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REVIEW ARTICLE

The perspectives of eye care professionals on the integration of artificial intelligence in eye care practices: A systematic review

Obehi Suzan Idogen*

Department of Optometry, Faculty of Life Sciences, University of Benin, Benin, Edo, Nigeria

Abstract

Artificial intelligence (AI) technology has recently been integrated into the health-care industry, including in optometry and ophthalmology. This systematic review assessed the opinions (i.e., perspectives, concerns, and degrees of acceptance) of eye care professionals regarding AI integration into eye care practices. The literature search was conducted using the PubMed and MEDLINE databases. A total of 780 related articles were identified. Among these articles, 304 duplicates were removed, 450 articles were excluded after reviewing the abstract, and 18 articles were excluded after reviewing the full text as these articles were not relevant and/or did not report surveys. The remaining eight included studies were assessed accordingly. Most ophthalmologists and optometrists had a positive perception toward incorporating AI into eye care practices, and these professionals shared that AI would effectively enhance clinical eye care practices. However, certain eye care professionals were concerned about the diagnostic accuracy of AI, the high implementation costs, privacy issues, and the quality of AI-integrated patient care. Several eye care professionals also expressed concerns that AI technology could eventually replace some of their major responsibilities in the practice, suggesting that stakeholders should essentially address these concerns and ensure that AI integration in eye care practices is implemented thoughtfully and ethically to maximize its benefits while preserving the quality of patient care. Nonetheless, this systematic review highlighted the predominantly positive attitude among eye care professionals toward AI integration into eye care practices, warranting further research and collaboration between AI developers and eye care professionals to effectively address the current challenges.

Keywords: Artificial intelligence; Perspective of ophthalmologists; Perspective of optometrists; Eye care

***Corresponding author:**
Obehi Suzan Idogen
(obehi.idogen@lifesci.uniben.edu)

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1. Introduction

Artificial intelligence (AI) technology has become a pivotal aspect of the health-care industry, including optometry and ophthalmology.[1-15] AI technology has been widely used in different eye care practices,[16-19] such as managing and analyzing clinical patient data (e.g., eye images) and addressing staff- and management-related issues.[2,20-32] In addition, AI technology has been used for diagnosing eye disorders, leading to a relatively faster and simpler diagnosis of ocular conditions. As a result, eye care professionals can provide more thorough patient care and generally better practices.[33,34]

However, health-care practitioners and stakeholders often feel apprehensive and uncertain about adopting new and advanced technologies, due to various reported reasons.[35-37] Hence, eye care professionals may have their concerns and perceptions regarding the increasing use of AI technology in eye care practices. The evolving perception of AI in eye care necessitates a thorough evaluation of how the technological advancements of AI can better align with established norms and increase their acceptance within the field.

Herein, this systematic review aims to investigate and analyze the opinions of eye care professionals regarding the integration of AI in eye care practices. Through a comprehensive examination of existing literature, this study offers a detailed understanding of the perspectives, concerns, and knowledge of eye care professionals in adopting AI technology in eye care practices.

2. Methods

2.1. Systematic review approach

I employed the narrative synthesis approach to summarize the findings from multiple studies in this systematic review to provide a thorough explanation of the opinions and perspectives of eye care professionals regarding AI integration in eye care practices. This approach was selected to point out important key findings and patterns in the study's subject area and to offer a comprehensive understanding of the various findings among the included studies.

2.2. Literature search

A literature search was conducted between August and December 2023 using the PubMed interface to access articles in the MEDLINE database. The preference for utilizing only PubMed was due to its accessibility and its extensive collection of records relevant to the research topic. The search focused on studies related to the perception of ophthalmologists and optometrists on AI application in eye care and was not limited to articles published within any particular country, as AI technology had been increasingly applied in eye care practices across various countries. I used the Medical Subject Headings (MeSH) search strategy to identify original survey-based studies conducted among optometrists and ophthalmologists, using the following keywords: "ophthalmologist perception of artificial intelligence," "perception of artificial intelligence in optometry," and "applications of artificial intelligence in eye care."

