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PERSPECTIVES

Artificial Intelligence-Assisted Clinical Decision-Making: A Perspective on Advancing Personalized Precision Medicine for Elderly Diabetes Patients

Jian Hu[1,2,*], Lijun Ren[1,2,*], Tingwen Wang[1,2], Peng Yao[1,2]

[1]First Teaching Hospital of Tianjin University of Traditional Chinese Medicine, Tianjin, People's Republic of China; [2]National Clinical Research Center for Chinese Medicine Acupuncture and Moxibustion, Tianjin, People's Republic of China

*These authors contributed equally to this work

Correspondence: Peng Yao, First Teaching Hospital of Tianjin University of Traditional Chinese Medicine/National Clinical Research Center for Chinese Medicine Acupuncture and Moxibustion, Tianjin, 150006, People's Republic of China, Email 75232745@qq.com

Abstract: The global aging population is expanding at an unprecedented rate and is projected to reach 2 billion by 2050, presenting significant medical challenges, particularly multimorbidity and heterogeneous responses to treatment. Using diabetes as an illustrative case, this study explores the transformative potential of artificial intelligence (AI)-assisted clinical decision-making to advance personalized precision medicine for older adults. Through systematic analysis of current healthcare practices and emerging AI technologies, we examined the integration of machine learning algorithms, natural language processing, and intelligent monitoring systems into diabetes care for elderly populations. Based on current evidence showing up to 25% reduction in hospitalization rates and 30% increase in treatment adherence, we argue that AI integration represents a transformative approach to improving clinical outcomes in elderly diabetes care. We contend that AI-driven clinical decision support systems (CDSS) offer superior performance in risk prediction and treatment optimization, with studies demonstrating diagnostic accuracy rates of up to 93.07%, supporting our argument for their widespread implementation. Furthermore, AI-enhanced monitoring systems improved medication adherence by 17.9% compared to conventional monitoring approaches. Nonetheless, several challenges persist, including issues related to data standardization, algorithm transparency, and patient privacy protection. These results underscore the necessity of adopting a balanced implementation strategy that addresses both technical limitations and ethical considerations, while upholding patient autonomy. This perspective emphasizes the critical importance of multidisciplinary collaboration among healthcare professionals, technology developers, and regulatory authorities in establishing a comprehensive framework for AI deployment in clinical settings. By demonstrating the capacity of AI-assisted clinical decision-making to enhance healthcare quality and efficiency for elderly patients with diabetes, this study makes a meaningful contribution to the evolving field of personalized medicine.
Keywords: machine learning, decision support systems, clinical, aged, diabetes mellitus, type 2, telemedicine, medical informatics

Introduction

The unprecedented growth of the global aging population represents one of the foremost challenges confronting healthcare in the 21st century.[1] By 2050, the number of individuals aged 60 years and older is projected to reach 2 billion, accounting for nearly 25% of the global population, while those aged 80 and above are expected to rise from 1% to 4%.[2] Consequently, the escalating prevalence of chronic diseases among older adults has emerged as a critical public health priority. Recent data indicate that the global prevalence of diabetes reached 533 million cases in 2022 and is anticipated to increase substantially to 783 million cases by 2045, with healthcare expenditures projected to exceed USD 105.4 billion.[3] Older adults with diabetes present significant heterogeneity in physiological conditions, pharmacological regimens, and care needs, posing complex clinical challenges. In response, personalized medicine has emerged as a transformative paradigm, shifting from conventional

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standardized treatments toward tailored interventions that integrate individual biological characteristics, environmental exposures, and lifestyle factors.[4] This transition is particularly vital for older adults with diabetes, as traditional "one-size-fits-all" approaches often fail to address the intricate interplay between diabetes, multiple chronic comorbidities, and geriatric syndromes.

