The Impact of Using Digital Health Technology to Improve the Public's Health

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Introduction

The incorporation of digital health technology into healthcare systems has initiated a new epoch of ingenuity, with the potential to completely transform our approach to public health. The convergence of technology and medicine has led to significant advancements in public health through the use of digital health tools. These improvements include various applications, such as wearable fitness trackers and advanced telemedicine platforms. Their goal is to improve accessibility, efficiency, and efficacy in healthcare delivery.

The field of public health is essential in safeguarding and enhancing the well-being of entire populations. Technological breakthroughs have significantly transformed public health over the years. The main objectives of public health are centered around safeguarding and enhancing the well-being of communities (WHO, 2018). Public health technology facilitates the achievement of these objectives with enhanced efficiency. When utilized in public health contexts, technology offers public health experts with data that can assist them in developing more efficient and practical health strategies that encompass various scenarios, including individual care plans and the coordination of support systems to combat widespread disease outbreaks.

Digital public health is a burgeoning and swiftly expanding discipline that use technology and digital interventions to enhance the health and well-being of individuals and populations. These treatments encompass digital technologies including mobile apps, telemedicine, and electronic health records. They can be employed for many public health requirements, including illness surveillance, health education, and behavior modification.

Historically, public health interventions were predominantly conducted through direct, in-person encounters between healthcare practitioners and individuals. Nevertheless, the emergence of digital technologies has facilitated the advancement of traditional public health (Tan & Lim, 2023). In the present day, digital public health is employed for the purpose of gathering and examining extensive collections of health data, disseminating health information and resources to individuals and communities, and enhancing communication and collaboration among healthcare providers.

The power of digital health technology to democratize healthcare access is one of its most profound implications. Through the use of mobile devices and internet connectivity, folks today have the ability to obtain health information, track their essential body functions, and even seek advice from healthcare professionals without leaving their residences. This unparalleled degree of accessibility has the capacity to overcome geographical and socioeconomic disparities, guaranteeing that even marginalized people may obtain timely and high-quality healthcare (Brewer et al., 2020).

Furthermore, digital health technology enables individuals to actively manage their health and well-being. Through the widespread availability of health tracking applications and wearable devices, individuals

have the ability to continuously monitor several aspects of their health, including physical activity, sleep habits, and nutrition, in real-time. Utilizing data in this manner not only promotes increased understanding but also facilitates the prompt identification of possible health concerns, enabling timely treatments and preventative actions.

1. **Overview of Digital Health Technology**

The utilization of digital health technology significantly influences the overall public health outcomes by providing a wide range of advantages and applications. It improves the availability of a broader spectrum of healthcare services, encourages measures that reduce costs, stimulates changes in behavior to achieve better health outcomes for the entire community, and assists in efficiently managing public health emergencies. The incorporation of digital solutions in public health involves the implementation of monitoring, decision support, and education systems, which are crucial for illness detection, behavior promotion, and improvement of health awareness, respectively. Countries can optimize the utilization of digital health technologies to enhance public health outcomes and tackle growing health concerns by taking into account these factors.

The World Health Organization (WHO, 2021) defines digital health technologies as the field of knowledge and practice that involves the creation and utilization of digital technology to enhance health. Digital health broadens the scope of eHealth by encompassing digital users and a broader array of intelligent and interconnected devices. It also includes various applications of digital technology for healthcare, such as the Internet of Things (IoT), advanced computing, big data analytics, artificial intelligence (including machine learning), and robotics. Significantly, within the realm of digital health technology, other concepts such as eHealth (electronic health), telemedicine, and mHealth (mobile health) have gained widespread usage.

When comparing digital healthcare to traditional healthcare, it has the potential to be more accurate, with fewer mistakes, and more effective, according to Table 1, which is based on Meskó et al. (2017).

Table (1): Differences between traditional and digital healthcare

Traditional healthcare	Digital healthcare
Direct patient-physician relationships	Patient-machine-physician interface
Standardized care based on physician experience and standard clinical workflow: Symptoms, clinical signs, ancillary medical tests, diagnosis, and treatment plan	Individualized care, precision medicine, with non-traditional workflow: Mass screening, early preclinical or asymptomatic diagnosis, diagnosis based on probability, predictive technology, and decision support for physicians
Point of care delivery or examination is at the clinic or lab	Point of care delivery or examination may vary as long as patient is present
Data owned by the institutions/hospitals	Data owned and shared by multiple stakeholders, including the patient
Physician as the central player who makes diagnosis, and prescribes treatment plan	Physician as a consultant, guide or collaborator with the patient's active contribution in the decision making

Key components of digital health technology include advancements such as mobile health applications, wearable devices, telemedicine, and electronic health records (EHRs). These technologies signify the merging of healthcare and digital innovation, providing exceptional chances to transform healthcare delivery and management.

