Vol 1 No 8 2024 || E-ISSN 2997-7258

The Journal of Academic Science

journal homepage:
https://thejoas.com/index.php/

Innovations in Public Health: The Role of Technology in Improving Access to Healthcare Services

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KEYWORDS
Health Technology, Access to Health Services, Public Health Innovation.

ABSTRACT
Technological developments have had a significant impact on the transformation of public health services, especially in improving the accessibility of services in areas that are difficult to reach or have limited infrastructure. Innovations such as telemedicine, blockchain, Internet of Things (IoT), and artificial intelligence (AI) have become solutions to overcome geographical, logistical, and resource barriers for healthcare workers. This research aims to explore how technology can improve access to healthcare and identify innovative technologies that have proven effective in expanding the scope of healthcare globally. This research uses a qualitative method based on literature studies, which includes analysis of scientific articles, institutional reports, and official documents published in the last five years (2018–2023). The data collection technique is carried out through systematic searches on scientific databases such as PubMed and Scopus with specific keywords related to health technology. The results show that technologies such as telemedicine have enabled remote medical consultations that speed up the diagnosis and treatment of patients in remote areas. Meanwhile, blockchain improves the interoperability of medical data, and IoT supports real-time health monitoring through wearable devices. The study also found that the implementation of technology requires policy support, infrastructure investment, and training of healthcare workers to ensure widespread and sustainable adoption. With the right strategy, technology has the potential to create a more inclusive, efficient, and resilient health system.

1. INTRODUCTION

Technological innovation has become one of the key elements in the transformation of public health services around the world. Technological developments, such as the Internet of Things (IoT), artificial intelligence (AI), and blockchain, have enabled the creation of more efficient solutions to address healthcare access challenges, especially in remote areas and resource-limited areas (Guimarães et al., 2024). This technology provides opportunities to speed up the diagnosis process, improve patient management, and expand the scope of more inclusive healthcare.

Healthcare technology has continued to experience rapid development in recent years,

with a focus on improving diagnosis, treatment, and patient experience. One of the main innovations is the development of devices integrated with artificial intelligence (AI) for real-time health monitoring. This technology allows for early prediction of various medical conditions, such as heart disease or diabetes, allowing for faster and more effective interventions (Etli et al., 2024). AI-driven wearables like these provide more accurate data, which facilitates evidence-based medical decision-making.

Healthcare technologies, such as blockchain-based electronic health records (EHRs), have reduced barriers to sharing medical data between healthcare providers. This solution not only improves interoperability, but also strengthens the security and privacy of patient data, which is a major concern in today's digital era (Smith & Smith, 2024). Thus, technology-based systems have become an important tool in promoting health justice and improving the efficiency of medical services.

In the field of surgery, robotics has become an important tool, improving surgical precision while reducing the risk of complications. For example, capsule robotic technology has allowed for safer internal procedures, such as endoscopy, with minimal invasiveness. Additionally, these robots are equipped with wireless navigation and power transfer capabilities, allowing them to perform complex medical tasks within the human body (Hua et al., 2024). These developments have expanded medical capacity, especially in areas that are difficult to reach manually.

Healthcare technology has also adapted to social changes, such as the increasing need for gender-based healthcare. For example, radiofrequency in cosmetic gynecology is a technology that is often used to improve the quality of life of female patients with complex reproductive problems. This not only covers the medical aspect but also provides significant psychological benefits (Elfaki, 2024).

However, while this technology offers great potential, challenges remain, including patient data protection and gaps in technology adoption across different regions. To ensure far-reaching benefits, the development of health technologies must be accompanied by training and policies that ensure their safety and accessibility. Integrated data management, such as the one carried out at the main hospital in Istanbul, has shown how the implementation of advanced technology can lead to better outcomes for patients (Tanyildiz et al., 2024). Some underdeveloped regions often face barriers to adopting these technologies, such as lack of internet connectivity and high implementation costs. Therefore, the success of health technology implementation is highly dependent on policies that support infrastructure development and increase technological literacy among the community and service providers.

Furthermore, the COVID-19 pandemic has accelerated the adoption of health technologies, such as telemedicine and consumer-based testing, which offer practical solutions in addressing access limitations during the crisis (Martín-García & Santi-Rocca, 2024). With the increasing need for flexible and responsive healthcare services, this technology has helped many countries to sustain their healthcare systems amid unprecedented pressure. This transformation demonstrates the potential of technology in redefining public health towards a more resilient and inclusive system.