AI holds substantial promises for revolutionizing healthcare through applications such as medical imaging analysis, Natural language processing (NLP), and CDSS. AI technologies are adept at processing large volumes of multimodal health data, generating real-time insights and personalized recommendations essential for managing elderly patients with diabetes complicated by multimorbidity and individual variability.[5,6] Recent advances in machine learning algorithms have facilitated the development of sophisticated risk prediction models and automated monitoring systems, markedly enhancing the efficiency and accuracy of clinical decision-making.[7] However, much of the current research focuses on single-disease models or younger populations, leaving the unique complexities of diabetes management in older adults insufficiently addressed. Despite the growing interest in AI in healthcare, few studies specifically address its comprehensive application in elderly diabetes management, particularly regarding the integration of personalized medicine approaches for this vulnerable population with complex multimorbidity patterns. Current systematic reviews demonstrate that elderly patients (≥65 years) represent less than 20% of participants in AI-diabetes clinical trials, despite comprising over 40% of the global diabetes population, highlighting a significant representation gap that limits the generalizability of existing AI solutions to geriatric populations. Despite the growing interest in AI in healthcare, few studies specifically address its comprehensive application in elderly diabetes management, particularly regarding the integration of personalized medicine approaches for this vulnerable population with complex multimorbidity patterns. Older adults with diabetes represent a highly diverse group, distinguished from younger populations by unique pathophysiological features, lifestyle patterns, and treatment adherence challenges. These differences introduce significant obstacles to AI implementation, including issues related to data quality, representational bias, and ethical considerations concerning privacy and patient autonomy.[8]

This perspective article examines the intersection of AI-assisted clinical decision-making and personalized medicine in the context of diabetes care for older adults, from both clinical and research perspectives. Drawing upon current evidence, we argue for AI's transformative capacity to integrate complex datasets and its critical role in supporting individualized clinical pathways. This perspective specifically aims to: (1) advocate for advanced AI-assisted clinical decision-making systems in elderly diabetes care based on current technological capabilities; (2) propose a strategic framework for AI integration in advancing personalized precision medicine for older adults with diabetes; (3) address key implementation barriers and ethical considerations including data privacy, digital accessibility, and healthcare equity; and (4) provide evidence-based recommendations for future research directions and clinical implementation strategies. Through interdisciplinary dialogue and forward-looking analysis, this paper seeks to advance the practical implementation of AI-driven personalized medicine in this rapidly evolving field.

Methods

This perspective article presents evidence-based arguments and strategic recommendations for advancing AI-assisted clinical decision-making in elderly diabetes care. Our work is guided by the research question: How can artificial intelligence be strategically integrated into clinical decision-making and personalized precision medicine for elderly patients with diabetes, and what are the key implementation considerations, challenges, and future directions?

Evidence Selection Framework

We drew upon high-quality publications from major databases (PubMed, Scopus, IEEE Xplore, Google Scholar, 2018–2024) focusing on AI applications in diabetes care, elderly healthcare, and clinical decision-making systems. Our selection prioritized peer-reviewed studies that provide robust evidence for the arguments and strategic recommendations we advance in this perspective.

Analytical Approach

Our analysis is structured around four key domains: (1) current capabilities and potential of AI-assisted clinical decision-making systems; (2) strategic opportunities for AI integration in personalized precision medicine; (3) implementation challenges and ethical considerations; and (4) evidence-based recommendations for future directions. Rather than providing exhaustive literature coverage, we strategically selected evidence that best supports our perspective on how the field should evolve and the recommendations we propose.

Discussion

Recent advances in AI for diabetes care support our findings regarding the transformative potential of AI-assisted clinical decision-making. Sheng et al [9] demonstrated through systematic analysis of 44 studies that AI applications show promise in elderly populations due to their complex comorbidity profiles, corroborating our findings on improved diagnostic accuracy and personalized treatment optimization. The importance of explainable AI (XAI) has gained significant attention, with Kim et al[10] showing that XAI-based clinical decision support systems can improve clinician confidence and patient trust by up to 73%, directly addressing the "black box" challenge we identified. Similarly, Shiwani et al[11] examined AI applications in geriatric healthcare, highlighting the need for age-specific algorithms and human oversight in elderly patient care, which aligns with our observations regarding unique considerations for older adults.

Urgency of Integrating Artificial Intelligence Into

The following sections systematically examine the current evidence for AI applications in elderly diabetes care, beginning with the urgent clinical need for AI integration, followed by analysis of AI-powered clinical decision support capabilities, and concluding with an assessment of implementation challenges and future research priorities.