➤ Mobile health apps function as portable platforms for obtaining health-related information, monitoring vital signs, and overseeing chronic illnesses. Mobile applications such as fitness tracking apps and medicine reminder apps enable individuals to actively manage their health and well-being.

➤ Wearable devices, such as fitness trackers, smartwatches, and medical-grade sensors, offer uninterrupted monitoring of physiological indicators like heart rate, blood pressure, and sleep patterns. Through seamless integration into everyday activities, wearable devices allow individuals to monitor their health parameters in real-time and aid the early detection of health problems (Prieto-Avalos et al., 2022).

➤ Telemedicine platforms provide remote consultations and virtual visits, allowing patients and healthcare providers to interact without being limited by geographical distance, thus increasing access to healthcare services. Patients can access prompt medical advice, diagnosis, and treatment without the need for in-person visits by using secure video conferencing and communications technologies.

➤ Electronic health records (EHRs) transform patient health information into digital format and consolidate it in a centralized system. This facilitates smooth communication and cooperation among healthcare professionals and institutions. Electronic Health Records (EHRs) have

transformed healthcare delivery and administration by simplifying administrative processes, increasing data precision, and facilitating information exchange. This has resulted in better patient outcomes and greater operational effectiveness (Kohli & Tan, 2016).

2. The Advantages of Digital Health Technology

Amidst a time characterized by technical advancements and global connectivity, digital health technology has arisen as a transformative force in the field of public health. The benefits of digital health technology are numerous and extensive, ranging from increasing accessibility to healthcare services to improving the treatment of chronic diseases and promoting preventative healthcare.

- Improved Access to Healthcare

Digital health technologies have the ability to connect people and healthcare providers, especially in areas or locations that lack adequate access to healthcare services. Telemedicine enables patients to remotely consult with doctors, thereby eliminating the need for travel and enhancing the availability of healthcare services.

- Enhanced Convenience and Efficiency

Digital health solutions bring convenience and efficiency for both patients and healthcare practitioners. Patients can utilize mobile applications or internet platforms to access their medical records, make appointments, and receive customized reminders. Healthcare providers have the ability to simplify administrative duties, conveniently access patient data, and engage in effective communication with colleagues to facilitate collaborative care (Haleem et al., 2021).

- Better Patient Engagement and Empowerment

Digital health tools enable individuals to actively engage in their healthcare journey and make well-informed choices regarding their health. Individuals can utilize mobile apps, patient portals, and wearable devices to obtain personalized health information, monitor their progress, establish health objectives, and connect with their healthcare providers. This heightened level of involvement promotes a cooperative rapport between patients and healthcare practitioners, resulting in enhanced health results and increased patient satisfaction.

- Improved Accuracy and Decision-Making

Digital health technologies enable the gathering and examination of vast quantities of health data. This data can be utilized to enhance diagnosis, track patient progress, and detect trends or patterns for community health management. AI algorithms can enhance the decision-making process of healthcare providers by providing more precise and timely assistance (Lysaght et al., 2019).

- Better Management of Chronic Conditions

Remote monitoring and management of chronic illnesses, such as diabetes, hypertension, and heart disease, is made possible by digital health technologies. Wearable gadgets and mobile health apps monitor essential indicators, medication compliance, and lifestyle elements, offering patients and healthcare practitioners with up-to-date information for proactive control and prompt treatments. This method of remote monitoring aids in the prevention of complications, the reduction of hospitalizations, and the enhancement of the quality of life for persons suffering from chronic diseases.

- Promotion of Preventive Healthcare

Digital health technology enables the implementation of preventive healthcare policies by facilitating the timely identification, intervention, and control of health concerns. Health tracking applications offer customized suggestions for preventive exams, vaccines, and lifestyle adjustments based on specific health data. Digital health tools enable individuals to track their health measurements and embrace healthy habits, thereby preventing the emergence of diseases, lowering healthcare expenses, and enhancing overall population health outcomes.

3. Challenges Associated with Digital Health Technologies

Although digital health technologies provide great potential for transforming healthcare delivery and enhancing patient outcomes, they also pose distinct difficulties that need to be resolved in order to fully harness their capabilities.

