al*. Generative adversarial networks in medicine: important considerations for this emerging innovation in artificial intelligence. Ann Biomed Eng [Internet]. 2023 [acesso 23 set 2025];51(10):2130-42. DOI: 10.1007/s10439-023-03304-z
4. Abdullah YI, Schuman JS, Shabsigh R, Caplan A, Al-Aswad LA. Ethics of artificial intelligence in medicine and ophthalmology. Asia Pac J Ophthalmol (Phila) [Internet]. 2021 [acesso 23 set 2025];10(3):289-8. DOI: 10.1097/APO.0000000000000397
5. Keskinbora K, Güven F. Artificial intelligence and ophthalmology. Turk J Ophthalmol [Internet]. 2020 [acesso 23 set 2025];50(1):37-43. DOI: 10.4274/tjo.galenos.2020.78989
6. Albisua J, Pacheco P. Límites éticos en el uso de la IA en medicina. Open Respir Arch [Internet]. 2024 [acesso 23 set 2025];7(1):100383. DOI: 10.1016/j.opresp.2024.100383
7. Plano Brasileiro de Inteligência Artificial (PBIA) 2024-2028 [Internet]. Brasília: LNCC; 7 ago 2024 [acesso 23 set 2025]. Disponível: https://bit.ly/4dfpKTT
8. Assembleia Geral da ONU aprova resolução de Brasil e Alemanha sobre direito à privacidade [Internet]. Brasília: Nações Unidas Brasil; 19 dez 2013 [acesso 24 set 2025]. Disponível: https://bit.ly/42YjdYF
9. Li Z, Wang L, Wu X, Jiang JW, Qiang W, Xie E *et al*. Artificial intelligence in ophthalmology: the path to the real-world clinic. Cell Rep Med [Internet]. 2023 [acesso 23 set 2025];4(7):101095. DOI: 10.1016/j.xcrm.2023.101095
10. RetinaLyze [Internet]. Herlev: RetinaLyze; 2025 [acesso 21 set 2025]. Disponível: https://retinalyze.com/
11. Screen Retina [Internet]. [Houston: Retina-AI]; 2025 [acesso 21 set 2025]. Disponível: https://www.screenretina.com/
12. SELENA+ obtains approval for market access in EU [Internet]. Singapore: EyRIS; 9 mar 2020 [acesso 25 set 2025]. Disponível: https://bit.ly/49wPl9s
13. EyeScreenTM Human+AI Diagnostic Service to be launched at ATA 2019 [Internet]. Woodland Hills: Eyenuk; 9 abr 2019 [acesso 25 set 2025]. Disponível: https://bit.ly/4u2EtbY
14. AI eye screening [Internet]. Woodland Hills: Eyenuk; 2025 [acesso 25 set 2025]. Disponível: https://bit.ly/4dsCmrL
15. Eleiwa T, Elsawy A, Özcan E, Abu Shousha M. Automated diagnosis and staging of Fuchs' endothelial cell corneal dystrophy using deep learning. Eye Vis (Lond) [Internet]. 2020 [acesso 25 set 2025];7(1):44. DOI: 10.1186/s40662-020-00209-z
16. Ahuja AS, Wagner IV, Dorairaj S, Checo L, Ten Hulzen R. Artificial intelligence in ophthalmology: a multidisciplinary approach. Integr Med Res [Internet]. 2022 [acesso 23 set 2025];11(4):100888. DOI: 10.1016/j.imr.2022.100888
17. Maeda N, Klyce SD, Smolek MK, Thompson HW. Automated keratoconus screening with corneal topography analysis. Invest Ophthalmol Vis Sci [Internet]. 1994 [acesso 23 set 2025];35(6):2749-57. Disponível: https://bit.ly/4cVufUx
18. Cohen E, Bank D, Sorkin N, Giryes R, Varssano D. Use of machine learning to achieve keratoconus detection skills of a corneal expert. Int Ophthalmol [Internet]. 2022 [acesso 23 set 2025];42(12):3837-47. DOI: 10.1007/s10792-022-02404-4
19. Vandevenne M, Favuzza E, Veta M, Lucenteforte E, Berendschot TT, Mencucci R *et al*. Artificial intelligence for detecting keratoconus. Cochrane Database Syst Rev [Internet]. 2023 [acesso 23 set 2025];11(11):014911. DOI: 10.1002/14651858.CD014911.pub2

