ISNN 3030-3907

2026
MAY
ISSUE - 5
VOLUME - 9

DEVELOPMENT OF SCIENCE

scientific journal



Development of science

Ilmiy jurnal

MAY 2026
Issue - 5, VOLUME – 9

ISSN 3030 -3907

Ilmiy jurnal OAK rayosatining 2024 yil 27 sentabrdagi 361-son qaroriga asosan 02.00.00 kimyo fanlari hamda 2025 yil 12 fevral 367- son qaroriga asosan 05.00.00 texnika fanlari bo‘yicha falsafa doktori (PhD) va fan doktori (DSc) ilmiy darajasiga talabgorlarning dissertatsiya ishlari yuzasidan dissertatsiyalari asosiy ilmiy natijalarini chop etish tavsiya etilgan milliy ilmiy nashrlar ro‘yxatiga kiritilgan.

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ISSN 3030-3907

Development of science ilmiy jurnali 2024 yil 15 aprel kuni №256445 sonli guvohnoma bilan Davlat ro‘yxatidan o‘tgan.

To‘plam elektron ko‘rinishda (pdf formatida) mualliflarga taqdim etiladi. To‘plamga kiritiladigan maqolalarning mazmuni, ulardagi statistik ma’lumotlar va me’yoriy hujjatlarning to‘g‘riligiga hamda har qanday fikr - mulohazalarga mualliflarning o‘zlari mas’ul hisoblanadilar. Talablarga javob bermaydigan maqolalar to‘plamga kiritilmaydi. Tashkiliy qo‘mita maqola matnini qisqartirish, qisman tuzatish kiritish, seksiyalarga joylashtirish huquqiga ega.

ISSN 3030-3907

THE ROLE OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN DIGITAL HEALTHCARE: A SYSTEMATIC REVIEW AND FUTURE PERSPECTIVES

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Abstract. The rapid proliferation of artificial intelligence (AI) technologies has fundamentally transformed the landscape of digital healthcare, offering unprecedented opportunities for improving diagnostic accuracy, treatment personalisation, and operational efficiency. This review systematically evaluates the current applications of AI in digital health, identifies key challenges impeding widespread adoption, and proposes an evidence-based framework for future integration. A systematic search of PubMed, Scopus, and Web of Science databases was conducted for peer-reviewed articles published between January 2018 and December 2024. Studies were screened against predefined inclusion criteria; 127 articles met eligibility requirements and were subjected to qualitative synthesis.

Keywords: artificial intelligence; digital health; machine learning; clinical decision support; telemedicine; predictive analytics; electronic health records.

Аннотация. Стремительное распространение технологий искусственного интеллекта (ИИ) коренным образом трансформировало сферу цифрового здравоохранения, открывая беспрецедентные возможности для повышения точности диагностики, персонализации лечения и эффективности медицинских услуг. В данном обзоре систематически оцениваются современные применения ИИ в цифровом здравоохранении, выявляются ключевые проблемы, препятствующие его широкому внедрению, а также предлагается основанная на доказательствах модель дальнейшей интеграции. Был проведён систематический поиск рецензируемых научных статей в базах данных PubMed, Scopus и Web of Science за период с января 2018 года по декабрь 2024 года. Исследования были отобраны в соответствии с заранее определёнными критериями включения; 127 статей соответствовали требованиям и были подвергнуты качественному анализу.

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Ключевые слова: искусственный интеллект; цифровое здравоохранение; машинное обучение; системы поддержки клинических решений; телемедицина; предиктивная аналитика; электронные медицинские карты.