Diabetes Care for Older Adults

The rapid expansion of the global aging population, alongside the rising prevalence of diabetes among older adults, underscores the urgent need to integrate AI into diabetes care for this vulnerable population. Compared to their non-diabetic counterparts, older adults with diabetes experience higher rates of premature mortality, functional impairment, accelerated sarcopenia, and increased incidence of comorbid conditions, including hypertension, coronary heart disease, and stroke.[12] Moreover, this population faces heightened risks of geriatric syndromes, further complicating clinical management. The pronounced heterogeneity among older diabetic patients-reflected in diverse physiological responses, varied therapeutic tolerance, and individualized care requirements-presents substantial challenges to traditional, standardized clinical approaches, which often fail to adequately address these complexities.[13] Additionally, the rapid growth of medical knowledge in the precision medicine era has generated a significant informational burden, complicating the optimization of therapeutic decisions for older adults with diabetes. Conventional clinical strategies have increasingly proven insufficient for managing the highly individualized care demands of this population, highlighting the need for innovative, data-driven solutions.

Compounding these challenges is the worsening shortage of diabetes specialists, which further intensifies the urgency for AI integration. Current projections indicate that as the demand for diabetes specialists exceeds supply by more than 30%, severe shortages will limit healthcare access, especially in rural and underserved regions, thereby increasing the workload on existing healthcare providers.[14] Artificial intelligence offers promising solutions to these systemic issues by enhancing clinical decision-making. AI-driven CDSS have already demonstrated significant clinical benefits, including optimized treatment strategies and reductions in medication errors by up to 50%, as demonstrated by Corny et al in their machine learning-based clinical decision support system for identifying high-risk prescriptions.[15] Furthermore, AI's predictive analytics facilitate early identification of high-risk patients, supporting preventive interventions and proactive disease management, ultimately improving therapeutic outcomes.[16] Thus, integrating AI into elderly diabetes care represents not merely an innovative advancement but an essential response to the mounting healthcare demands of an aging global population. Addressing this imperative through strategic, interdisciplinary collaboration will better equip healthcare systems to manage the unique complexities of geriatric diabetes care in the era of personalized medicine.

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The Power of Artificial Intelligence-Assisted Clinical Decision Support Systems

Artificial intelligence-based clinical decision support systems (AI-CDSS) provide exceptional capabilities in integrating diverse and complex data streams—such as electronic health records (EHRs), genomic data, lifestyle factors, and environmental information—to create comprehensive health profiles for older adults with diabetes.[17] This integrated approach enables precise risk assessment and the formulation of individualized therapeutic recommendations. Multiple studies have confirmed that AI-CDSS represent a transformative advancement in managing diabetes care for elderly patients, including Li et al's diabetes prediction model based on GA-XGBoost and stacking ensemble algorithms[18] and other AI-driven clinical decision support systems showing measurable improvements in patient outcomes.[16] By leveraging deep learning frameworks to analyze historical patient data, advanced identification algorithms to detect high-risk individuals, and by aligning recommendations with current clinical guidelines,[19] AI-CDSS are increasingly accurate in predicting diabetes complications and in delivering evidence-based, personalized treatment plans.[20,21] For example, Rabie et al demonstrated that their deep learning-based decision support system achieved a diabetes diagnostic accuracy rate of 93.07%, significantly enhancing diagnostic precision and improving patient care quality.[22] These systems offer a robust foundation to address the unique clinical challenges of elderly diabetes care, ensuring that clinical decisions are both data-driven and personalized to meet individual patient needs.

Furthermore, AI substantially advances personalized treatment planning, particularly in the context of genomics-informed therapy selection and individualized risk stratification. Advanced machine learning algorithms are highly effective in analyzing complex genomic data alongside clinical parameters, enabling the evaluation of genetic variations and patient-specific risk factors, thereby minimizing adverse treatment outcomes.[23] In this context, polygenic risk scores have emerged as valuable tools to identify individuals at elevated risk for diabetes, facilitating early intervention and personalized management strategies, which ultimately contribute to reducing diabetes incidence and associated complications.[24]

AI demonstrates significant efficacy in medication management, including automated medication reminders and adherence monitoring. Clinical studies, including Ouanes and Farhah's evaluation of AI effectiveness in clinical decision support systems, reveal that patients managed with AI-supported platforms achieve medication adherence rates 17.9% higher than those managed with traditional methods.[25] By enabling proactive and personalized care, AI integration directly addresses the critical healthcare needs associated with a rapidly aging population, enhancing both patient outcomes and system-wide healthcare efficiency.

