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The role of artificial intelligence in enhancing healthcare for people with disabilities

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ABSTRACT

The integration of artificial intelligence (AI) in healthcare delivery represents a transformative opportunity to enhance the lives of people living with disabilities. AI-driven technologies, such as assistive devices, conversational agents, and rehabilitation tools, can mitigate health disparities, improve diagnostic accuracy, and facilitate effective communication with healthcare providers, fostering more equitable healthcare environments. This commentary explores these applications while addressing the ethical challenges and limitations associated with AI deployment. Specific challenges, such as algorithmic bias, privacy risks with patient data, and the complexity of designing inclusive technologies, are discussed to provide a balanced perspective. For example, biased diagnostic tools may lead to inequitable care, and privacy breaches can compromise sensitive data. Key areas of focus include personalised care through AI-powered systems, the design of inclusive AI technologies incorporating continuous feedback loops and partnerships with advocacy groups, and the development of AI-enabled robotics for physical assistance. This commentary paper emphasises the importance of addressing these limitations alongside advancing ethical AI practices and ensuring continuous user involvement to meet the diverse needs of people living with disabilities, ultimately promoting greater independence and participation in society. Consequently, while AI holds transformative potential in advancing equitable and inclusive healthcare for people with disabilities, addressing ethical challenges, overcoming limitations, and fostering user-centred design are essential to fully realise its benefits and ensure these innovations promote autonomy, accessibility, and well-being.

1. Introduction

Artificial intelligence (AI) refers to the simulation of human intelligence by machines that are programmed to learn, reason, and make decisions (Morandín-Ahuerma, 2022). In healthcare, AI encompasses technologies designed to analyse complex medical data, support clinical decision-making, and automate tasks to improve healthcare delivery and outcomes (Olawade et al., 2024). The advent of AI in healthcare has ushered in a new era of possibilities, particularly in enhancing the quality of life for people living with disabilities. AI's ability to analyse large datasets, recognise patterns, and provide personalised recommendations holds immense potential for mitigating health disparities and improving access to medical services (Krishnan et al., 2023). People living with disabilities, who often face significant barriers in healthcare, can greatly benefit from AI-driven innovations that offer tailored support, enhance diagnostic accuracy, and facilitate effective communication with healthcare providers. Given that about 16% of the global population, or roughly 1.3 billion people, live with substantial disabilities (Adebisi, 2024). This significant portion of the population necessitates dedicated attention in healthcare planning and policy to ensure their unique needs are adequately addressed (Adebisi, 2024). This transformation is not only about technological advancement but

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also about fostering a more equitable and inclusive healthcare environment where the needs of people living with disabilities are met more comprehensively and compassionately.

AI's integration into healthcare can revolutionise various aspects of medical care for people living with disabilities. From AI-powered assistive technologies that enhance mobility and communication to advanced diagnostic tools that provide early and accurate detection of health issues, AI can significantly improve the quality of life for people living with disabilities. For instance, AI-driven speech recognition systems can assist individuals with speech impairments, while machine learning algorithms can predict health outcomes and manage chronic conditions more effectively. Moreover, AI-enabled robotics and virtual reality technologies are paving the way for innovative rehabilitation and physical therapy methods, offering personalised and engaging treatment options. These advancements not only improve the efficacy of healthcare interventions but also promote greater independence and participation in daily activities for people living with disabilities. This commentary aims to explore the various applications of AI in healthcare delivery for people living with disabilities, examining both the advancements and the challenges encountered. Table 1 provides a comprehensive overview of various AI technologies discussed in this commentary, highlighting their applications in healthcare for individuals with disabilities.

Table 1
Overview of AI technologies and their applications in addressing disabilities.