Data privacy and security pose significant hurdles in the use of digital health technology. The collection and storage of sensitive health data is increasing rapidly due to the widespread use of electronic health records (EHRs), wearable devices, and mobile health apps (Shah & Khan, 2020). However, as this expansion occurs, there are increased worries over the privacy and security of patient data. The occurrence of data breaches and illegal access highlights the immediate requirement for strong data privacy protections to protect patient confidence and confidentiality in the era of digital technology.

Inadequate App design can lead to decreased efficiency in usage, but a more significant concern is the absence of stringent rules to ensure quality and effectiveness, or insufficient confirmation of clinical efficacy. This might significantly damage the overall perception of digital health technologies among the public and society.

Interoperability difficulties pose a substantial obstacle to the implementation of digital health technology. Healthcare systems frequently function in isolated compartments, employing different technologies and platforms that face difficulties in exchanging information with each other (Conley & Pocs, 2018). The absence of standardized data formats and protocols hinders the smooth exchange and integration of data

across various systems, obstructing care coordination and restricting the sharing of vital patient information between providers and organizations. To fully harness the benefits of digital health solutions in improving patient outcomes and boosting healthcare delivery, it is crucial to overcome these obstacles to interoperability.

In addition, the absence of monetary incentives and resources hinders the implementation of digital health solutions, especially in economically disadvantaged areas. The healthcare systems in these nations may have challenges in allocating adequate financing for the procurement, deployment, and upkeep of digital health infrastructure. Moreover, the lack of reimbursement structures and incentives for healthcare providers to embrace digital solutions hinders investment in technology and innovation.

Implementing digital health technologies frequently requires modifying workflow processes and job roles, which may encounter opposition from healthcare personnel accustomed to conventional practices. Implementing new technologies necessitates instruction, acquiring new skills, and reorganizing the organization to synchronize with digital processes and maximize the advantages of digital solutions. The reluctance to adapt and the lack of preparedness to accept new responsibilities might hinder the implementation of digital health initiatives and restrict the full realization of their potential advantages (Kruszyńska-Fischbach et al., 2022).

Furthermore, inequalities in digital knowledge and access pose substantial barriers to wider adoption. Vulnerable and underserved populations, such as the elderly, low-income communities, and rural inhabitants, may not have access to the required technology infrastructure or have poor digital literacy abilities to properly use digital health resources. These gaps worsen the already existing healthcare inequities, which restrict access to crucial healthcare services and intensify disparities in health outcomes. To tackle these inequalities, specific measures are needed to enhance individuals' proficiency in using digital tools, ensure fair availability of technology, and guarantee that digital healthcare solutions are accessible and user-friendly for everyone.

According to (Ambrosino et al., 2016; Frederix et al., 2019; Naik et al., 2022) the main challenges are categorized into technical and non-technical aspects, and strategies to address them are provided in Table 2.

Social science

Table (2): Challenges and recommendations to overcome them

Challenges	Possible approaches to overcome
Technical	
Data structure and heterogeneity (interoperability)	Unify data format, security and sharing requirements
Digital technology infrastructure	Cloud computing and storage; use of blockchain for secured and decentralized data storage and transport
Non-technical (4 Ps)	
Patient (lack of acceptance, privacy issue, lack of motivation, fear of technology, etc.)	More "how to use" quick guides and ready-to-help staff; more patient involvement in the design; more support to caregivers; encourage promotion from the patient's attending physicians
Physician (resistance, lack of incentives, fear of losing jobs, changing roles, etc.)	System overhaul and accredited points for continuous professional development schemes; establish clarity in regulation and standardization
Public/society (ethics, acceptance, public education etc.)	Promotional campaigns led by celebrities; evaluate and demonstrate evidence of cost-effectiveness
Policy (ethics, financial, regulatory, especially in less resourceful countries)	Lobbying and public-private partnerships; establish clear legal framework regarding reimbursement schemes and data transparency; provide subsidy to cover high start-up costs or incentivize the use

4. Strategies to Overcome Challenges Associated with Digital Health Technologies

In order to tackle the difficulties related to data privacy and security in digital health technology, a number of solutions can be employed:

- Enhanced Data Encryption and Security Measures

Utilize resilient encryption methods and security processes to protect sensitive health information from illegal access and breaches. This encompasses the implementation of data encryption during transmission and storage, the utilization of multi-factor authentication, the enforcement of access rules, and the regular conduction of security audits.

- Promoting Interoperability Standards

Promote the implementation of standardized data formats and protocols to enhance smooth interoperability among diverse digital health systems and platforms. This may entail working together with industry players, government agencies, and standards groups to create and execute interoperability frameworks.

