

A New Frontier in Public Health: Leveraging Artificial Intelligence for Behavioural Change in Health Education Programmes

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Abstract

The integration of Artificial Intelligence (AI) into health education presents a transformative approach to addressing the global rise in chronic health conditions by offering personalized, scalable, and data-driven interventions. Traditional health education methods, while valuable, often struggle to achieve sustained behavioural change due to their generalized, one-size-fits-all nature. AI, through technologies such as machine learning, natural language processing, and predictive analytics, provides tailored interventions that adapt in real-time to individual needs, promoting healthier behaviours and preventing disease. This paper reviews the role of AI in health education, exploring its applications in personalized interventions, real-time feedback, predictive analytics, and motivation, while addressing the challenges of data privacy, equity, and user engagement. Special attention is given to the potential of AI in low-resource settings, where it can overcome infrastructural barriers and improve access to healthcare. The paper also discusses the effectiveness of AI-powered interventions, highlighting case studies and research demonstrating improved outcomes in physical activity, diet, and mental health. The paper concludes by emphasizing the need for ongoing research to evaluate the long-term impact of AI-driven interventions and ensure their ethical, equitable, and effective implementation in global health promotion efforts.

Keywords: artificial intelligence, behavioural change, health education, public health, digital health.

Introduction

The global rise in chronic health conditions has underscored the need for innovative approaches to health promotion and disease prevention. Traditional health education programmes, while crucial, often face limitations in achieving sustained behavioural

change. The incorporation of Artificial Intelligence (AI) into health education presents an exciting opportunity to address these gaps. AI refers to the simulation of human intelligence processes by machines, such as learning from data, decision-making, perception, and language processing (Russell & Norvig, 2021). In the realm of behavioural change, AI leverages machine learning, natural language processing, and predictive analytics to provide tailored, real-time interventions aimed at influencing individuals to adopt healthier behaviours or modify detrimental ones. This technological advancement holds the promise of transforming public health by offering personalized, data-driven solutions that are scalable and adaptive to the needs of diverse populations (Jordan & Mitchell, 2015).

AI for behavioural change works by processing large datasets, identifying patterns, and generating insights that inform tailored interventions. For example, AI-powered mobile apps, virtual health coaches, and chatbots can offer real-time feedback, reminders, and motivational support, helping individuals track their progress and stay engaged with their health goals (Meyer et al., 2021). These systems analyse an individual's health data - such as activity levels, dietary habits, and medical history - to provide customized recommendations that encourage healthier lifestyle choices (Jalal et al., 2022). AI tools can predict health risks, identify behaviours linked to negative health outcomes, and deliver proactive interventions that enhance engagement and improve long-term health outcomes. In this way, AI offers a more personalized and efficient approach to health education, overcoming the limitations of traditional, one-size-fits-all models (Timmermans et al., 2020).

Public health education, especially in low-resource settings like Nigeria, faces significant challenges such as insufficient healthcare infrastructure, low health literacy, and cultural barriers to behavioural change (Adebayo et al., 2020; Oni et al., 2021). In such contexts, traditional face-to-face interventions are often difficult to scale, particularly in rural or under-served areas. The digital divide further exacerbates these issues, limiting access to technological solutions. AI can help bridge these gaps by offering scalable, accessible, and personalized health education interventions, thus improving access to healthcare in remote regions and among marginalized populations (Jalal et al., 2022). AI systems, such as virtual health assistants and chatbots, can engage individuals in their native languages, providing culturally relevant, easy-to-understand health information that fosters better decision-making and behavioural change (Meyer et al., 2021). Moreover, AI's ability to provide continuous, real-time support helps maintain user engagement and adherence to health programmes, making it particularly effective in promoting long-term behavioural changes (Shah, Patel, & Malhotra, 2021).

Despite the numerous advantages, the integration of AI into health education programmes is not without challenges. Issues surrounding data privacy, the need for robust evidence of efficacy, and digital divide remain barriers to widespread adoption (Nguyen, Yoon, & Young, 2021). However, ongoing research and development in AI technologies are addressing these concerns, ensuring that AI applications in health education are both effective and equitable. AI's ability to design personalized health education programmes based on data-driven insights can significantly improve the precision and inclusivity of behavioural change interventions, ultimately contributing to healthier populations and sustainable public health outcomes (Kaplan & Hovav, 2021). Thus, AI represents a new frontier in public health, offering innovative solutions that can revolutionize behavioural change efforts across diverse global contexts.

The role of artificial intelligence in behavioural change

AI refers to the use of algorithms and machine learning to perform tasks that traditionally require human intelligence, such as analysing patterns, learning from data, and making predictions (Miller et al., 2023). Within health education, AI is applied to personalize interventions, provide real-time feedback, and predict health risks, thus enabling a more tailored approach to behavioural change.