Technology	Area of Disability Addressed	Examples/Details of Applications
AI-powered assistive technologies	Physical disabilities (e.g., mobility, communication)	Smart wheelchairs with obstacle detection, speech recognition systems for individuals with speech impairments.
AI-driven conversational agents	Cognitive disabilities (e.g., dementia, Parkinson's disease)	Personalised AI chatbots providing cognitive assistance, user-friendly interfaces for effective communication.
AI-enabled robotics	Physical disabilities	Robotic assistants performing tasks like fetching objects, assisting in personal care routines, and adapting to user needs.
Virtual reality (VR) technologies	Physical rehabilitation for mobility impairments	Simulated environments for practicing physical therapy exercises, interactive rehabilitation sessions tailored to abilities.
Wearable devices	Physical and chronic conditions	Fitness trackers and smart clothing monitoring health metrics, providing real-time feedback for tailored rehabilitation.
Telecommunication tools	Physical and cognitive disabilities	Remote monitoring and guidance by healthcare professionals, tele-rehabilitation programs reducing barriers to healthcare.
Mind-controlled exoskeletons	Severe physical disabilities	Brain-computer interface-controlled exoskeletons enabling mobility and task performance for individuals with paralysis.
Smart home assistants	Physical and cognitive disabilities	Voice-activated devices managing home systems (e.g., lights, appliances), setting reminders for medications or appointments.
AI-enhanced wheelchair mobility	Physical disabilities	Autonomous wheelchairs with adaptive speed control, path planning, virtual training environments for safe wheelchair usage.
Brain-computer interfaces (BCIs)	Severe physical disabilities	Devices translating neural signals into commands for controlling computers, assistive devices, and smart home systems.
AI-driven rehabilitation technologies	Physical and neurological disabilities	Personalised exercise programs, wearable technology integrated with rehabilitation plans, virtual coaching for physical therapy.
AI-powered diagnostic tools	All areas of disability	Machine learning algorithms improving diagnostic accuracy for comorbid conditions common among people living with disabilities.
AI-enabled communication aids	Speech and hearing impairments	Devices converting speech to text or generating speech from text for individuals with hearing or speech disabilities.
AI-powered mobility solutions	Physical disabilities	Smart navigation systems for individuals with mobility challenges, such as route optimization and obstacle avoidance.

2. Artificial intelligence-based conversational systems for cognitive disabilities

AI-driven dialogue agents have shown significant promise in supporting individuals with cognitive disabilities such as dementia and Parkinson's disease (Huq et al., 2024). These systems can facilitate communication and provide cognitive assistance, thereby enhancing the quality of life for elderly and cognitively impaired individuals. Developing conversational agents with specific characteristics tailored to the needs of users with cognitive disability is important (Pancholi et al., 2024). This involves creating user-friendly interfaces, personalised responses, and robust error-handling capabilities to ensure effective communication and support. One of the key advancements in this area is the personalisation of conversational AI systems. By using machine learning algorithms, these systems can learn from user interactions and tailor their responses to fit individual preferences and needs. This level of personalisation is essential for users with cognitive disabilities, who may require specific types of interactions and support to engage effectively with AI systems.

Moreover, user-friendly interfaces are critical for ensuring that these technologies are accessible to all users, including those with limited technical skills (Willingham et al., 2024). Designing intuitive and straightforward interfaces can help minimise the learning curve and make these systems more useable for people with cognitive impairments. Robust error-handling capabilities are also vital, as they ensure that the AI can handle misunderstandings or miscommunications effectively, maintaining a smooth and supportive interaction for the user.

3. Inclusive design of conversational artificial intelligence

The design and implementation of inclusive chatbots in healthcare settings are essential for achieving health equity. A comprehensive roadmap to ensure that conversational AI systems are developed inclusively involves collaborative efforts from diverse stakeholders, including patients, AI designers, and healthcare professionals (Nadarzynski et al., 2024). This inclusive approach is vital for ensuring that AI tools cater to the diverse needs of people living with disabilities, promoting equitable access to healthcare services and minimising biases that could otherwise limit their effectiveness and reach.