2.3. Study selection

I established selection criteria for the screening process. The inclusion criteria were as follows: articles published in English; studies published between 2018 and 2023; and survey-based studies that evaluated the perception of ophthalmologists and optometrists on AI integration in eye care. The exclusion criterion was studies involving AI application and implementation in eye care but did not include the perception of optometrists and ophthalmologists toward AI technology.

The literature search yielded a total of 780 articles. From these, 304 duplicate articles were excluded from the study. Subsequently, the abstracts of the remaining 576 articles were screened based on the above selection criteria, resulting in 450 excluded articles. The full text of the remaining 26 articles was further screened, resulting in 18 excluded articles that lacked relevance and/or were not a survey-based study. The remaining eight studies were included and assessed accordingly. Figure 1 illustrates the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) article selection process.

2.4. Data extraction

Relevant information was extracted from the eight included articles, that is, authors' names, year of publication, sample size, survey type, the objective of the study, primary findings, and assessment tools (questionnaire type) used to assess the perceptions of eye care professionals toward the application of AI technology in eye care.

3. Results

Our findings on the included articles are summarized in Table 1.[38-45] Collectively, the eye care professionals displayed varying degrees of optimism toward the application of AI technology in eye care. They recognized the potential advantages of AI technology but had some doubts about its diagnostic precision. Scanzera *et al.*[38] conducted a survey among members of the American Academy of Optometry to determine their opinions, reservations, and readiness to use AI in clinical settings. According to the survey results, 66.8% of optometrists were familiar with AI, suggesting the increasing awareness and interest in AI technology advancements. Some optometrists presented opposing viewpoints on AI, and 25.1% of them were concerned that AI could potentially replace them. Most respondents (72.0%) indicated that AI could improve optometric practices, but 53.0% of respondents had doubts about the technology's diagnostic accuracy. In summation, the opposing responses suggest that AI technology development and implementation in eye care should be further assessed, particularly the accuracy of AI-assisted diagnosis.

Gunasekeran *et al.*[39] comprehensively evaluated the perspectives of ophthalmologists regarding AI in managing

