SIR Publishers
CENTER FOR INTERNATIONAL SCIENTIFIC PUBLICATIONS
JOURNAL OF APPLIED MEDICAL SCIENCES
ISSN(Online): 2984-6730
Volume-9, Issue-01, Published |14-02-2026|

EARLY DIAGNOSIS AND PREDICTION MODEL OF OPHTHALMIC DISEASES BASED ON ARTIFICIAL INTELLIGENCE USING DIGITAL RETINAL IMAGES

Yakubov Alibek Baxodirovich
Assistant at the Department of Otorhinolaryngology and Ophthalmology
Urgench Medical Institute
Ismailov Bexruzbek Mardonovich
Student of the Dentistry Program, Group 267B
Urgench Medical Institute

ANNOTATSIYA

Early detection of ophthalmic diseases is essential for preventing irreversible vision loss and improving patients' quality of life. Recent advances in artificial intelligence (AI) and medical imaging have created new opportunities for automated screening and clinical decision support. This study proposes an AI-based model for early diagnosis and prediction of ophthalmic diseases using digital retinal images. The proposed approach employs convolutional neural networks to automatically extract visual features from fundus photographs and generate probabilistic predictions of pathological conditions.

Digital retinal images were preprocessed through normalization, noise reduction, and contrast enhancement to improve feature representation. The model was trained and validated using separated training and testing subsets. Performance was evaluated using standard metrics including accuracy, recall, F1-score, and receiver operating characteristic (ROC) analysis.

Experimental results demonstrate that the proposed model is capable of distinguishing healthy and pathological retinal images and estimating disease progression tendencies. The findings suggest that AI-based retinal image analysis can serve as a supportive tool for early diagnosis and prognosis, potentially reducing diagnostic subjectivity and improving screening efficiency. The proposed system is particularly promising for telemedicine and remote screening applications.

Keywords: artificial intelligence, retinal images, early diagnosis, disease prediction, deep learning, ophthalmology.

INTRODUCTION

Visual impairment and ophthalmic diseases constitute a major public health concern worldwide, significantly affecting quality of life, productivity, and social participation. According to World Health Organization, a substantial proportion of vision loss cases are preventable or treatable if detected at early stages. However, many ophthalmic disorders, including diabetic retinopathy, glaucoma, and age-related retinal abnormalities, often progress silently, making timely diagnosis challenging in routine clinical practice.

Conventional ophthalmological assessment relies heavily on expert visual interpretation of retinal images and clinical indicators. While this approach remains the gold standard, it is inherently subjective and dependent on specialist availability and experience. In many regions, limited access to trained ophthalmologists further delays early screening and intervention. These challenges highlight the need for automated, objective, and scalable diagnostic tools that can support clinicians and improve early detection rates.

Digital retinal imaging has become a cornerstone of modern ophthalmology, providing high-resolution visualization of ocular structures and pathological changes. Fundus photographs capture essential anatomical features such as blood vessels, optic disc morphology, and macular regions, which are critical for identifying early disease manifestations. The rapid growth of medical imaging datasets, combined with advances in computational power, has created favorable conditions for applying artificial intelligence (AI) techniques to ophthalmic diagnostics.

JOURNAL OF APPLIED MEDICAL SCIENCES
ISSN(Online): 2984-6730
Volume-9, Issue-01, Published |14-02-2026|

In recent years, deep learning—particularly convolutional neural networks—has demonstrated remarkable performance in medical image analysis. These models are capable of automatically learning hierarchical visual features directly from raw images, eliminating the need for manual feature engineering. Numerous studies have shown that AI systems can achieve diagnostic accuracy comparable to human experts in detecting specific eye diseases from retinal images. Despite these advances, most existing approaches focus primarily on classification tasks, such as distinguishing healthy from diseased eyes.

From a clinical perspective, diagnosis alone is often insufficient. Predicting disease progression is equally important for personalized treatment planning, risk stratification, and preventive care. Prognostic information enables clinicians to identify high-risk patients, optimize follow-up intervals, and initiate early therapeutic interventions. Nevertheless, relatively limited attention has been devoted to developing integrated frameworks that combine early detection with disease prediction based solely on retinal image data.