Inclusive design requires considering the various barriers that people with disabilities might face when interacting with AI systems (Smith and

Smith, 2021). This includes not only physical and sensory barriers but also cognitive and emotional barriers. Technically, conversational agents leverage advanced natural language processing (NLP) models to interpret user inputs and generate responses, but these models need continuous optimisation to meet the needs of diverse users (Bansal et al., 2024). For example, enhancing NLP systems with sentiment analysis and intent recognition ensures the chatbot can adapt its responses to the emotional or situational context of the user. Additionally, incorporating multi-turn dialogue capabilities allows the system to engage in more complex conversations, which is particularly useful for individuals requiring detailed explanations or step-by-step guidance.

By involving people living with disabilities in the design process, developers can gain valuable insights into these barriers and develop solutions that address them effectively. For instance, incorporating multiple modes of interaction (such as voice, text, and visual aids) can help accommodate users with different disabilities. Voice-activated interfaces for visually impaired individuals and simplified text-based interfaces for those with cognitive impairments are examples of such multi-modal solutions (Jaddoh et al., 2024). Moreover, embedding real-time language translation into chatbots enhances accessibility for non-native speakers and individuals from multilingual communities. These functionalities must be rigorously tested in real-world settings to ensure practical effectiveness.

Ensuring that chatbots can understand and respond to a range of communication styles and preferences is also important for creating a more inclusive user experience. Additionally, ongoing user feedback and testing are key for identifying and addressing any issues that may arise during real-world use. Continuous evaluation through metrics such as user satisfaction scores, task completion rates, and the chatbot's ability to handle diverse queries ensures iterative improvements. Partnerships with disability advocacy groups can provide ongoing feedback to ensure that the chatbots remain aligned with the evolving needs of users.

4. Assistive technologies and the convention on the Rights of Persons with disabilities

Assistive technologies (AT) powered by AI are integral to realising the rights outlined in the Convention on the Rights of Persons with Disabilities (CRPD). AI-enhanced AT can support people living with disabilities in achieving greater autonomy and participation in society. Ensuring widespread access to these technologies is essential for fulfilling the commitments made by states under the CRPD, thereby promoting inclusivity and accessibility in healthcare (Smith and Smith, 2024). By providing tools that enhance mobility, communication, and daily living activities, AI-enabled AT helps bridge the gap between ability and accessibility.

AI-enhanced AT can take many forms, from advanced mobility aids like smart wheelchairs to communication devices that help individuals with speech impairments. These technologies can significantly improve the quality of life for people living with disabilities by enabling them to perform tasks that they might otherwise find challenging or impossible. For example, smart wheelchairs equipped with AI can help users navigate their environments more easily by detecting obstacles and planning optimal routes (Pancholi et al., 2024). Communication devices that use natural language processing can assist individuals with speech impairments in expressing themselves more effectively. These tools not only enhance the independence of people living with disabilities but also promote their inclusion in various aspects of society, from education and employment to social activities.

5. AI-enabled robotics for physical assistance

AI-enabled robotics have emerged as valuable tools in assisting individuals with physical disabilities. These robots are generally welcomed for tasks that enhance independence and autonomy, but there are concerns about their design and functionality (Sørensen et al., 2024). Customising robotic assistance to meet individual needs is pertinent for maximising their utility and acceptance among users. This includes adapting the robots' capabilities to perform specific tasks required by the users, ensuring they are intuitive to use, and addressing any psychological barriers to their adoption.

Robotic assistants can perform a wide range of tasks, from simple actions like fetching items to more complex tasks like assisting with personal care routines. For instance, robotic arms can be programmed to assist users in daily tasks, such as holding utensils, drinking from a cup, or dressing. Exoskeletons equipped with advanced sensors can aid individuals with mobility impairments by providing powered support for walking and standing, allowing for improved physical rehabilitation and reduced caregiver dependency (Rodríguez-Fernández et al., 2021). These functionalities are made possible through machine learning algorithms that enable real-time motion tracking and predictive control, allowing the robots to adapt dynamically to user intentions and environmental changes.

However, the design and functionality of these robots must be carefully considered to ensure they are effective and user-friendly. Safety mechanisms, such as obstacle detection sensors and fail-safe algorithms, are pertinent to prevent accidents during operation. Furthermore, ensuring the robots are compatible with different environments—such as narrow spaces in homes or crowded public areas—enhances their practicality. Ergonomic designs and intuitive user interfaces, such as touch screens or wearable controls, further improve usability for individuals with varying physical capabilities.