Real-time monitoring and alert systems represent a critical application of artificial AI in enhancing diabetes care for older adults. These systems utilize advanced sensors and wearable devices to continuously track vital signs, while machine learning algorithms detect subtle physiological changes that may indicate impending health issues.[26] For example, Shi et al's study evaluating a non-invasive, wrist-worn wearable device for detecting elevated blood glucose levels using machine learning and photoplethysmography sensors reported an average accuracy of 84.7%, sensitivity of 81.05%, and specificity of 88.3%.[27]

Moreover, advanced predictive models can forecast adverse events—such as hypoglycemic episodes, cardiovascular complications, and diabetic foot problems—hours or even days before clinical symptoms emerge, enabling timely interventions. One study demonstrated that an automated predictive model for diabetic retinopathy significantly enhanced the accuracy of long-term outcome predictions by precisely quantifying clinical parameters, thereby improving complication monitoring and management.[28] Notably, approximately 98% of vision loss associated with diabetic retinopathy and diabetic macular edema is preventable through early detection, accurate prediction, and optimized therapeutic interventions, and the cost-effectiveness of such predictive models has been well established.[29] Furthermore, AI-driven monitoring systems incorporate communication platforms that facilitate emergency response coordination, strengthen connections with family caregivers, and enable timely responses to critical health events in elderly diabetic populations.[30]

NLP also offers significant potential to optimize clinical workflows, enable early complication prediction, and support functional status assessments. NLP-driven intelligent medical interview systems automatically extract comprehensive medical histories and utilize advanced language understanding algorithms to analyze patient-reported symptoms, substantially improving clinical communication and patient care.[31] These systems also enhance the efficiency of clinical documentation, improve the accuracy of medical coding, and streamline overall healthcare processes. In elderly diabetes management, integrating NLP algorithms with machine learning substantially improves early complication identification.[32] Additionally, NLP-based analyses of unstructured EHRs enable more accurate prediction and detection of complications, while also providing non-invasive and holistic evaluations of elderly diabetic patients' cognitive, physical, and psychological conditions.[33] These insights assist healthcare professionals in designing individualized treatment strategies. Moreover, advanced visualization tools, such as Gradient-weighted Class Activation Mapping (Grad-CAM), facilitate interpretation of AI-driven predictions by clarifying which data features are emphasized, thereby supporting clinician decision-making.[34]

AI-driven smart home healthcare systems represent a cutting-edge innovation in elderly diabetes management, capable of automatically adjusting environmental parameters such as temperature, humidity, and lighting based on individual preferences and diabetes care needs.[35] These systems not only enhance patient comfort but also promote more effective and personalized disease management.[36] Additionally, mobile applications integrated with comprehensive nutritional databases enable elderly diabetic patients to access detailed dietary information, facilitating informed food choices and effective dietary self-management at home.[37]

The integration of AI into elderly diabetes has also demonstrated significant economic benefits. For instance, a tongue-feature-fusion-based non-invasive diabetes risk prediction model enables early identification of prediabetes and diabetes risk factors, thereby avoiding unnecessary hospitalizations and promoting optimal healthcare resource allocation.[38] Analyses of healthcare utilization show that AI-assisted systems significantly reduce hospitalization rates among elderly patients. Moreover, the expansion of home-based monitoring and early intervention programs allows more elderly diabetic patients to maintain independent living, reducing reliance on long-term care facilities. Healthcare institutions that have implemented AI technologies report significant improvements in operational efficiency and patient outcomes. Studies on AI-driven predictive analytics demonstrate substantial cost reductions and improved healthcare delivery, with research indicating potential for decreased readmission rates through enhanced patient monitoring and predictive capabilities.[39,40] These technological innovations also address long-standing barriers in disease management for both healthcare providers and patients by optimizing resource distribution and streamlining service delivery models, thereby enhancing patient autonomy and mitigating healthcare resource shortages.

Khan et al's research on real-time predictive health monitoring using AI-driven wearable sensors indicates that AI-facilitated early diagnosis can lower hospitalization rates by 25% and improve treatment adherence by 30%.[41] Additionally, quality-of-life indicators show favorable improvements, with patients demonstrating greater independence in daily activities and reporting higher overall satisfaction with care.[42] Furthermore, a study evaluating the AI-based Health Education Accurately Linked System for type 2 diabetes self-management revealed significant improvements in both self-management capabilities and glycemic control among participants. These outcomes were achieved through systematic monitoring of physiological parameters and lifestyle behaviors, medication and glucose monitoring reminders, and automated delivery of personalized educational messages.[43] This level of systematic optimization not only averts medical resource shortages but also supports a sustainable healthcare system, which is crucial for addressing the increasingly complex care needs of elderly diabetic populations.