Artificial Intelligence (AI) is increasingly playing a central role in health education by offering innovative ways to influence and promote behavioural change. With the capacity to analyse vast amounts of data, deliver personalized interventions, and scale effectively, AI technologies are revolutionizing health education programmes designed to improve behaviours related to physical activity, diet, and mental health (Meyer et al., 2021). As the global health landscape faces rising challenges like chronic diseases, AI-powered solutions are emerging as powerful tools in preventing illness and promoting well-being through tailored behavioural change strategies (Jalal et al., 2022).

Types of AI in health education

Several types of AI technologies are employed to facilitate behavioural change in health education. Machine learning algorithms, for example, process large datasets to identify patterns in individual behaviour and predict health outcomes. Natural language processing (NLP) is used in AI-powered chatbots or virtual assistants to communicate with users, providing motivational support and guidance (Shah, Patel, & Weiner, 2021). Additionally, AI-powered mobile applications are increasingly popular for managing health-related behaviours such as diet, exercise, and mental health through real-time data tracking and feedback (Graham et al., 2022).

Mechanisms of AI in promoting behavioural change

AI influences behavioural change by offering personalized health recommendations that adjust based on individual data, such as physical activity, nutrition, and medical history (Timmermans et al., 2020). Real-time feedback through AI allows individuals to track their progress and receive immediate reinforcement, which is a key element in fostering sustained behavioural change (Hollis et al., 2022). Furthermore, AI can predict health risks, enabling early intervention by delivering targeted educational content that addresses specific health concerns (Kaplan & Hovav, 2021).

Theoretical frameworks for AI-driven behavioural change

AI-driven health education programmes often draw from established behavioural change models, such as the Health Belief Model, which emphasizes the role of perceived threats and benefits in motivating behavioural change. Similarly, the Transtheoretical Model (Stages of Change) and Social Cognitive Theory inform AI systems that offer personalized interventions based on an individual's readiness to change (Meyer et al., 2021).

Personalization of health interventions through AI

AI is particularly effective in delivering personalized interventions, where recommendations are tailored to an individual's specific needs, preferences, and behaviours. Such tailoring of interventions is usually based on user data. AI systems analyse diverse sources of data - such as activity logs, dietary habits, and health status - to craft individualized health education strategies. This customization leads to more relevant and actionable advice, which increases user engagement (Jalal et al., 2022). For instance, AI-powered mobile apps like My Fitness Pal and Lark Health provide tailored guidance on nutrition, exercise, and mental health, adjusting their recommendations as users progress toward their health goals (Miller et al., 2023).

Advantages of personalized interventions

Personalized interventions have been shown to enhance engagement and adherence by meeting the specific needs of individuals, increasing the likelihood of achieving sustained behavioural change (Timmermans et al., 2020). Furthermore, personalized interventions are often more effective in addressing complex behaviours, such as those related to chronic disease management, where patients require ongoing, customized support (Meyer et al., 2021).

Case studies of personalized AI-driven health interventions

Virtual health coaches powered by AI offer another example of personalized interventions. These tools use machine learning algorithms to provide real-time feedback on exercise

routines, diet plans, and mental health practices. For example, AI-driven chatbots like Woebot use cognitive behavioural therapy principles to assist users in managing mental health conditions such as anxiety and depression (Shah, Patel, & Weiner, 2021).

AI in real-time feedback and motivation

One of the primary strengths of AI in health education is its ability to deliver real-time feedback, which helps individuals stay motivated and track their progress toward health goals.

a) Importance of immediate reinforcement: Immediate feedback has been found to be critical for sustaining behavioural change, as it reinforces positive behaviours and provides motivation to continue pursuing health goals (Graham et al., 2022). AI systems can deliver timely messages, reminders, and progress reports that encourage individuals to stay on track.

b) AI-powered virtual assistants for motivation: Virtual health assistants powered by AI can play an important role in promoting motivation and encouraging adherence to health programmes. These systems provide continuous encouragement and check-ins, helping users set achievable goals and stay committed to their long-term health objectives (Kaplan & Hovav, 2021). Research shows that AI-driven virtual assistants have been particularly effective in promoting physical activity and mental health interventions (Miller et al., 2023).

Benefits and challenges in real-time AI interventions

While real-time feedback offers numerous benefits, there are challenges in ensuring sustained user engagement. Over-reliance on AI systems can sometimes reduce human interaction, leading to disengagement in some users (Nguyen, Robinson, & Thompson, 2021). Balancing AI support with human involvement remains an important area of consideration.