Additionally, addressing psychological barriers, such as concerns about privacy and the potential for reduced human interaction, is important for promoting the acceptance and widespread use of robotic assistants. User trust can be fostered by involving end-users in co-designing robot functionalities and incorporating personalisation options, such as customisable voice assistants or adaptive learning features that align with individual preferences. Collaborative initiatives with disability advocacy organisations and healthcare providers can ensure these systems align with the nuanced needs of people living with disabilities. Measuring user acceptance through trust indices and usability testing provides actionable insights for improving robotic designs and functionalities.

6. Cutting-edge technologies in rehabilitation and exercise

Emerging technologies such as virtual reality, wearables, and telecommunication tools are expanding the possibilities for rehabilitation and exercise among people living with disabilities. Combining these technologies with AI can overcome barriers to participation in physical activities, addressing health inequities (Willingham et al., 2024). The integration of AI facilitates personalised rehabilitation programs, enhancing their effectiveness and accessibility. For example, virtual reality can simulate environments for physical therapy, wearables can monitor progress in real time, and telecommunication tools can connect patients with healthcare providers for remote guidance and support.

The VR technology can provide immersive and interactive environments that make rehabilitation exercises more engaging and enjoyable. By simulating real-world scenarios, VR can help users practice and improve their physical abilities in a safe and controlled setting (Yang et al., 2022). AI algorithms can track users' progress and adjust the difficulty of exercises to match their current abilities, ensuring that rehabilitation programs remain challenging and effective. Wearable devices, such as fitness trackers and smart clothing, can continuously monitor users' physical activities and provide real-time feedback. This data can be used to personalise rehabilitation programs, ensuring that exercises are tailored to individual needs and abilities (Sumner et al., 2023). Additionally, telecommunication tools can facilitate remote monitoring and support, allowing healthcare providers to track progress and provide guidance without the need for in-person visits.

7. Artificial intelligence solutions for daily living assistance

AI-driven solutions are revolutionising the support provided to individuals with disabilities in their daily activities. Innovations such as mind-controlled exoskeletons and smart home assistants foster autonomous living. These technologies not only enhance accessibility but also promote inclusivity by enabling people living with disabilities to lead more independent lives (Almufareh et al., 2024). Mind-controlled exoskeletons allow users to move and perform tasks with greater ease, while smart home assistants can control various home devices through voice commands or other interfaces, making everyday tasks more manageable. Mind-controlled exoskeletons represent a significant advancement in assistive technology, allowing individuals with mobility impairments to regain control over their movements. These devices use brain-computer interfaces to translate neural signals into commands that control the exoskeleton, enabling users to perform tasks that would otherwise be difficult or impossible. Smart home assistants, such as voice-activated devices, can help people living with disabilities manage their daily routines more effectively. These devices can control lights, appliances, and other home systems, making it easier for users to perform everyday tasks. Additionally, smart home assistants can provide reminders and notifications, helping users stay organised and manage their health and wellness.

8. Artificial intelligence in wheelchair mobility

The development of AI-enhanced wheelchair mobility solutions illustrates the potential of robotics in improving the safety and independence of users. Partnerships aimed at creating driving assistance modules for power wheelchairs help users navigate obstacles and learn to drive in virtual environments. These innovations highlight the collaborative efforts required to address the complex needs of people living with disabilities through AI technologies. Such systems can include features like obstacle detection and avoidance, path planning, and adaptive speed control to ensure safe and efficient mobility. This is particularly useful for people living with physical disabilities.

AI-enhanced wheelchairs can significantly improve the mobility and independence of users by providing advanced navigation and control features (Kumar et al., 2024). For example, obstacle detection systems can help users avoid collisions, while path planning algorithms can identify the most efficient routes to their destinations. Additionally, adaptive speed control can adjust the wheelchair's speed based on the user's preferences and environmental conditions, ensuring a safe and comfortable ride. Virtual environments can also be used to train users to operate their wheelchairs, helping them build confidence and improve their driving skills. By simulating real-world scenarios, these virtual environments can provide a safe and controlled setting for users to practice and learn.