Potential Challenges

Technical Challenges and Implementation Barriers

The integration of AI into diabetes care for older adults faces several critical technical challenges, with data quality and standardization being among the most prominent.[44] Healthcare datasets often lack consistency and uniformity, arising from varying data standards and incomplete patient records, which complicate the development of robust AI models. Moreover, ensuring the accuracy and reliability of AI systems specifically designed for older adults with diabetes remains a significant challenge due to factors such as multimorbidity and polypharmacy, which complicate both therapeutic management and clinical decision-making. Additionally, variations in disease presentation and treatment responses across different ethnic and demographic groups highlight the need for AI models capable of accommodating population diversity. Therefore, enhancing the adaptability, inclusiveness, and robustness of AI algorithms is essential to achieve precise, equitable, and personalized care for elderly diabetic populations.

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Infrastructure and resource limitations present another major barrier to AI adoption, particularly in rural and underserved regions.[45] The implementation of AI-driven healthcare systems requires substantial upfront investments in hardware, software, and network infrastructure, alongside ongoing costs related to maintenance, system updates, and technical support. These demands are especially challenging for resource-limited settings, where existing healthcare infrastructure is often inadequate and shortages of trained personnel hinder the effective deployment of advanced technologies. Addressing these infrastructure and resource gaps is essential to ensure equitable access to AI-driven solutions and to improve health outcomes for elderly diabetic patients across diverse healthcare settings.

Psychological and Ethical Considerations

The psychological and ethical dimensions of AI-assisted clinical decision-making require careful consideration, particularly when caring for elderly patients. Family members, who frequently serve as primary caregivers and decision-makers, play a crucial role in the successful implementation of AI-based healthcare systems. Their understanding, acceptance, and trust in AI technologies directly influence both patient engagement and clinical outcomes. Notably, older adults' acceptance of AI varies significantly, and the opacity of AI decision-making processes-commonly referred to as the "black box" problem-may undermine trust, especially when AI-generated recommendations conflict with established clinical practices.[46]

To foster trust, AI recommendations must be validated by demonstrable clinical outcomes. Moreover, transparent communication regarding AI system functions, limitations, and decision-making principles is vital. Such transparency is critical for building confidence among patients and caregivers, ensuring that AI technologies are ethically and effectively integrated into elderly care.

Privacy Protection and Data Security

Privacy protection and data security represent critical ethical concerns in the implementation of AI-assisted healthcare, especially given AI's dependence on the extensive collection and analysis of sensitive personal health data. These concerns are heightened in elderly populations, who may have limited familiarity with digital privacy and security principles.[47] To address these challenges, healthcare providers must adopt robust data protection strategies that do not compromise AI system performance. This includes implementing transparent informed consent processes that clearly outline AI's role in patient care and uphold patient autonomy.

The potential harm associated with privacy breaches underscores the need for stringent security protocols to protect patient data. Furthermore, legal and regulatory frameworks governing AI-assisted clinical decision-making introduce additional complexity, particularly in determining accountability for adverse outcomes arising from the interplay between human clinical judgment and AI-generated recommendations. The rapid pace of AI innovation often outpaces regulatory development, leading to uncertainty regarding compliance requirements and legal liability for healthcare providers and institutions.[48]

To mitigate these risks, healthcare organizations must implement comprehensive risk management frameworks, including ethical oversight and legal safeguards. Such strategies are crucial to balancing the clinical and operational benefits of AI-assisted decision-making with the protection of patient rights and safety, thereby supporting the responsible use of AI in elderly diabetes care.

Future Directions

Seamless Integration and Workforce Development

The successful implementation of AI-assisted clinical decision-making systems requires seamless integration with existing EHRs and clinical workflows. Maximizing benefits while minimizing disruptions demands careful operational and technological alignment with current medical practices. Central to this process is effective workforce development, which entails comprehensive, role-specific training programs that address both technical competencies and organizational cultural barriers. Such programs should focus on continuous professional development, ensuring that healthcare providers across all levels of care delivery are equipped to engage with AI systems efficiently and confidently.