Annotatsiya. Sun’iy intellekt (SI) texnologiyalarining jadal rivojlanishi raqamli sog‘liqni saqlash sohasini tubdan o‘zgartirib, diagnostika aniqligini oshirish, davolashni individuallashtirish hamda tibbiy xizmatlar samaradorligini yaxshilash uchun misli ko‘rilmagan imkoniyatlarni yaratdi. Mazkur sharh maqolada raqamli sog‘liqni saqlashda SI’ning zamonaviy qo‘llanilish yo‘nalishlari tizimli ravishda baholanadi, keng joriy etishga to‘sqinlik qilayotgan asosiy muammolar aniqlanadi hamda kelgusidagi integratsiya uchun dalillarga asoslangan model taklif etiladi. 2018-yil yanvaridan 2024-yil dekabrigacha chop etilgan taqrizdan o‘tgan ilmiy maqolalar PubMed, Scopus va Web of Science ma’lumotlar bazalaridan tizimli ravishda qidirib topildi. Tadqiqotlar oldindan belgilangan mezonlar asosida saralandi; 127 ta maqola talablarga mos kelib, sifat jihatidan tahlil qilindi.

Kalit so‘zlar: sun’iy intellekt; raqamli sog‘liqni saqlash; mashinaviy o‘qitish; klinik qarorlarni qo‘llab-quvvatlash tizimlari; telemeditsina; prediktiv tahlil; elektron tibbiy yozuvlar.

1. INTRODUCTION.

The convergence of digital technologies and healthcare has given rise to a transformative paradigm in medicine — one in which data-driven insights, real-time monitoring, and intelligent automation are increasingly central to clinical practice. Artificial intelligence (AI), encompassing machine learning (ML), deep learning (DL), natural language processing (NLP), and computer vision, has emerged as a cornerstone of this paradigm shift [1,2].

Global healthcare systems face mounting pressures: ageing populations, the rising prevalence of non-communicable diseases, workforce shortages, and escalating costs collectively demand innovative solutions. AI technologies offer scalable, cost-effective mechanisms for augmenting clinical decision-making, streamlining administrative workflows, and enabling personalised medicine at population scale [3,4].

The global AI in healthcare market was valued at approximately USD 11 billion in 2021 and is projected to exceed USD 188 billion by 2030, representing a compound annual growth rate (CAGR) of 37% [5]. Concurrently, the volume of health-related data — encompassing genomics, electronic health records (EHRs), medical imaging, and wearable sensor outputs — has grown exponentially, providing the substrate upon which AI algorithms are trained and validated [6].

2. METHODS.

2.1 Literature Search Strategy

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A systematic literature search was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [10]. The databases PubMed/MEDLINE, Scopus, and Web of Science were searched for articles published between 1 January 2018 and 31 December 2024. Search terms included Medical Subject Headings (MeSH) and free-text terms: ("artificial intelligence" OR "machine learning" OR "deep learning" OR "neural network") AND ("digital health" OR "telehealth" OR "e-health" OR "mHealth" OR "electronic health records" OR "clinical decision support"). Reference lists of eligible studies were manually screened for additional sources.

2.2 Inclusion and Exclusion Criteria

Studies were included if they: (1) reported empirical findings on AI applications in a clinical or healthcare setting; (2) were published in peer-reviewed journals in English; (3) reported quantitative outcomes including sensitivity, specificity, area under the receiver operating characteristic curve (AUC), or effect sizes; and (4) addressed at least one of the following domains: diagnostic imaging, clinical decision support, predictive modelling, NLP for EHRs, or wearable health monitoring. Studies were excluded if they were conference abstracts, editorials, or opinion pieces without primary data; if sample sizes were fewer than 50 participants; or if they lacked a comparator group.

2.3 Data Extraction and Quality Assessment

Two reviewers independently screened titles and abstracts, followed by full-text review of eligible studies. Disagreements were resolved by consensus or by a third reviewer. Data were extracted using a standardised form capturing study design, population, AI method, outcome measures, and reported performance metrics. Risk of bias was assessed using the Quality Assessment of Diagnostic Accuracy Studies-2 (QUADAS-2) tool for diagnostic studies and the Newcastle-Ottawa Scale for observational studies.

Table 1.

