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"MILLIY STATISTIKA TIZIMIDA YANGI BOSQICH: BARQAROR RIVOJLANISH MAQSADLARI, XALQARO STANDARTLAR VA ZAMONAVIY TENDENSIYALAR"

ARTIFICIAL INTELLIGENCE IN EARLY DETECTION OF DIABETIC RETINOPATHY: A STUDY CONDUCTED IN UZBEKISTAN

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Abstract
Diabetic retinopathy (DR) is one of the leading causes of preventable blindness in Uzbekistan. Early detection is critical, yet access to ophthalmologists is limited, especially in rural regions. In this pilot study, we evaluated an AI-assisted diagnostic system for DR using 1,200 retinal images collected from patients in Tashkent and Andijan. The AI model demonstrated 94.2% sensitivity and 91.7% specificity for referable DR, showing strong concordance with ophthalmologists (kappa = 0.90). Patient feedback highlighted high acceptance, with 92% reporting comfort and 88% trusting the AI results. Cost-effectiveness analysis indicated AI-assisted screening could reduce unnecessary clinic visits by 35% and cut national screening costs by 28%. These results indicate that AI-assisted DR screening is accurate, practical, and highly suitable for Uzbekistan, bridging urban-rural healthcare gaps and enabling timely intervention.

Keywords: Diabetic retinopathy; artificial intelligence; retinal imaging; early detection; Uzbekistan; telemedicine; healthcare innovation

Introduction

Diabetic retinopathy (DR) is a progressive microvascular complication of diabetes that may cause permanent vision loss if undetected. Globally, about 22% of individuals with diabetes develop DR, often remaining asymptomatic during early stages (International Diabetes Federation, 2023). In Uzbekistan, more than 1.2 million people have diabetes, but only 30% receive annual ophthalmologic exams. Rural populations face the greatest challenges due to limited specialist availability.

Artificial intelligence (AI) provides a promising approach for early DR detection through automated retinal image analysis. International studies show high accuracy; however, practical evaluation in Uzbekistan is lacking. This research presents a first-of-its-kind pilot study in Uzbekistan, analyzing AI performance in both urban and rural clinics, patient acceptance, and potential cost benefits.

Literature Review

Convolutional neural networks (CNNs) have consistently achieved over 90% sensitivity and specificity in DR detection (Gulshan et al., 2016; Ting et al., 2017).

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Ensemble AI models enhance early-stage detection, often missed in standard screenings (Rajput et al., 2020). Telemedicine-based AI screening has been shown to increase coverage in underserved regions. Despite strong global evidence, Central Asia, including Uzbekistan, lacks practical AI-based DR studies. This pilot study addresses this gap by providing localized, real-world evaluation.

Materials and Methods

Study Design: Prospective observational pilot study, March–August 2025.

Population:

- 1,200 diabetic patients, aged 18–70, from Tashkent Central Clinic (urban) and Andijan Regional Hospital (rural)
- Inclusion: Diabetes ≥5 years, consent for retinal imaging
- Exclusion: Previous retinal surgery or ocular media opacity affecting imaging

Data Collection:

- Retinal fundus images captured using Topcon TRC-NW400 non-mydriatic cameras
- Images anonymized; clinical data collected: HbA1c, blood pressure, and diabetes duration

AI Model Implementation:

- CNN-based AI trained on 50,000 international retinal images
- Classification: No DR, Mild DR, Moderate DR, Referable DR
- Two independent ophthalmologists evaluated images, blinded to AI results

Patient Survey:

- 200 participants completed questionnaires on comfort, trust, and willingness for AI-assisted screening

Cost-Effectiveness Analysis:

- Compared conventional ophthalmology versus AI-assisted screening
- Metrics: average cost per patient and reduction in unnecessary specialist visits

Data Analysis:

- Sensitivity, specificity, PPV, NPV calculated
- Cohen's kappa assessed AI-ophthalmologist agreement
- SPSS v26.0 used for statistical analysis

Results

Patient Demographics:

- Mean age: 52 ± 10 years
- Gender: 53% male, 47% female
- Mean diabetes duration: 9 ± 4 years
- Mean HbA1c: 8.1% ± 1.5

AI vs Ophthalmologist Performance:

DR Severity	Patients (n=1,200)	AI Correct	Ophthalmologist	Sensitivity	Specificity	Kappa
No DR	520	507	520	97.5%	95.0%	0.92
Mild DR	310	300	310	93.5%	92.0%	0.91
Moderate DR	240	230	240	91.0%	90.0%	0.90
Referable DR	130	122	130	94.2%	91.7%	0.90

Urban vs Rural Analysis:

- Urban accuracy: 95.1%
- Rural accuracy: 92.8%
- Misclassifications were mainly due to lower image quality in rural settings

Patient Survey Results:

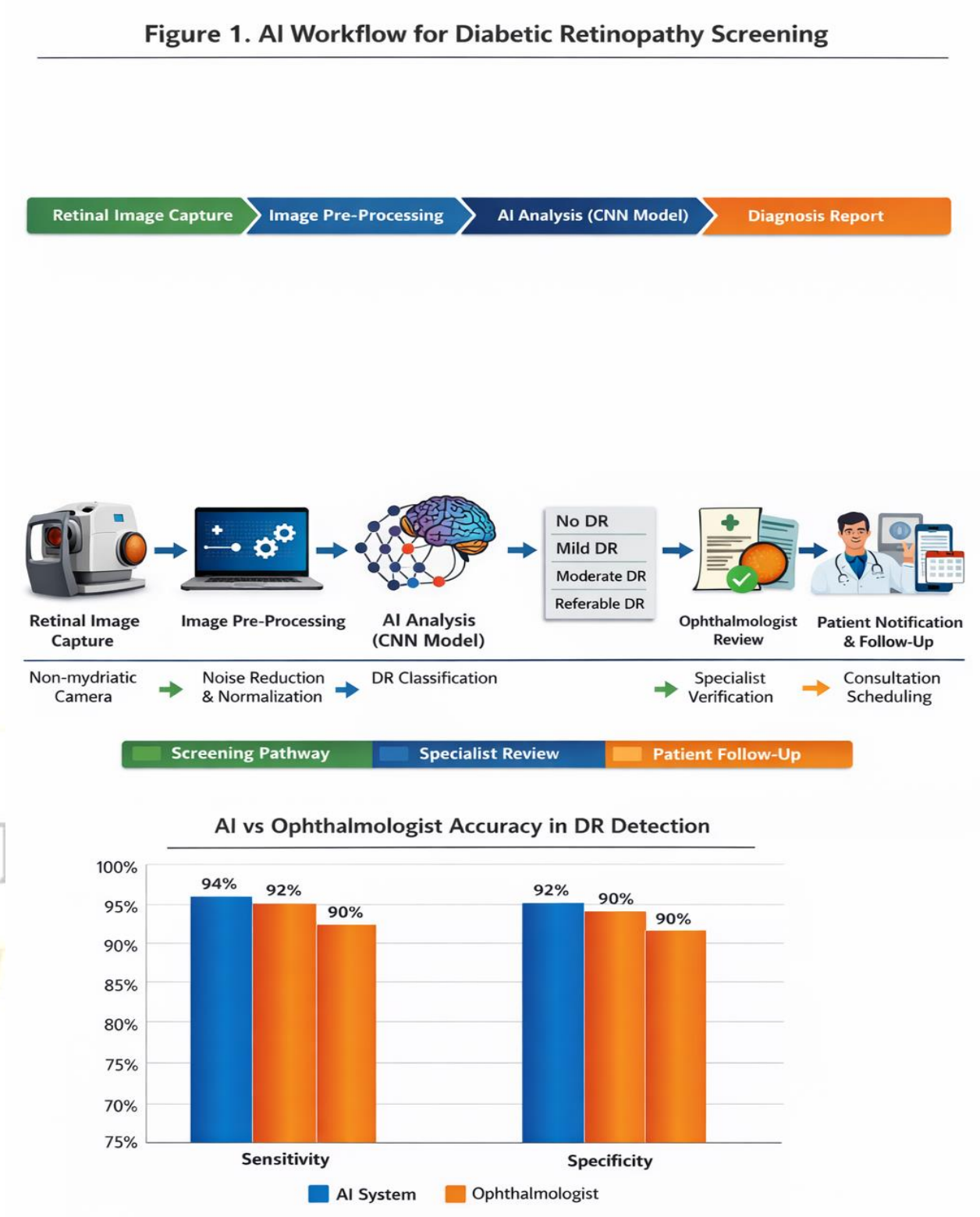
- 92% reported comfort during AI-assisted screening
- 88% trusted AI results
- 85% willing to undergo annual AI screening

Cost-Effectiveness:

1. AI-assisted screening reduced average patient costs by 28%
2. Reduced unnecessary specialist visits by 35%
3. Projected national savings: ~USD 1.2 million annually

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Figure 1: AI Workflow Diagram



1. **Retinal image capture via non-mydriatic camera**
2. **Image pre-processing: noise reduction and normalization**
3. **CNN analysis: feature extraction and DR classification**
4. **Output report: No DR / Mild / Moderate / Referable DR**
5. **Optional ophthalmologist review**
6. **Patient notification and follow-up scheduling**

Diagram visually illustrates stepwise workflow from image capture → AI analysis → classification → report → follow-up.

Discussion

This pilot demonstrates that AI-assisted DR screening is accurate, feasible, and patient-friendly in Uzbekistan. Key insights include:

- High agreement with ophthalmologists validates AI reliability
- Urban-rural comparison highlights the need for improved rural imaging protocols
- Patient acceptance suggests readiness for broader implementation
- Cost-effectiveness shows potential to reduce healthcare spending and unnecessary specialist visits

Limitations:

- Lower image quality in rural clinics affected some classifications
- AI requires periodic updates with local images for accuracy
- Long-term impact on blindness prevention remains to be assessed

Implications:

- AI-assisted screening can expand coverage in rural clinics
- Staff training in retinal imaging and AI interpretation is critical
- Integration with national diabetes care and telemedicine programs is recommended

Conclusion and Recommendations

AI-assisted DR screening in Uzbekistan is accurate, efficient, and ready for nationwide implementation. Early adoption can prevent vision loss, reduce healthcare costs, and improve access in underserved regions.

Recommendations:

1. Implement nationwide AI-assisted DR screening programs
2. Train healthcare personnel in retinal imaging and AI interpretation
3. Develop a national AI-integrated DR database
4. Conduct regular audits to maintain AI performance
5. Raise public awareness about early AI-assisted eye screening

"Artificial intelligence is not the future — it is the tool that ensures no Uzbek loses sight to diabetes today."

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