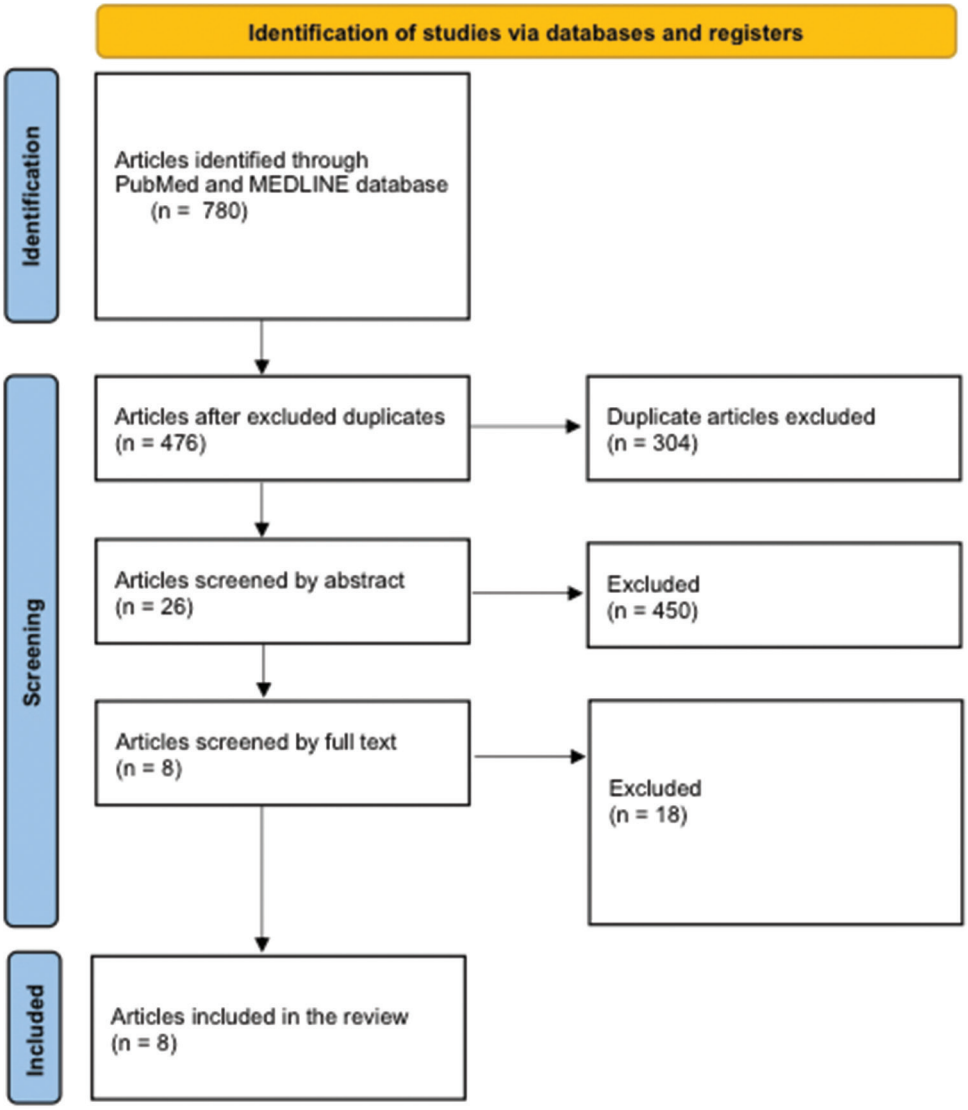

Figure 1. PRISMA diagram illustrating the process of article selection. Adapted from Page *et al.*[67]
Abbreviation: PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

prevalent eye conditions, such as diabetic retinopathy, glaucoma, age-related macular degeneration, and cataracts. The global survey involved 1176 ophthalmologists from 70 countries, and the response rates were 78.8–85.8% per question. According to the survey findings, 88.1% of ophthalmologists expressed readiness to use AI technology, particularly as clinical assisting tools. However, the preference for the use of AI as a tool for diagnosis and assisting clinical decisions declined at a response rate of 64.5% and 78.8%, respectively. Most of the respondents expressed confidence that AI would not take their jobs (68.2%). Approximately 72.5% of respondents identified notable challenges in AI implementation, including concerns regarding medical liability resulting from errors. The diagnosis of diabetic retinopathy was identified to be the most significant area for AI application (78.2%), followed by the diagnoses of glaucoma (70.7%), age-related macular degeneration (66.8%), and cataracts (51.4%).

Ho *et al.*[40] assessed the perspectives of optometrists on the use of AI in the diagnosis of retinal disorders. A paper-based survey was conducted among 133 optometrists to determine the factors and obstacles affecting AI implementation in optometry, as well as their general opinion toward AI technology. The primary results of the survey revealed that the surveyed optometrists generally had an optimistic view toward using AI as a support tool to diagnose retinal disorders. The optometrists' perception of AI-assisted diagnosis was positive, with a mean score of 4.0 out of 5 (standard deviation [SD]: 0.8). Furthermore,