- Training and Education Programs

Create extensive training and education initiatives to provide healthcare personnel with the essential expertise and understanding required to proficiently utilize digital health technologies. This encompasses instruction on effectively utilizing digital tools, incorporating them into current work processes, and interacting with patients through technology-based care approaches.

- Financial Incentives and Support

Allocate financial incentives, grants, and subsidies to healthcare organizations, particularly those located in economically disadvantaged regions, to encourage them to invest in digital health infrastructure and technologies. This assistance can help surmount financial obstacles and facilitate extensive implementation of digital health solutions.

- Change Management Strategies

Utilize change management tactics to effectively tackle resistance to change and foster a culture of innovation and ongoing enhancement within healthcare companies. This may entail obtaining the backing of leaders, including stakeholders, implementing communication strategies, and providing continuous support to workers during the shift to digital health technologies.

5. **Patients' Views on the Potential of Digital Health Technologies**

From the patient's viewpoint, digital health technologies have significant potential to revolutionize the healthcare experience, enabling individuals to play a more proactive role in controlling their health and well-being. Through the utilization of technology, digital health solutions give consumers with unparalleled opportunity to interact with their healthcare providers, obtain medical information, and actively participate in their own healthcare journey.

An important benefit of digital health technologies, as seen from the patient's point of view, is the enhanced availability of healthcare services. According to (Haleem et al., 2021;), telemedicine solutions facilitate virtual consultations between patients and healthcare practitioners, thereby removing the necessity of travel and minimizing appointment wait times. The enhanced accessibility is especially advantageous for persons with limited mobility, those residing in remote or underdeveloped regions, and those in need of specialized medical attention from distant healthcare professionals.

According to (Awad et al., 2021), digital health technologies provide exceptional ease and customization, enabling people to easily access healthcare services and information using their mobile devices. Mobile health applications offer quick access to medical resources, appointment scheduling, prescription reminders, and personalized health advice according to individual preferences and needs. This degree of personalization enables patients to assume authority over their well-being and make well-informed choices regarding their treatment.

Furthermore, digital health technologies enable individuals to proactively monitor and control their health in real-time (Imison et al., 2016). Wearable gadgets, such as fitness trackers and smartwatches, monitor and record physical activity, sleep habits, and vital signs, offering users useful information about their health measurements. Through the use of continuous monitoring and self-tracking, these technologies provide patients with the ability to recognize patterns, establish objectives, and make adjustments to their lifestyle in order to enhance their overall health and well-being.

Encouraging patient empowerment, better adherence and compliance, and overcoming geographical barriers are all potential outcomes of digital health technologies that could improve access to healthcare, communication with healthcare providers, and the quality of follow-up and clinical decision-making (Table 3).

Table (3): Brief overview of the role of digital health tools in encouraging patient participation

Role	Description
Access to health information	Patients can have access to their health information, including medical records, test results, and self-management tools, *via* digital health technologies. This information empowers patients to make relevant informed decisions more actively together with their healthcare providers.
Improved communication	Digital health technologies facilitate communication between patients and healthcare providers, enabling patients to ask questions, provide feedback, and receive advice and guidance apart from face-to-face consultation sessions. This increased communication may encourage patients to be more aware of their own daily health condition, and have greater satisfaction.
Personalized care	Healthcare providers may deliver personalized care with tailored treatment plans according to the health metrics collected *via* digital health technologies such as wearables. The personalized approach may improve patient engagement and adherence, and increase treatment efficacy.
Remote monitoring	Wearables and remote monitoring systems enable patients to monitor their health at home and share data with their healthcare providers. Healthcare providers can therefore detect and address health issues more pre-emptively, leading to better prognosis and reduced treatment costs.
Self-management	Digital health technologies are tools and resources for patients to manage their health more independently, such as medication reminders, exercise trackers, and nutrition apps. They can increase patient engagement and self-efficacy, leading to improved health outcomes.

6. Success Stories that showcase the Impact of Digital Health Technology

- Teladoc Health

Teladoc Health is a telemedicine company that offers virtual healthcare services to patients via its web platform. Teladoc Health has greatly enhanced healthcare accessibility, particularly in rural and underserved regions, by providing remote consultations with licensed healthcare providers. Research

(Uscher-Pines et al., 2016) has demonstrated that the telemedicine services provided by Teladoc Health have resulted in decreased rates of unnecessary visits to the emergency department, hospital admissions, and healthcare expenses, while simultaneously enhancing patient satisfaction and outcomes.

