

Editorial

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From ancient wisdom to modern practices: transformative potential of digital health innovations in advancing traditional medicine

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which seeks to merge traditional knowledge with modern science for a more equitable and sustainable future. This article examines digital health's role in TM, addressing its potential, ethical considerations, and policy implications.

Introduction

Traditional medicine (TM) has long been a cornerstone of health and well-being, especially in underserved and rural communities. With its deep roots in cultural heritage, TM encompasses practices such as herbal medicine, acupuncture, and indigenous healing systems [1]. Globally, 88 % of World Health Organization (WHO) member states (170 countries) have recognised the use of TM by developing policies, laws, regulations, and programs [2]. However, TM's integration into modern healthcare is hindered by inconsistent documentation, limited evidence, standardization challenges, and inequitable access. Digital health technologies, including artificial intelligence (AI), telehealth, and digital devices, offer potential solutions by modernizing TM with rigorous data while preserving its cultural significance [3]. These innovations align with the WHO's upcoming 2025 Traditional Medicine Summit,

The potential of digital health technologies in traditional medicine

Digital documentation, knowledge access and knowledge preservation

Digitising TM is crucial for preserving its heritage, improving accessibility, and enabling rapid knowledge retrieval. AI-integrated tools enhance storage, analysis, and organization, supporting better application of TM. However, standardisation, essential for quality and safety, poses challenges, including the risk of neglecting non-standardised knowledge, such as family traditions in Ayurveda and East Asian Medicine (EAM) [3]. Balancing standardisation with the preservation of TM's diversity and cultural significance is vital. Furthermore, protecting intellectual property (IP) rights ensures equitable sharing of benefits with Indigenous communities and prevents misappropriation [4]. Collaborative and crowdsourced policies are crucial to empowering indigenous knowledge holders, allowing them to retain control while contributing to broader healthcare applications.

Telehealth for broader accessibility

Telehealth platforms are expanding access to TM, particularly in underserved areas. Virtual consultations incorporating traditional practices enable practitioners to reach patients across geographic and socio-economic barriers. By integrating AI, telehealth tools can provide preliminary diagnostic and therapeutic decisions, reviewed and finalised by TM practitioners [5].

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For instance, telehealth initiatives in India have successfully integrated Ayurveda consultations under telemedicine guidelines, improving access and patient outcomes [6]. Similarly, a digital platform in China offers remote consultations and personalised treatment plans, achieving high diagnostic accuracy [7]. These advancements modernise TM practices while preserving their cultural and historical significance, demonstrating telehealth's transformative potential.

Digital devices and monitoring

Digital devices are revolutionizing TM diagnostics and treatment, bridging the gap with modern healthcare. Sensor-equipped tools, integrated with Ayurvedic and EAM principles, offer personalized health insights and real-time monitoring for tailored TM recommendations. Stress-tracking systems support mindfulness practices, while high-resolution tongue diagnosis enhances precision by analysing key indicators like colour, texture, and coating. These technologies improve standardization and diagnostic accuracy for TM practitioners [8]. In addition, wearable devices enable continuous monitoring of various physiological parameters. Smartwatches and biofeedback wearables can track heart rate variability, sleep patterns, and stress levels, providing valuable insights for TM-based interventions. By leveraging AI, TM recommendations can be effectively personalized for holistic wellness, optimizing treatments based on real-time physiological data [8].

Multidisciplinary research platforms

Big data and AI are pivotal in advancing TM by identifying patterns that connect traditional knowledge with modern science. AI applications in TM include prescription decision-support systems and the evaluation of herbal extracts for efficacy [9, 10]. Machine learning models have been employed to analyse neuroprotective compounds in herbal formulations used for vascular function regulation and stroke recovery. AI also aids in pattern diagnostics, symptom classification, and drug discovery in TM. For example, AI-driven analyses of herbal medicine databases help predict compound interactions and potential therapeutic effects, improving treatment precision [9]. Additionally, AI is increasingly used in TM diagnostics, such as tongue and pulse analysis, enhancing accuracy and reliability. While these technologies modernize TM and improve its credibility, further validation through large-scale clinical trials is necessary to ensure their effectiveness and broader integration into healthcare frameworks [10].

Ethical and equity considerations

Respectful knowledge exchange

Equitable benefit-sharing mechanisms are essential to ensuring the ethical use of TM knowledge. Mechanisms for conflict resolution and arbitration should be established to ensure that all stakeholders – Indigenous communities, researchers, and policymakers – have an equal voice in decision-making processes. Digital frameworks can support to uphold Indigenous peoples' rights, fostering community participation, and informed consent for transparent agreements and mitigating risks of exploitation. Education and capacity-building initiatives can also empower communities to engage confidently in negotiations and collaborations involving their traditional knowledge [4].