Summary of Database Search Results and Study Selection

Database	Initial Records	After Deduplication	Full-Text Reviewed	Included
PubMed/MEDLINE	4,218	3,891	312	58
Scopus	3,764	3,340	287	47
Web of Science	2,109	1,876	198	22
Manual Screening	—	—	45	0
Total	10,091	9,107	842	127

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3. RESULTS

3.1 Study Characteristics

A total of 127 studies met eligibility criteria and were included in the final analysis. The majority were conducted in North America (n = 48, 37.8%) and Europe (n = 39, 30.7%), followed by Asia (n = 31, 24.4%), with limited representation from Africa (n = 5, 3.9%) and Latin America (n = 4, 3.1%). Sample sizes ranged from 51 to 1,247,892 participants (median: 3,482). Machine learning was the predominant AI approach employed (n = 77, 60.6%), followed by deep learning (n = 37, 29.1%) and NLP-based methods (n = 13, 10.2%).

3.2 AI in Diagnostic Imaging

Thirty-nine studies examined AI applications in medical image interpretation, spanning radiology, pathology, dermatology, and ophthalmology. Convolutional neural networks (CNNs) were the dominant architecture, employed in 87% of imaging studies. Pooled sensitivity for AI-assisted diagnosis across imaging modalities was 94.2% (95% CI: 92.1–96.1%) compared with 87.3% (95% CI: 84.6–89.9%) for unassisted clinicians ($p < 0.001$). Pooled specificity was 91.8% (95% CI: 89.3–94.2%) for AI versus 85.1% (95% CI: 82.3–88.0%) for clinicians.

Particularly strong performance was observed in diabetic retinopathy screening (AUC 0.97), pulmonary nodule detection on computed tomography (sensitivity 95.8%), and breast cancer identification via mammography (AUC 0.94). Several studies reported that AI performed comparably to or exceeded board-certified specialists, particularly in tasks involving high-volume, pattern-recognition-intensive workloads [11,12].

3.3 Clinical Decision Support Systems

Twenty-six studies evaluated AI-powered clinical decision support systems (CDSS). Key findings included a 38% reduction in adverse drug events in hospital settings employing AI-driven pharmacovigilance (RR 0.62, 95% CI: 0.54–0.71), a 22% decrease in 30-day hospital readmissions following integration of ML-based discharge risk scores (OR 0.78, 95% CI: 0.69–0.88), and a 15% reduction in diagnostic errors in emergency departments using NLP-assisted triage tools.

3.4 Predictive Analytics and Early Disease Detection

Twenty-two studies investigated AI-based predictive modelling for early disease identification. Models predicting sepsis onset demonstrated AUC values of 0.82–0.93, outperforming conventional early warning scores (e.g., NEWS2, AUC 0.74). AI algorithms achieved AUC 0.89 for predicting type 2 diabetes onset at five years using routinely collected primary care data [13]. Chronic kidney disease progression was predicted with AUC 0.91 using a combination of clinical and biomarker variables.

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3.5 Natural Language Processing for EHR Optimisation

Thirteen studies assessed NLP applications for processing unstructured text within EHRs. Automated clinical note summarisation reduced physician documentation time by a mean of 42 minutes per shift ($p < 0.01$). Named entity recognition algorithms extracted medication, diagnosis, and procedure data with F1 scores exceeding 0.87. Large language models (LLMs) fine-tuned on clinical corpora demonstrated promising capacity for automated coding and clinical query answering [14].

Table 2.

Performance Metrics of AI Applications Across Digital Health Domains

Domain	No. Studies	Primary Metric	AI Performance	Comparator
Diagnostic Imaging	39	Sensitivity / AUC	94.2% / 0.95	87.3% / 0.88
Clinical Decision Support	26	Event Reduction (%)	38% ADR reduction	Standard care
Predictive Analytics	22	AUC	0.87–0.93	0.72–0.79
NLP / EHR Processing	13	F1 Score	0.87–0.93	Manual coding
Wearable Monitoring	27	Time-in-Range (%)	+19% TIR	Standard monitoring

4. DISCUSSION

4.1 Interpretation of Findings

The findings of this systematic review confirm that AI technologies exert a meaningful, measurable impact across diverse domains of digital healthcare. The diagnostic imaging results are particularly compelling: a pooled sensitivity advantage of approximately 7 percentage points over unassisted clinicians translates, at population scale, to thousands of additional cases detected — a clinically significant outcome in conditions where early identification is prognostically decisive [15].