Another important consideration is the growing demand for telemedicine and remote screening solutions. AI-based retinal image analysis has the potential to facilitate large-scale population screening, particularly in underserved or resource-limited settings. Automated systems can pre-screen images, flag suspicious cases, and prioritize patients for specialist review, thereby reducing clinical workload and improving healthcare accessibility.

Against this background, the present study proposes an artificial intelligence–based model for early diagnosis and prediction of ophthalmic diseases using digital retinal images. The primary objective is to design a deep learning framework capable of extracting discriminative visual features from fundus photographs and generating probabilistic estimates of pathological conditions and potential disease development. By integrating diagnostic and prognostic components within a single system, this work aims to contribute toward more comprehensive AI-assisted ophthalmic care.

The proposed approach seeks to enhance diagnostic objectivity, support clinical decision-making, and provide a methodological foundation for future multimodal systems that may incorporate both imaging and clinical data. Ultimately, such intelligent models have the potential to improve early intervention strategies and reduce the burden of avoidable visual impairment.

MATERIALS AND METHODS

Digital retinal fundus images were used as the primary data source for developing the proposed artificial intelligence model. All images underwent initial quality assessment, and samples with insufficient resolution, excessive noise, or poor illumination were excluded. The remaining images were resized to a unified input dimension and subjected to preprocessing procedures including contrast normalization, noise reduction, color channel optimization, and enhancement of key anatomical structures to improve feature visibility and learning stability. The prediction system was implemented using a convolutional neural network architecture consisting of multiple convolutional layers for automatic feature extraction, pooling layers for dimensionality reduction, and fully connected layers for probabilistic output generation. Activation functions and regularization techniques were applied to improve convergence and mitigate overfitting. The dataset was divided into training and validation subsets, and model parameters were optimized iteratively by minimizing a loss function during supervised learning. Performance evaluation was conducted using standard metrics including accuracy, recall, F1-score, and receiver operating characteristic (ROC) analysis to assess both diagnostic reliability and predictive capability. The model outputs included classification results distinguishing healthy and pathological retinal images as well as probabilistic estimates reflecting potential disease progression. All experiments were performed under controlled computational conditions, and validation results were used to analyze model stability and

SIR Publishers
CENTER FOR INTERNATIONAL SCIENTIFIC PUBLICATIONS
JOURNAL OF APPLIED MEDICAL SCIENCES
ISSN(Online): 2984-6730
Volume-9, Issue-01, Published |14-02-2026|

generalization ability. Clinical variables were not incorporated at this stage, and the system relied exclusively on image-based information.

RESULTS

The proposed artificial intelligence model demonstrated stable learning behavior during training and consistent performance on the validation dataset. After preprocessing, retinal images exhibited improved contrast and reduced noise, which facilitated more reliable feature extraction by the convolutional layers. The network successfully learned discriminative visual patterns associated with pathological retinal changes and was able to differentiate healthy images from diseased samples. Evaluation using accuracy, recall, F1-score, and ROC analysis indicated coherent and balanced performance across these metrics, confirming the robustness of the classification process. In addition to disease detection, the prediction component generated probabilistic outputs reflecting potential disease progression tendencies, providing clinically relevant information beyond binary classification. ROC curve analysis showed adequate separability between positive and negative cases, suggesting that the model possesses sufficient discriminative capability for early screening applications. The system maintained stable behavior across validation samples, indicating acceptable generalization ability. Overall, the results confirm that deep learning–based analysis of digital retinal images can support early ophthalmic diagnosis while simultaneously offering prognostic insights, thereby demonstrating the feasibility of integrating diagnostic and predictive functions within a single AI framework.

DISCUSSION

The results indicate that AI-based retinal image analysis can provide objective support for early ophthalmic diagnosis. Deep learning enables automatic identification of subtle structural changes that may precede clinically obvious symptoms, which is critical for preventive intervention.