Table 1. Summary of the systematic review

Source	Sample size	Objective	Survey type	Findings	Questionnaire
Scanzera *et al.*[38]	400 optometrists	Assess the opinions of optometrists on using AI in eye care	Quantitative	Most optometrists (72.0%) believed that AI could enhance the practice of optometry.	Electronic-based
Gunasekeran *et al.*[39]	1,176 ophthalmologists	Assess the opinions of ophthalmologists on using AI in four primary ocular conditions	Quantitative and qualitative	Ophthalmologists were open to integrating AI as a support tool for managing ocular conditions.	Electronic-based
Ho *et al.*[40]	133 optometrists	Assess the opinions of optometrists on using AI for diagnosing retinal diseases	Quantitative	Optometrists were optimistic about the potential application of AI in diagnosing retinal diseases.	Paper-based
Constantin *et al.*[41]	18 optometrists	Assess the perception of optometrists on utilizing AI in primary eye care and their willingness to provide their patients' ocular scan images to a research repository	Qualitative	Optometrists were willing to share their patients' eye images but raised concerns about technical challenges. They supported AI utilization but emphasized the importance of maintaining their role and responsibilities without diminishment.	Electronic-based
Al-Khaled *et al.*[42]	170 ophthalmologists	Assess the perception of ophthalmologists on AI	Quantitative	Most respondents (75%) reported that AI will advance ophthalmic practice, and 45% of respondents expressed concern about the technology's ability to diagnose patients accurately.	Electronic-based
Scheetz *et al.*[43]	632 healthcare specialists (305 ophthalmologists)	Assess the present utilization, comprehension, and viewpoints on AI in ophthalmology, radiology, and dermatology	Quantitative and qualitative	Most respondents (71%) believed that AI would improve their respective health-care sectors.	Electronic-based
Valikodath *et al.*[44]	80 ophthalmologists	Assess the viewpoints of pediatric ophthalmologists on utilizing AI in ophthalmology	Quantitative and qualitative	Most respondents (70%) were optimistic that AI will enhance ophthalmology practices, while 26% expressed concerns about its potential negative impact on the patient-doctor relationship.	Electronic-based
Alwadani *et al.*[45]	57 ophthalmologists	Assess the knowledge and awareness of junior and senior ophthalmologists on AI	Qualitative	The ophthalmologists had a thorough comprehension of the application of AI in the treatment of eye disorders and had a positive attitude toward it.	Online and paper-based

Abbreviation: AI: Artificial intelligence.

the optometrists were generally agreeable to utilizing AI technology if it had demonstrated improvements in patient access to healthcare (mean score: of 4.4 out of 5). The study also reported that optometrists preferred to use AI to obtain an additional opinion after patient consultation rather than at the point of care. This finding illustrates the potential of integrating AI technology into the patients' therapeutic process to facilitate decision-making with regard to patient care.

Medical images in research archives offer a viable way to improve clinical practice in healthcare.[46] Constantin *et al.*[41] evaluated the attitudes and perspectives of optometrists toward the creation of an image research library and the application of AI to support decision-making in primary eye care. Structured interviews were conducted to determine the expectations, concerns, and recommendations of the eye care professionals with regard to the aim of their study. All of the respondents agreed that retinal images should be contributed to create a comprehensive and long-lasting research archive. The respondents also recognized the possible advantages of the research archive and anticipated improved collaboration between optometry and ophthalmology, particularly with regard to patient referrals. However, the respondents also raised concerns regarding the perceived effort involved in sharing digital photos, lack of standardization, and technical complexity. The respondents displayed their willingness to adopt AI technology to support the diagnosis and treatment of eye disorders. However, the respondents stressed that the application of AI should not diminish their roles and responsibilities and expressed concerns regarding the cost associated with implementing AI technology in eye care.

Taken together, the study demonstrated the willingness among eye care professionals to utilize AI to improve eye care practices but also reflected concerns on the cost of AI implementation, potential job replacements, and the possible compromise in long-standing professional standards.

Several studies have explored the possible effects of AI technology on conventional treatment and doctor-patient interactions.[47,48] For instance, Al-Khaled *et al.*[42] assessed the opinions of 170 ophthalmologists from the United States on incorporating AI into clinical practice. Most of the respondents indicated that they comprehended the prospect of AI technology. However, 22% of respondents were concerned about the effect of AI technology on doctor-patient relationships. The thought that AI would replace doctors was disagreed by 64% of respondents, who also viewed AI as an assistive technology to ophthalmologists instead of their replacement. Approximately 75% of respondents suggested that AI could enhance eye care practices in ophthalmology, and 44% of respondents expressed their interest in using AI in their daily clinical work. However, 45% of ophthalmologists expressed some concerns about the diagnostic accuracy of AI technology, implying their reluctance to depend entirely on AI technology for clinical decision-making.