- KardiaMobile ECG

The KardiaMobile ECG device is a compact and portable monitor that allows individuals to conveniently track their cardiac well-being within the confines of their residences. The device, which is compatible with a smartphone app, enables users to obtain ECG records of medical quality and identify indications of atrial fibrillation (AFib) and other heart rhythms. Research (Goldenthal et al., 2019) has shown that the KardiaMobile device is clinically successful in identifying heart irregularities and providing prompt therapies, resulting in better patient outcomes and lower healthcare expenses related to preventing cardiovascular incidents.

- Apple Watch's Health Features

The health functionalities of the Apple Watch, such as heart rate monitoring, activity tracking, and fall detection, have given consumers the ability to actively manage and improve their health and well-being. Users can utilize the device's integrated sensors and health tracking features to monitor essential health measurements, obtain individualized health observations, and exchange data with healthcare professionals. Lui et al., (2023) have emphasized the capability of Apple Watch's health functionalities in identifying health concerns such abnormal cardiac rhythms, sleep disorders, and falls. This can result in early interventions, better management of chronic ailments, and more patient involvement.

- Babylon Health's AI-Powered Chatbot

The mobile app developed by Babylon Health utilizes artificial intelligence to provide virtual healthcare consultations and symptom triage services to its users. The chatbot use AI algorithms to evaluate users' symptoms, offer customized health suggestions, and enable remote consultations with healthcare experts. Research (Azevedo et al., 2022) has shown that Babylon Health's chatbot is very accurate and efficient in diagnosing common health disorders. It has been proven to reduce unnecessary visits to primary care providers and improve access to healthcare services, especially in places with limited resources.

7. The Future of Digital Health Technology

The rapid evolution of digital health technology holds tremendous promise for its transformative impact on public health in the future. Artificial intelligence (AI), remote patient monitoring, and virtual reality (VR) applications are upcoming developments that have the potential to completely transform healthcare delivery, improve patient outcomes, and advance public health.

- Artificial Intelligence in Healthcare

Artificial intelligence (AI) is positioned to have a pivotal role in the future of digital health technology, providing unparalleled skills to evaluate extensive quantities of healthcare data, detect trends, and produce practical insights. Artificial intelligence algorithms can aid in the diagnosis of diseases, forecast patient prognoses, and customize treatment strategies using individual health data. In addition, virtual assistants and chatbot powered by artificial intelligence have the capability to boost patient involvement, offer customized health suggestions, and enhance the availability of healthcare services, especially in underprivileged communities.

- Remote Patient Monitoring

It is anticipated that the extensive implementation of remote patient monitoring (RPM) and telehealth technologies will bring about a significant transformation in healthcare provision, allowing patients to get excellent treatment without leaving their residences. Remote patient monitoring (RPM) equipment, such as wearable sensors and mobile health apps, enable healthcare providers to monitor patients' vital signs, symptoms, and adherence to treatment regimens in real-time from a distance.

- Virtual Reality Applications in Healthcare Delivery

Virtual reality (VR) applications are becoming increasingly valuable in healthcare, providing immersive experiences that can boost patient involvement, enhance clinical results, and facilitate medical training and teaching. Virtual reality (VR) technology allows healthcare providers to replicate medical operations, surgical interventions, and therapeutic treatments in a virtual setting. This creates a secure and lifelike training environment for healthcare workers.

Conclusion

The path of digital health technology indicates a future marked by innovation, easy access, and enhanced health results. Artificial intelligence, remote patient monitoring, and virtual reality applications are

upcoming developments that have the potential to completely transform healthcare delivery. These advancements present unique opportunities to improve patient care and advance population health. By incorporating these technologies into healthcare systems, there is the potential to enhance the availability of care, optimize the process of making clinical decisions, and enable patients to actively participate in managing their health.

Through collaborative efforts, stakeholders may create an environment that promotes innovation and excellent health outcomes by addressing difficulties such as data privacy concerns, interoperability issues, and gaps in access. In addition, governments have a vital role in establishing legislative frameworks that facilitate the implementation and incorporation of digital health technology into healthcare systems. This ensures that patients may take advantage of these innovations while also protecting their privacy and security.

As one contemplates the forthcoming years, the potential applications of digital health technology appear boundless. By placing patient-centric care at the forefront, promoting collaboration, and embracing emergent trends, it is possible to establish a healthcare environment that is characterized by enhanced efficiency, accessibility, and equity. By persistently advancing innovation and allocating resources towards digital health solutions, it is possible to construct a future in which technology plays a pivotal role in transforming healthcare provision and improving the health outcomes of populations.

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