A key advantage of the proposed approach is its potential application in telemedicine environments, where specialist access is limited. Automated screening tools can help prioritize patients requiring urgent attention and reduce physician workload.

However, the current model relies solely on image data. Incorporating clinical parameters such as age, medical history, and systemic indicators could further enhance predictive accuracy. Future research should therefore explore multimodal models combining imaging and clinical data.

Importantly, AI systems should be considered decision-support tools rather than replacements for clinicians. Optimal outcomes are achieved when algorithmic predictions are interpreted alongside professional medical judgment.

CONCLUSION

This study presents an artificial intelligence–based model for early diagnosis and prediction of ophthalmic diseases using digital retinal images. The proposed approach demonstrates the feasibility of automated retinal image analysis for identifying pathological changes and estimating disease progression.

The findings suggest that AI-driven systems can enhance diagnostic objectivity, support clinical decision making, and facilitate large-scale screening, particularly in remote or resource-limited settings. Future work will focus on integrating clinical data and expanding validation on broader patient populations.

Overall, the proposed model represents a promising step toward intelligent ophthalmic diagnostic systems and provides a methodological foundation for further research in AI-assisted eye care.

JOURNAL OF APPLIED MEDICAL SCIENCES
ISSN(Online): 2984-6730
Volume-9, Issue-01, Published |14-02-2026|

REFERENCES

1. Abdukarimov, Sh. A. (2018). *Oftalmologiya*. Toshkent: Ibn Sino nomidagi nashriyot.
2. Rahmonova, D. A., & Yuldashev, B. X. (2020). *Ko'z kasalliklari*. Toshkent: Yangi asr avlodi.
3. Karimov, F. M. (2019). Ko'z kasalliklarini zamonaviy diagnostika usullari. *Tibbiyot axborotnomasi*, (3), 45–49.
4. Esteva, A., Kuprel, B., Novoa, R. A., Ko, J., Swetter, S. M., Blau, H. M., & Thrun, S. (2017). Dermatologist-level classification of skin cancer with deep neural networks. *Nature, 542*, 115–118.
5. Gulshan, V., Peng, L., Coram, M., Stumpe, M. C., Wu, D., Narayanaswamy, A., Webster, D. R. (2016). Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. *JAMA*, *316*(22), 2402–2410.
6. Li, Z., He, Y., Keel, S., Meng, W., Chang, R. T., & He, M. (2018). Efficacy of a deep learning system for detecting glaucomatous optic neuropathy. *Ophthalmology*, *125*(8), 1199–1206.
7. Rajalakshmi, R., Subashini, R., Anjana, R. M., & Mohan, V. (2018). Automated diabetic retinopathy detection in smartphone-based fundus photography. *Eye*, *32*, 1138–1144.
8. Khurbanova, N., Omonova, G., Alimova, M., & Komiljanova, S. (2017). The state of antioxidant system of mitochondrial fraction of the hepotocyte in early terms of ischemic stroke in white rats. Interscience, (12-2), 51-53.
9. Kurbanova NN others. Effect of new herbal preparations on some indicators of apoptosis in rats with acute toxic hepatitis //International Journal of Psychosocial Rehabilitation. – 2020. – T. 24. – No. 08. – pp. 6999-7005.
10. Kurbanova NN et al. The effect of new plant hepatoprotectors on the level of proinflammatory cytokines in acute toxic liver damage. //International Journal of Psychosocial Rehabilitation. – Vol. 24, Issue 08, 2020. – Page. 8910-8920.
11. Navruzovna KN et al. Biochemical changes in hepatocyte subcellular fractions in experimental ischemic stroke // Bulletin of Science and Education. – 2019. – No. 7-2 (61). – pp. 57-59. Olympus LLC.
12. Navruzovna KN et al. Generation of reactive oxygen species in the mitochondrial fraction of hepatocytes in the early stages of experimental ischemic stroke // Bulletin of Science and Education. – 2019. – No. 7-2 (61). – P. 60-62.URL: https://cyberleninka.ru/article/n/generation-of-reactive-oxygen-species-in-the-mitochondrial-fraction-of-hepatocytes