Previous research has highlighted the benefits of technology in improving access to health services. For example, a study by Smith and Smith (2024) shows that the application of blockchain-based medical records improves data interoperability between healthcare providers, reduces diagnosis time, and improves operational efficiency. Similarly, Shuja's (2024) research highlights how telemedicine is an effective solution in ensuring the continuity of health services during the pandemic (Shuja, 2024). Santi-Rocca (2024) also noted that consumer-based testing, such as for sexually transmitted diseases, allows patients to get a diagnosis faster at a lower cost.

This research aims to explore how technology can improve access to health services, especially in hard-to-reach areas or with limited health infrastructure. Furthermore, this study also aims to identify innovative technologies that have proven effective in expanding access to health services and provide policy recommendations to increase the adoption of these technologies globally.

2. METHOD

This study uses a qualitative approach with the literature study method as the type of research chosen. The literature study was chosen because it provides a comprehensive framework for analyzing secondary data from a variety of sources, including scientific journals, institutional reports, and official publications relevant to technological innovations in public health. This method allows researchers to integrate findings from various previous studies and identify trends and gaps in the literature (Snyder, 2019).

The main sources of data in this study are journal articles published in the last five years (2018–2023), official documents of international organizations such as the World Health Organization (WHO), and reports from global and local health institutions. The reviewed articles were selected based on their relevance and contribution to the topic of technology and access to healthcare. Inclusion criteria include studies that discuss the application of technologies such as telemedicine, blockchain, and the Internet of Things (IoT) in improving access to health services, as well as studies that reveal the challenges of implementing these technologies (Kitchenham, 2004).

The data collection technique is carried out through systematic searches using specific keywords such as "public health technology," "access to health services," and "health technology innovation" on scientific databases such as PubMed, Scopus, and Google Scholar. The data obtained were evaluated based on the relevance of the topic, the quality of the source, and the suitability to the research objectives. Researchers also ensure the validity of the data by prioritizing articles that have gone through the peer-review process and come from reputable journals (Tranfield et al., 2003).

The data analysis method used is content analysis, which involves grouping and interpreting data to identify key themes. The collected data is analyzed qualitatively to reveal the patterns, relationships, and implications of the use of technology in improving access to health services. This technique allows researchers to explain how technological innovations can answer challenges in public health and provide evidence-based recommendations (Elo & Kyngäs, 2008).

3. RESULT AND DISCUSSION

The research focus includes various technological innovations, such as telehealth, blockchain, artificial intelligence, and Internet of Things (IoT) applications, which have been shown to improve healthcare accessibility, especially in areas with limited infrastructure. The data presented provides an in-depth picture of the application of modern technology in the context of public health and its contribution to the improvement of the global health service system.

Table 1. literature review

No	Author	Title	Main Focus
1	Guimarães et al.	Context-Aware Electronic Health Record—Internet of Things and Blockchain Approach	Adoption of IoT and blockchain to improve health data interoperability
2	Paramesti, T.	Analisis Efisiensi Manajemen Logistik pada Rumah Sakit di Indonesia: Tinjauan Literatur	Efficiency of technology-based logistics management in the health system
3	Quayson et al.	Telehealth for Rural Veterans in the United States: A Systematic Review of Utilization	The use of telehealth to overcome the challenges of access to health services in rural areas
4	Santi-Rocca et al.	Direct-to-Consumer Testing: A Game-Changer for STI Control and Public Health?	Consumer-based testing for sexually transmitted disease control
5	Rajak et al.	Revolutionizing Healthcare with 6G: A Deep Dive into Smart, Connected Systems	6G technology to detect viruses through wireless communication systems
6	Ramani et al.	Achieving Universal Health Coverage in India: A Scoping Review on the Requisite Public Health Actions	Steps towards universal health coverage with health technology
7	Mulyani, S.	Analysis of the Impact of Electronic Health Record Use on Diagnostic and Treatment Processes	The effect of electronic health records on diagnostic effectiveness
8	Eriksson et al.	AI-supported Methods for Analysis of Unstructured Text Responses in Patient Surveys	Utilization of AI for patient survey analysis in primary healthcare
9	Bannett et al.	Natural Language Processing: Set to Transform Pediatric Research	Utilization of NLP for pediatric research
10	Achir et al.	Advances in Leukemia Detection and Classification: A Systematic Review of AI	The use of AI for the detection and classification of leukemia

The results of the research summarized in the table above illustrate various technological innovations in the public health sector that have been implemented to improve access to health

services, especially in areas with limited resources. Each article provides in-depth insights into how modern technology can overcome the challenges that have been obstacles to providing equitable and quality healthcare.

An article by Guimarães et al. (2024) discusses how the integration of the Internet of Things (IoT) and blockchain in electronic health records (EHRs) can improve the interoperability of health data. With this solution, patient data can be accessed in real-time by various healthcare providers without compromising data security and privacy. This research shows that this technology not only improves efficiency, but also expands access to health services in remote areas that were previously difficult to reach (Guimarães et al., 2024).