Research

20. Akram U, Salam AA, Khawaja SG. RIDB: a dataset of fundus images for retina-based person identification. Data Brief [Internet]. 2020 [acesso 23 set 2025];33:106433. DOI: 10.1016/j.dib.2020.106433

21. Artificial Intelligence and Biometric Technologies [Internet]. Vilnius: Neurotechnology; 2025 [acesso 22 set 2025]. Disponível: https://www.neurotechnology.com/

22. IrisGuard [Internet]. Buckinghamshire: IrisGuard; 2025 [acesso 21 set 2025]. Disponível: https://www.irisguard.com/

23. Eyecool Technology [Internet]. Beijing: Eyecool Technology; 2025 [acesso 22 set 2025]. Disponível: https://www.eyecooltech.com/

24. Kazemzadeh K. Artificial intelligence in ophthalmology: opportunities, challenges, and ethical considerations. Med Hypothesis Discov Innov Ophthalmol [Internet]. 2025 [acesso 23 set 2025];14(1):255-72. DOI: 10.51329/mehdiophthal1517

25. Dunlap PAB, Michalowski M. Advancing artificial intelligence data ethics in nursing: future directions for nursing practice, research, and education (Preprint). JMIR Nurs [Internet]. 2024 [acesso 23 set 2025];7. DOI: 10.2196/62678

26. AI In Eye Care. The battle for privacy in the world of artificial intelligence [Internet]. Newark; 2025 [acesso 22 set 2025]. Disponível: https://bit.ly/4dYNT2j

27. RetinAI [Internet]. Boston: RetinAI; 2025 [acesso 23 set 2025]. Disponível: https://www.retinai.com

28. Brasil. Lei nº 13.709, de 14 de agosto de 2018. Lei Geral de Proteção de Dados Pessoais (LGPD). Diário Oficial da União [Internet]. Brasília, 15 ago 2018 [acesso 22 set 2025]. Disponível: https://bit.ly/4wgePSs

29. European Commission. EU cybersecurity policies [Internet]. [acesso 22 maio 2026]. Disponível em: https://bit.ly/4usxEAE

30. Regulamento Geral sobre a Proteção de Dados (RGPD, GDPR) [Internet]. Berlin: DPO Europe GmbH; 2024 [acesso 23 set 2025]. Disponível: https://gdpr-text.com/pt/

31. U.S. Centers For Disease Control and Prevention. Health Insurance Portability and Accountability Act of 1996 (HIPAA) [Internet]. 10 set 2024 [acesso 22 set 2025]. Disponível: https://bit.ly/42TZnhp

32. Andrew MVD. Ocular disease recognition (ODIR-5K) [Internet]. San Francisco: Kaggle; 2020 [acesso 22 set 2025]. Disponível: https://bit.ly/4dbpYLJ

33. Kulyabin M, Zhdanov A, Nikiforova A, Stepichev A, Kuznetsova A, Ronkin M *et al*. OCTDL: optical coherence tomography dataset for image-based deep learning methods. Sci Data [Internet]. 2024 [acesso 23 set 2025];11(1):365. DOI: 10.1038/s41597-024-03182-7

34. Dataset 25855 [Internet]. London: Dtechtive; 2023 [acesso 23 set 2025]. Disponível: https://bit.ly/4uBYUfG

35. Fuhl W, Kasneci G, Kasneci E. TEyeD: over 20 million real-world eye images with pupil, eyelid, and iris 2D and 3D segmentations, 2D and 3D landmarks, 3D eyeball, gaze vector, and eye movement types [Internet]. IEEE; 2021 [acesso 15 maio 2026]. Disponível: https://bit.ly/4wJkUXB