Algorithm Enhancement and Predictive Accuracy

Enhancing AI algorithms remains a critical priority for improving the predictive accuracy, reliability, and clinical applicability of AI solutions in elderly diabetes care. Developing specialized algorithms that account for the complexities of comorbidities and polypharmacy prevalent among older diabetic populations is essential. Moreover, improving algorithm interpretability and transparency is vital to facilitate clinical trust and acceptance. Tools such as Grad-CAM offer practical solutions, enabling healthcare professionals to visualize and understand which data features AI models emphasize during decision-making—an approach already validated in ophthalmologic disease classification.[31] Additionally, establishing comprehensive decision-tracking systems is crucial to document AI-assisted decisions, ensuring accountability and traceability. Robust evaluation frameworks are also necessary to systematically assess AI's short- and long-term impacts on patient outcomes, clinician satisfaction, and healthcare system efficiency.

Change Management and Cost-Benefit Analysis

Effective change management strategies are essential to overcome potential resistance among healthcare professionals and promote acceptance of AI-driven technologies. Regulatory frameworks must align closely with existing clinical and ethical standards, introducing AI-specific guidelines for validation, performance monitoring, and quality improvement. Establishing such comprehensive and transparent regulatory pathways will help ensure that AI technologies are safely and effectively implemented, upholding patient safety, clinical effectiveness, and equity in healthcare delivery.

Furthermore, developing AI models tailored specifically to elderly diabetes populations-supported by specialized databases that reflect the unique clinical complexities of this group-is imperative. These models must account for regional variations in genetics, treatment practices, economic factors, and healthcare resource availability, ensuring context-specific applicability. Simultaneously, thorough cost-effectiveness analyses are critical to evaluate both the initial and ongoing investments required for AI deployment, as well as potential cost savings derived from improved clinical efficiencies and reduced adverse outcomes. Such analyses are essential for strategic planning and for demonstrating AI's long-term value in elderly diabetes care.

Study Limitations

This perspective article has several important limitations that should be acknowledged. First, our analytical approach focuses on strategic evidence selection rather than exhaustive literature coverage, which may limit the breadth of evidence considered in our arguments. Second, the heterogeneity in study designs, AI technologies, and population characteristics across the evidence we examined makes direct comparisons challenging and limits the generalizability of our recommendations. Third, the rapid pace of AI technological development means some evidence may become outdated quickly, and most available studies report only short-term outcomes, limiting our ability to assess long-term implementation impacts. Particularly "black box" nature of many AI algorithms presents ongoing implementation challenges, particularly in elderly care where patient-provider trust relationships are crucial for successful technology adoption.

Conclusion

The integration of AI into clinical decision-making represents a transformative advancement in the field of personalized precision medicine for elderly diabetic patients. This innovation comes at a critical time, as healthcare systems face mounting challenges posed by severe diabetes-related complications and significant patient heterogeneity among older adults. Traditional care models are increasingly inadequate to address the complex, multifactorial healthcare needs of elderly diabetic populations, particularly those with multiple comorbidities and variable responses to treatment.

Although research demonstrates that AI shows substantial promise in areas such as data integration, individualized treatment planning, real-time monitoring and alerts, natural language processing, and smart home healthcare, fully realizing these benefits requires overcoming important barriers. Technical challenges, including data standardization issues and insufficient representation of elderly populations in AI training datasets, underscore the need for advancements in algorithm development and comprehensive data acquisition strategies. Equally, psychological and ethical concerns-ranging from patient and family acceptance to privacy and accountability issues-demand a balanced and transparent implementation approach that upholds ethical integrity and patient trust.

Future progress will depend on coordinated collaboration among healthcare providers, AI developers, and regulatory bodies to establish robust frameworks for AI integration. Despite current challenges, evidence indicates that AI-assisted clinical decision-making holds significant opportunities, particularly through the integration of wearable technologies and the development of elderly-specific diabetes databases, which are essential for advancing truly personalized care. Critical elements for successful AI implementation include comprehensive healthcare staff education, seamless integration with EHRs, and ongoing research dedicated to refining AI algorithms tailored to the unique and complex healthcare profiles of elderly diabetic patients. These advancements have the potential to markedly improve clinical outcomes, including reduced hospitalization rates, enhanced patient autonomy, and better quality of life, ultimately contributing to greater longevity and well-being among elderly diabetic populations. Thus, we believe that AI represents a transformative force with the potential to fundamentally reshape elderly diabetes care and elevate healthcare delivery to meet the demands of an aging global population.

Disclosure

The authors report no conflicts of interest in this work.

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