9. Artificial intelligence techniques in assistive technologies

AI techniques have been integrated into assistive technologies, such as brain-computer interfaces and intelligent wheelchairs. These innovations facilitate greater independence and productivity for individuals with physical disabilities (Pancholi et al., 2024). However, challenges remain in further refining these technologies for widespread use. Brain-computer interfaces, for example, can allow users to control devices using their thoughts, while intelligent wheelchairs can navigate autonomously. Continuous research and development are needed to improve the accuracy, reliability, and affordability of these technologies to ensure they can benefit a broader population.

The BCIs represent a cutting-edge technology that allows users to control devices using their neural signals. This can be particularly beneficial for individuals with severe physical disabilities, providing them with a new way to interact with their environment. However, further research is needed to improve the accuracy and reliability of BCIs, as well as to reduce their cost and complexity, making them more accessible to a wider range of users. Intelligent wheelchairs equipped with AI can navigate autonomously, helping users move around more safely and efficiently. These wheelchairs can use sensors and machine learning algorithms to detect obstacles, plan routes, and adjust their speed and direction as needed. However, ongoing development is needed to refine these systems and ensure they can handle a wide range of environments and user needs.

10. Psychological and social implications of robotic assistants

While robotic assistants offer significant technical capabilities, such as adaptive functions and task customisation, their psychological and social implications must be carefully considered to ensure widespread acceptance and usability among people living with disabilities. Emotional resistance to robotic support is a common challenge, as some users may feel uneasy or stigmatised by relying on robots for daily activities (Street et al., 2022). This discomfort can stem from concerns about reduced human interaction, the perception of being "watched," or a loss of personal privacy. For example, robotic assistants with integrated monitoring features may raise concerns about how and where data is stored, potentially deterring users who value autonomy and confidentiality.

Addressing these concerns requires a user-centred approach in both the design and deployment of robotic assistants. Engaging users early in the development process through participatory design can help identify potential psychological barriers and develop solutions tailored to their preferences. For instance, incorporating features such as personalisation options—like customisable interfaces or interaction styles—can foster a sense of control and familiarity, reducing resistance. Moreover, privacy-enhancing measures, such as localised data processing and user-defined access settings, can alleviate concerns about data security and surveillance.

User-centred studies evaluating the effectiveness and acceptance of robotic assistants are essential for understanding their real-world viability. For example, research involving people living with disabilities using robotic arms for tasks like cooking or dressing could measure both task success rates and user satisfaction, providing insights into practical improvements. Similarly, studies assessing how robotic companions impact users' mental well-being and social inclusion can guide the development of robots that not only assist but also integrate seamlessly into users' lives. By addressing these psychological and social factors, robotic assistants can be better designed to meet the holistic needs of people living with disabilities, ensuring both their functional utility and emotional acceptability.

11. Challenges and future directions

Despite the promising potential of AI in enhancing healthcare for people living with disabilities, several challenges must be addressed to realise its full benefits. One critical ethical challenge is ensuring fairness in how AI systems address disability, as the declaration of a disability is often complex and may vary across cultural, legal, and personal contexts. This ambiguity could result in inconsistent treatment and exacerbate disparities rather than mitigate them. Data privacy and security are also significant concerns, as people living with disabilities often provide sensitive personal information that, if mishandled, could lead to breaches of confidentiality or misuse. For example, AI-powered diagnostic tools could inadvertently expose patient data during model training or cloud-based analyses, creating risks of data breaches. Furthermore, there is a risk of algorithmic bias, where AI systems trained on non-representative data sets may unintentionally reinforce existing disparities. For instance, biased diagnostic tools could fail to accurately assess health conditions in underrepresented populations, leading to misdiagnoses or inadequate care.