The attitudes and perspectives of early-career and established clinicians are crucial to the successful integration and adoption of AI in healthcare, as they are key players in its implementation.[49] Scheetz *et al.*[43] conducted a survey with fellows and trainees from three different fields (i.e., ophthalmology, radiology, and dermatology) in Australia and New Zealand to collect their opinions on AI technology. A total of 632 complete responses were obtained, offering valuable insights into the general opinions held by doctors about the potential and influence of AI technology in their respective disciplines. The findings revealed that 71% of respondents expressed optimism that AI would improve medicine, and 85.8% of respondents agreed that AI would directly influence the medical workforce within the next 10 years. AI technology was generally perceived to enhance diagnostics and automate routine clinical procedures, thereby improving the accuracy and efficiency of the clinical sector. However, the respondents also expressed several concerns about AI implementation, such as the possible transfer of health-care duties to tech firms, which could compromise patient privacy, quality of care, and decision-making authority.[43]

Valikodath *et al.*[44] assessed the opinions of 80 pediatric ophthalmologists regarding the use of AI in pediatric ophthalmology. The survey results revealed that the ophthalmologists had a generally optimistic view of AI technology, and 91% of them were familiar with the concept of AI in eye care, demonstrating the foundational knowledge of AI technology developments among the surveyed ophthalmologists. The respondents generally expressed positive views on the possible advantages of AI in ophthalmology. Interestingly, 70% of respondents were confident that AI could improve pediatric ophthalmology practice. Furthermore, 68% of them would be open to integrating AI into their clinical practices, indicating their readiness to use AI technology for improving patient care and diagnosis. Approximately 65% of them did not perceive AI as a replacement for physicians but rather as a complementary tool in clinical decision-making. This perspective aligns with the belief that AI would augment rather than diminish the role of healthcare professionals in delivering quality care to patients. Nonetheless, a minority of the surveyed group expressed some concerns; 15% of respondents expressed concerns regarding the possibility of AI technology replacing medical professionals and negatively impacting the workforce of the healthcare sector;[50,51] 26% of respondents were concerned that AI could undermine the doctor-patient relationship. These concerns highlight the value of preserving human relationships in healthcare.

Alwadani *et al.*[45] conducted a survey among 57 ophthalmologists (i.e., consultants, residents, and fellows) to evaluate their understanding of AI applications in ophthalmology. The questionnaire addressed a wide range of topics, such as demographics, ophthalmology-related expertise, and opinions toward AI. Approximately 91.26% of respondents were confident about the critical role of AI in treating a range of eye conditions. They emphasized the value of AI in the diagnosis and treatment of conditions, such as glaucoma, strabismus, and cataracts. The findings highlighted the respondents' remarkably high knowledge and favorable opinions about the use of AI in treating the aforementioned ocular conditions, implying the significance and advantages of integrating AI education into training programs. Overall, ophthalmologists are becoming increasingly aware of the use of AI in improving patient care, its therapeutic effectiveness, and diagnostic accuracy.

4. Discussion

The integration of AI in eye care practices is gradually becoming more prevalent in certain regions worldwide.[52-54] This review aimed to evaluate the reception of eye care professionals toward embracing AI technology and acknowledging its pivotal role in eye care practices. The utilization of AI technology spans various aspects of eye care, such as the diagnosis of eye diseases, ocular image analysis, and the management of eye care practices.[16,26,32]

Moreover, several studies have highlighted the significant advancements in eye care practices through the integration of AI technology.[17-19,34]

This systematic review revealed that eye care professionals have typically demonstrated favorable enthusiasm and openness toward the integration of AI technology into their clinical practices, considering the remarkable progress AI has made in the field of ophthalmology and optometry.[39,40,44,45] The gradual acceptance of AI technology among eye care professionals suggests that AI technology could potentially establish itself as a fundamental component within eye care practices. Therefore, the opinions of clinicians, as elucidated in this review, are imperative for maximizing the clinical utility of AI and ensuring its successful implementation into routine eye care practice.