Leveraging AI and digital frameworks for equitable TM representation

AI and digital tools help ensure fair knowledge representation, preventing monopolization by systematically documenting TM origins and recognizing Indigenous contributions. Natural language processing (NLP) techniques preserve TM traditions by analyzing historical texts [4]. The Traditional Knowledge Digital Library (TKDL) plays a key role in safeguarding traditional Indian medical knowledge by providing patent examiners with prior art information to prevent the erroneous grant of patents. By digitizing Ayurveda, Unani, Siddha, and Yoga texts in multiple languages, the TKDL ensures TM knowledge remains protected from misappropriation. AI-driven policy monitoring can further track TM-related investments and trade patterns, helping regulators prevent market imbalances. Blockchain ensures transparent and immutable records in many sectors, including intellectual property (IP) and health. This technology would support the equitable use of traditional knowledge while protecting its IP. Digital certification tools standardize TM without erasing cultural diversity, ensuring balanced and inclusive development [11].

Artificial intelligence and algorithmic bias

AI systems trained on limited or non-representative data risk perpetuating biases that marginalize TM-reliant communities. Models based on Western biomedical data may overlook effective EAM, Ayurveda, or other TM therapies, leading to lower-quality recommendations. Bias in NLP-based AI tools can also marginalize TM by prioritizing widely published

texts over oral traditions. Inclusive datasets and culturally sensitive algorithms by incorporating diverse TM sources are essential to mitigate this. AI must provide interpretable, verifiable insights aligning with traditional diagnostic methods. Transparent, explainable algorithms and governance structures are key to ethical, trustworthy AI in TM [3, 8].

Reducing disparities

Digital health can address disparities by improving access to TM services for marginalized populations. Telehealth and mobile health interventions can bridge geographic and economic gaps, delivering TM-based care to those who need it most while also empowering users to follow preventing healthcare interventions. These technologies can also facilitate the collection of data on health outcomes in underserved communities, providing valuable insights to tailor TM services to specific local needs. However, addressing language barriers and cultural differences in the delivery of digital health interventions is critical to ensure that these services are accessible and acceptable to diverse populations [3, 4].

Challenges and policy implications

Regulatory and governance challenges

Balancing innovation with safety, efficacy, and quality assurance remains a critical challenge. Standardized guidelines for the integration of digital health in TM are needed to ensure patient safety and trust. In this context, the recent introduction of the ICD-11 classification framework in TM is a welcome step towards standardising and mainstreaming TM [12]. Developing these guidelines requires international collaboration to address regional variations in TM practices, as well as incorporating input from both traditional practitioners and modern healthcare professionals. Ensuring that digital health tools adhere to evidence-based standards while respecting traditional knowledge systems is critical for fostering trust among stakeholders. Establishing clear regulatory pathways for TM innovations is also essential to prevent the misuse of digital health technologies. Policies must strike a balance between promoting innovation and safeguarding the quality and safety of TM services. Regulatory frameworks should include mechanisms for monitoring and evaluating the effectiveness of digital health applications in TM, ensuring continuous improvement and adaptation to emerging challenges [3].

Digital health infrastructure

Inequities in digital infrastructure and literacy must be addressed to fully realize the potential of digital health in TM. Investments in technology and training are critical for scaling these innovations globally. Addressing these disparities involves building robust digital ecosystems in low-resource settings, including reliable internet access, affordable devices, and culturally appropriate training programs. Strengthening local capacity to develop, implement, and maintain digital health solutions is equally vital. Promoting digital literacy among both healthcare providers and patients is a key component of this effort. Tailored educational initiatives can help traditional practitioners adopt digital tools without compromising their core practices, while patients can be empowered to engage with these technologies to improve health outcomes. Additionally, public-private partnerships can play a crucial role in mobilizing resources and expertise to bridge the digital divide [3].

Conclusion and way forward

Digital health innovations are transforming the validation of TM by identifying patterns through holistic concepts, reducing bias, and strengthening its credibility within global healthcare. Beyond validation, digital tools serve as decision-support systems, enabling practitioners to navigate and analyse vast TM knowledge with greater precision. AI-driven databases ensure transparency in TM's evolution while preserving its core principles. The integration of digital health technologies offers significant opportunities for TM's advancement while respecting its cultural origins. Achieving this will require sustained collaboration among TM practitioners, technology experts, researchers, and policymakers. By leveraging digital innovations including AI, TM can contribute to equitable, sustainable, and improved health outcomes worldwide.

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