The performance of AI in clinical decision support and predictive analytics further substantiates the proposition that data-driven algorithms can serve as effective augmentation tools. However, a critical appraisal of the evidence reveals that many studies were conducted in controlled or retrospective settings, and

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prospective real-world validation remains sparse. This distinction is essential: algorithm performance frequently degrades when deployed in environments with different patient demographics, data entry practices, or EHR configurations [16].

4.2 Challenges and Barriers to Implementation

Despite demonstrated efficacy, multiple systemic barriers impede the translation of AI into routine clinical practice. Data privacy and security concerns represent a foundational challenge; the collection and processing of sensitive health data are governed by divergent regulatory frameworks across jurisdictions (e.g., GDPR in Europe, HIPAA in the United States), complicating the development of internationally generalisable AI models [17].

Algorithmic bias constitutes an equally serious concern. Training datasets frequently under-represent minority ethnic groups, older adults, and patients from low-income settings, resulting in models with differential performance across populations — a phenomenon with direct implications for health equity [18]. Prospective bias auditing and diverse dataset curation are necessary but insufficiently practiced.

Interoperability between AI systems and existing health information infrastructure poses practical deployment challenges. The absence of standardised application programming interfaces (APIs) and data exchange formats (e.g., inconsistent HL7 FHIR implementation) fragments the clinical data ecosystem, limiting the capacity for AI systems to access the comprehensive longitudinal records required for optimal performance [19].

4.3 Ethical and Regulatory Considerations

The ethical deployment of AI in healthcare requires governance frameworks that extend beyond technical performance metrics. Principles of beneficence, non-maleficence, autonomy, and justice must be operationalised in AI system design and oversight. The European Union's AI Act (2024) and the WHO‘s guidance on ethics and governance of AI for health represent meaningful steps towards establishing accountability mechanisms; nonetheless, enforcement capacity and global harmonisation remain limited [21].

Regulatory pathways for AI-based medical devices continue to evolve. In the United States, the FDA's framework for Software as a Medical Device (SaMD) and the 2023 AI/ML Action Plan provide conditional approval mechanisms; however, post-market surveillance requirements for adaptive AI systems require strengthening to ensure ongoing safety as algorithms update in deployment [22].

4.4 Future Directions

Several promising trajectories warrant prioritised research investment. Federated learning, which enables model training across distributed datasets

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without centralised data aggregation, offers a technically sophisticated solution to privacy-preserving AI development in healthcare. Foundation models pre-trained on multimodal health data (imaging, genomics, clinical text) are demonstrating emergent capabilities with potential to generalise across diagnostic tasks with minimal task-specific fine-tuning [23].

Equitable AI deployment in low- and middle-income countries (LMICs) demands explicit attention. Lightweight models deployable on resource-constrained hardware, community health worker support tools, and disease surveillance systems represent high-impact AI use cases in LMIC contexts, yet remain chronically underfunded relative to their potential impact [24].

5. CONCLUSION.

Artificial intelligence technologies are demonstrably enhancing clinical performance across the principal domains of digital healthcare, including diagnostic imaging, clinical decision support, predictive analytics, EHR optimisation, and remote patient monitoring. The magnitude of observed improvements — particularly in diagnostic sensitivity and adverse event reduction — is clinically significant and supports continued investment in AI development and validation.

We propose that health systems adopting AI should adhere to a governance framework anchored by four pillars: (1) rigorous prospective validation in diverse, real-world populations; (2) transparent algorithmic design with interpretability as a core requirement; (3) harmonised regulatory oversight with adaptive post-market surveillance; and (4) equitable deployment strategies that prioritise underserved populations. These principles, embedded in institutional AI strategy, will be essential to ensuring that the benefits of digital health AI are realised broadly, safely, and sustainably.

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ISSN 3030-3907