1. Predictive analytics and early interventions using AI

AI's predictive capabilities allow for early intervention, identifying at-risk individuals and delivering targeted health education to prevent the onset of diseases.

i. Predicting health outcomes using AI: AI can be used to predict the likelihood of chronic diseases based on an individual's behaviours and risk factors. For example, machine learning algorithms can forecast the likelihood of developing diabetes based on activity levels, diet, and family medical history (Meyer et al., 2021). Such predictions enable health educators to intervene early, offering tailored education to prevent disease progression (Jalal et al., 2022).

ii. Data-driven decision-making in health education: AI systems make data-driven decisions to personalize interventions and refine health education strategies. By

continuously analysing user data, AI can adjust the delivery of health content based on real-time behavioural changes, leading to more efficient use of resources and improved outcomes (Timmermans et al., 2020).

iii. Ethical considerations in predictive AI applications: While predictive AI offers tremendous benefits, it raises ethical concerns, such as the need for data privacy protections and the avoidance of bias in algorithms (Nguyen, Robinson, & Thompson, 2021). Ethical frameworks for AI applications in health must address these concerns to build trust and ensure fairness in interventions (Shah, Patel, & Weiner, 2021).

2. Scalability and accessibility of AI-driven health programmes

AI offers the potential to scale health education interventions and reach under-served populations, breaking down barriers related to geographical and socioeconomic limitations.

i. AI for reaching under-served populations: AI's cost-effectiveness and scalability make it an ideal solution for health education in resource-limited settings. AI-powered mobile applications can deliver personalized health advice to individuals in remote or under-served communities, where access to healthcare resources may be limited (Kaplan & Hovav, 2021).

ii. The digital divide and challenges in equitable access: Despite its potential, AI faces challenges in ensuring equitable access. The digital divide - differences in access to technology - remains a significant barrier to the widespread implementation of AI-driven health interventions (Nguyen, Yoon & Young, 2021). To overcome these challenges, it is crucial to ensure that marginalized communities have access to the necessary infrastructure and digital literacy training.

Effectiveness of AI-powered interventions in promoting healthy behaviours

The growing integration of Artificial Intelligence (AI) in healthcare, particularly in health education, has sparked significant interest due to its potential to transform how healthy behaviours are promoted. AI-powered interventions, which utilize data-driven technologies to personalize health education, are proving to be effective tools in fostering healthier behaviours. Numerous studies have demonstrated that AI can enhance health education by tailoring interventions based on individual characteristics such as demographics, health history, and user behaviour patterns (Yang et al., 2023). This level of personalization increases user engagement, as interventions are better aligned with the individual's specific needs and preferences, which is a critical factor in behavioural change (Moore et al., 2022). For instance, AI-powered chatbots have been particularly successful in delivering tailored health advice and motivational messages in a conversational format, enhancing user experience and fostering a sense of connection that traditional health education methods often lack (Liu et al., 2021).

Effectiveness and evaluation of AI in health behavioural change

Evaluating the effectiveness of AI-driven health interventions is critical to understanding their impact on behavioural change and health outcomes. Several studies have shown the effectiveness of AI-based interventions in promoting behavioural change. For instance, AI-powered virtual coaches have been shown to significantly improve physical activity levels and mental health outcomes (Graham et al., 2022). Comparative studies reveal that AI-driven interventions tend to outperform traditional methods in engagement and adherence (Shah, Patel, & Weiner, 2021).

Effectiveness can be measured through both quantitative outcomes (such as weight loss, increased physical activity, and improved mental health) and qualitative feedback (such as user satisfaction and engagement). Studies suggest that AI interventions can achieve similar or better results compared to traditional face-to-face counselling (Meyer et al., 2021).

Limitations and areas for improvement

Despite their promise, AI interventions still face challenges, including limited long-term studies and concerns about data privacy (Kaplan & Hovav, 2021). Addressing these limitations is necessary to fully realize AI's potential in health education.

Challenges and barriers to AI implementation in health education

AI in health education must overcome several barriers to ensure successful implementation.

- i. Data privacy and security concerns: The use of personal health data in AI-driven systems raises significant privacy concerns. Stricter regulations and transparent data practices are needed to build trust and ensure that users' data is protected (Nguyen, Robinson, & Thompson, 2021; Nguyen, Yoon, & Young, 2021).
- ii. User trust and engagement: Building trust in AI technologies is critical to ensuring user engagement. Public perception of AI in healthcare can be a barrier to adoption, particularly in populations sceptical of automated systems (Meyer et al., 2021).
- iii. Technical challenges: Integrating AI into existing health education programmes and systems can be technically challenging. Ensuring that AI solutions are accurate, reliable, and accessible is essential to their success (Miller et al., 2023).

Conclusion

In conclusion, AI holds immense potential for advancing health education programmes and behavioural change interventions by offering personalized, scalable, and data-driven solutions. While there are challenges related to data privacy, equity, and user engagement,

the transformative impact of AI on public health is undeniable. To fully harness this potential, future research should focus on long-term studies to assess the sustained impact of AI on health outcomes and explore its integration with emerging technologies such as wearable devices and telehealth platforms. Ongoing research and development will be crucial in ensuring that AI is used effectively, ethically, and equitably, ultimately revolutionizing health education and behavioural change interventions.

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