Nonetheless, significant concerns were also raised among eye care professionals regarding AI applications. Some professionals indicated the potential inaccuracy and reliability issues of AI technology in diagnosing eye conditions within the clinical setting.[38,42] These concerns raised are valid as precise medical diagnoses are crucial for implementing the right treatment procedures and ensuring patient safety in any medical practice.[55,56] This negative viewpoint sheds light on the diverse perspectives and preferences of eye care professionals toward implementing AI technology in their daily eye care practices, essentially enabling us to identify the gaps in implementing AI in eye care practices.

The cost of implementing AI technology is another significant concern among eye care professionals. Despite their willingness to embrace AI in eye care, the financial limitations in accessing this technology were noted by the eye care professionals.[41] A study investigated the cost of AI implementation and emphasized that the practitioners would have to evaluate whether the benefits would outweigh the cost of AI implementation.[57] This highlights the business aspect of clinical practice, where stakeholders typically strive to balance the cost of production and service delivery with profit.[58]

Another notable concern was the potential replacement of eye care professionals by AI technology.[39,44] A survey among ophthalmologists revealed that most of them were not worried about their roles being replaced, but they did acknowledge the likelihood of certain primary eye care jobs and responsibilities being partially taken over by AI.[17] The study by Valikodath *et al.*[44] indicated that AI is more of an assisting tool rather than a complete replacement. However, AI is increasingly integrated into various aspects of life in the present day, thereby justifying the apprehension of AI technology potentially replacing primary eye care professionals.

Furthermore, health-care professionals, including ophthalmologists, have expressed concerns regarding patient privacy and care quality on AI integration.[43,44] Patient well-being and privacy stand as crucial pillars in healthcare,[59,60] and it is generally believed that human involvement in health-care delivery surpasses AI due to factors such as confidentiality, empathy, adaptability, and experiences only inherent in human health professionals.[61,62] These aspects collectively influence the willingness of health-care practitioners to fully embrace AI in patient care.[63-67]

Nonetheless, the generally positive viewpoints expressed by eye care professionals toward adopting AI highlight the necessity for targeted interventions to effectively address the challenges associated with implementing AI in eye care. To facilitate this, it is crucial to consider initiatives, such as increased funding specifically allocated for AI advancements in eye care. This funding would support research, development, and implementation of AI technologies tailored to the needs of the eye care sector. Moreover, it is important to also emphasize the pivotal role of AI in improving eye care outcomes through education and training programs designed for eye care professionals. By imparting knowledge about AI technology, its benefits, and its potential impact on eye care, professionals can develop a deeper understanding of how to integrate these technologies into their practice. The training programs should also address concerns surrounding the accuracy of AI diagnoses and their effect on patient care. Furthermore, it is beneficial to foster an environment that encourages the adoption of AI technology while actively addressing apprehensions and doubts within the eye care community. This could be achieved by establishing channels for open communication, information exchange, and collaborations between researchers, technologists, and eye care specialists to overcome current limitations and realize the full potential of AI in the field of eye care.

5. Conclusion

This systematic review demonstrated the generally positive perception of most eye care professionals regarding the implementation of AI technology in eye care practices. However, there were several key concerns raised, such as the high costs associated with implementing AI, the uncertain reliability of AI in performing diagnoses and making clinical decisions, and the fear of AI potentially replacing eye care professionals. Overall, this study highlighted the importance of optometrists and ophthalmologists embracing technological advancements such as AI, emphasizing the necessity of addressing the expressed concerns to ensure a harmonious integration of AI technology into eye care.

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Conflict of interest

The author declares no competing interests.

Author contributions

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