Another challenge is the integration of AI technologies into existing healthcare infrastructure, which can be complex and resource-intensive. Healthcare providers may require significant training to effectively utilise AI tools, and there may be resistance to adopting new technologies. Moreover, the high cost of developing and implementing AI systems can be a barrier, particularly in low-resource settings. Ensuring inclusivity is another critical challenge, as AI solutions must address the diverse needs of people living with disabilities to be effective. Inclusivity extends beyond user involvement to include continuous feedback loops, partnerships with disability advocacy groups, and proactive consideration of accessibility barriers across a wide spectrum of disabilities. For example, AI interfaces that rely solely on text may exclude individuals with visual impairments or low literacy, underscoring the need for multimodal design approaches.

Furthermore, scaling these innovations for widespread use in low- and middle-income countries (LMICs) presents several challenges. Many AI solutions rely on advanced infrastructure, such as high-speed internet, cloud computing, and reliable power supply, which are often limited in LMICs (Gore and Olawade, 2024). Additionally, the high costs of development, implementation, and maintenance of AI systems can make them inaccessible to under-resourced healthcare systems. Furthermore, data scarcity and the lack of diverse, representative datasets from LMIC populations hinder the development of AI tools that address the specific needs of people living with disabilities in these regions. For example, speech recognition systems may fail to understand local languages or dialects, and diagnostic algorithms trained on data from high-income countries may not perform well in LMIC contexts.

To overcome these challenges and harness the full potential of AI in healthcare for people living with disabilities, several future directions can be pursued. First, advancing ethical AI practices is pertinent, with a focus on developing transparent algorithms that minimise bias and protect user data. Specific strategies include anonymising patient data during model training, auditing algorithms for potential biases, and implementing robust encryption protocols to safeguard information. Collaborative efforts between technologists, ethicists, and communities of people living with disabilities can help create AI solutions that are both effective and fair. On the other hand, overcoming these challenges requires investments in local infrastructure, partnerships with governments and non-profits to subsidise costs, and the development of region-specific AI tools. Moreover, involving local communities and disability advocacy groups in the design and deployment process can help ensure that these technologies are both culturally appropriate and impactful. These efforts are critical to moving beyond speculative benefits and enabling AI to truly improve healthcare outcomes for people living with disabilities individuals in LMICs.

Second, promoting inclusive design principles is essential to ensure AI systems are accessible to all users, regardless of their specific disabilities. Actionable strategies include incorporating continuous feedback loops from diverse user groups throughout the development lifecycle, forming partnerships with disability advocacy organisations to validate accessibility features, and conducting regular usability testing under real-world conditions. Third, increasing investment in AI research and development is necessary to drive innovation and lower the costs of AI technologies, making them more accessible to healthcare providers and patients.

Additionally, enhancing training programs for healthcare professionals can facilitate the integration of AI into clinical practice, improving its adoption and effectiveness. Establishing regulatory frameworks to oversee the ethical deployment of AI in healthcare can also help address concerns about privacy and bias. For instance, regulations could mandate algorithmic transparency and provide guidelines for inclusive data collection, ensuring AI tools are equitable and reliable. Lastly, fostering global collaboration and knowledge sharing can accelerate the development and dissemination of AI innovations tailored to the needs of people living with disabilities.

12. Conclusion

AI holds significant promise for enhancing healthcare delivery among people with disabilities. By addressing the unique needs of people living with disabilities through inclusive design, advanced robotics, and personalised rehabilitation technologies, AI can contribute to more equitable healthcare systems. Future research and development efforts should focus on overcoming existing challenges, ensuring widespread access, and continuously improving AI technologies to empower people living with disabilities and promote their health, autonomy, and well-being. Advancing AI technologies for people living with disabilities requires an approach that prioritises user-centred design, ethical considerations, policy development, capacity building, community engagement, and global collaboration. By embracing these recommendations and fostering innovation, we can unlock the full potential of AI to enhance healthcare delivery, promote inclusivity, and improve the quality of life for people living with disabilities around the world.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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No data was used for the research described in the article.

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