36. Recommendation on the ethics of artificial intelligence [Internet]. Paris: Unesco; 2021 [acesso 21 set 2025]. Disponível: https://bit.ly/4uSOrwD

37. Adejumo OA, Adejumo OA. Legal perspectives on liability for medical negligence and malpractices in Nigeria. Pan Afr Med J [Internet]. 2020 [acesso 21 set 2025];35:44. DOI: 10.11604/pamj.2020.35.44.16651

38. Nebeker C, Torous J, Bartlett Ellis RJ. Building the case for actionable ethics in digital health research supported by artificial intelligence. BMC Med [Internet]. 2019 [acesso 23 set 2025];17(1). DOI: 10.1186/s12916-019-1377-7

39. Basic right to consent to medical care – Schoendorff v. Society of New York Hospital, 105 N.E. 92 (N.Y. 1914) [Internet]. Louisiana: The Climate Change and Public Health Law Site; 2025 [acesso 22 set 2025]. Tradução livre. Disponível: https://bit.ly/42jTpGq

40. Ay IE, Doğan M. An evaluation of the comprehensibility levels of ophthalmology surgical consent forms. Cureus [Internet]. 2021 [acesso 23 set 2025]; 13(7): e16639. DOI: 10.7759/cureus.16639

41. Brasil. Lei nº 14.874, de 28 de maio de 2024. Dispõe sobre a pesquisa com seres humanos e institui o Sistema Nacional de Ética em Pesquisa com Seres Humanos. Brasília; 2024 [acesso em 15 maio 2026]. Disponível: https://bit.ly/4wLbL0T

42. Brasil. Ministério da Saúde. Conselho Nacional de Saúde. Resolução nº 466, de 12 de dezembro de 2012. Diretrizes e normas regulamentadoras de pesquisas envolvendo seres humanos. Brasília; 13 jun 2013 [acesso em 15 maio 2026]. Disponível: https://bit.ly/4nHzwD3

43. Code of Ethics [Internet]. Tradução livre. San Francisco: American Academy of Ophthalmology; 1º jan 2025 [acesso 22 set 2025]. Disponível: https://bit.ly/4dtODMF

44. Yu M. LASIK surgery: do the advertising and risk disclosures reflect the true risk of complication? Voices in Bioethics [Internet]. 2020 [acesso 23 set 2025]. DOI: 10.7916/d8-ecmg-rt49

Gabrielle Araújo de Melo – Master's student – gabrielle.melo@ufam.edu.br

0009-0005-9911-3500

Fernando Luiz Westphal – PhD – flwestphal@ufam.edu.br

0000-0002-3468-7029

Thiago Russo – Graduate (specialist) – benaion.thiago@gmail.com

0009-0006-6790-3249

Silvania Furtado – PhD – silvaniafurtado@ufam.edu.br

0000-0003-0065-3119

Felipe Margem – Graduate (specialist) – felipemargem@gmail.com

0009-0003-0234-232X

Correspondence

Gabrielle Araújo de Melo. Rua Jordão, 27, Conj. Nossa Senhora de Fátima, Novo Aleixo. CEP 69099-355. Manaus/AM, Brasil.

Contribution of the authors

Gabrielle Araújo de Melo: study conception; literature search and selection; critical analysis of included studies; manuscript writing. Fernando Luiz Westphal: scientific guidance; critical review of intellectual content; approval of the final version of the manuscript. Silvania Furtado: scientific guidance; critical review of intellectual content; approval of the final version of the manuscript. Thiago Russo: technical review of the content in the ophthalmology area; approval of the final version of the manuscript. Felipe Margem: technical review of the content in the ophthalmology area; approval of the final version of the manuscript.

Data availability: All data used or generated in this study are described and presented in full in the body of the article.

Editor in charge: Dilza Teresinha Ambrós Ribeiro

Received: 9.24.2025

Revised: 2.27.2026

Approved: 3.10.2026

Research