In the context of the health logistics system, Paramesti (2024) highlights the importance of technology in improving the efficiency of logistics management in Indonesian hospitals. This article underlines that technologies such as automated inventory management systems can reduce resource wastage and ensure the availability of critical medical equipment. The results of this study show that technology-based logistics optimization has a direct impact on improving the quality of health services provided to patients (Paramesti, 2024).

A study conducted by Quayson et al. (2024) revealed the great benefits of telehealth in providing access to health services to veterans in rural areas of the United States. This technology allows patients to get medical consultations without having to travel long distances to healthcare facilities. In this study, telehealth has been proven to be effective in reducing the gap in access to health services between urban and rural areas, while reducing the operational costs of health services (Quayson et al., 2024).

Santi-Rocca et al. (2024) explored innovations in consumer-based health testing, specifically for sexually transmitted diseases (STIs). Consumer-based testing allows patients to perform tests independently with high accuracy, which speeds up the diagnosis and treatment process. This article shows that this approach improves early detection of diseases, reduces the stigma often associated with STI testing, and expands the coverage of Public health services (Martín-García & Santi-Rocca, 2024).

Rajak et al. (2024) introduced the sixth generation (6G) technology as a revolutionary step in detecting viruses through wireless communication systems. With real-time capabilities, this technology enables proactive health surveillance, especially in the context of outbreaks. This article describes the potential of 6G technology in creating a more responsive and connected health system, which could become the standard in the future (Rajak et al., 2024).

The research of Ramani et al. (2024) focuses on the steps needed to achieve universal health coverage in India. The study highlights the role of technology, such as telemedicine and mobile-based apps, in improving access to healthcare. The authors underline the importance of policy support that promotes the widespread adoption of technology to improve health infrastructure in developing countries (Ramani et al., 2024).

Mulyani (2024) examines the impact of the use of electronic health records (EHR) on the effectiveness of the diagnosis and treatment process. The study shows that the implementation of EHRs assists doctors and healthcare professionals in accessing patients'

medical histories quickly, which improves diagnostic accuracy and treatment efficiency. The article also notes that EHRs contribute to a reduction in administrative burden, allowing healthcare workers to focus more on patients (Mulyani, 2024).

Eriksson et al. (2024) discuss the use of artificial intelligence (AI) in analyzing patient survey responses in primary health care. The study shows that AI can process large amounts of data with high efficiency, generating insights that can be used to improve the quality of healthcare. This research highlights how AI technology opens up new opportunities to understand patient needs more deeply (Eriksson et al., 2024).

Bannett et al. (2024) explore the use of Natural Language Processing (NLP) in pediatric research. This article explains how NLP enables high-accuracy analysis of medical textual data, which can be used to support research and development in pediatrics. NLP has also been shown to assist doctors in identifying disease patterns in the pediatric population (Bannett et al., 2024).

Finally, Achir et al. (2024) discuss the use of artificial intelligence for the detection and classification of leukemia. The study shows that AI technology is able to improve the accuracy of diagnosis through the analysis of complex medical images. With this solution, early detection of leukemia can be carried out more efficiently, allowing for faster and more appropriate treatment (Achir et al., 2024).

Overall, these articles show that technology plays a very important role in improving access to healthcare, optimizing medical processes, and creating more inclusive health systems. Technological innovations not only provide solutions to physical and geographical barriers, but also open up new opportunities for the transformation of global health systems towards greater efficiency and justice.

Discussion

Technology has been a key driver in public health transformation, especially in improving access to healthcare in hard-to-reach areas or with limited infrastructure. In a global context, innovations such as telemedicine, artificial intelligence (AI), Internet of Things (IoT), and blockchain have shown great potential in overcoming traditional challenges, such as limited healthcare workers, geographical distance, and limited medical logistics. This discussion will outline the impact of technology on access to healthcare, the successful implementation of certain innovations, and strategies to increase the use of technology globally.

Technology and Access to Healthcare in Remote Areas

In rural and remote areas, major challenges in healthcare include a lack of medical personnel, inadequate healthcare facilities, and long distances between where patients live and healthcare providers. Technologies such as telemedicine have been an effective solution in answering this challenge. Telemedicine allows patients to consult a doctor virtually, eliminating the need for long trips. This service is also used to provide follow-up treatment without requiring patients to return to the healthcare facility in person. Some countries such as India and South Africa have used telemedicine to reach populations that previously did not have access to medical services.

In addition, IoT allows the collection of health data from wearable devices, such as heart rate and oxygen level monitoring devices. This

technology makes it easy for patients to independently monitor their health conditions and send data to healthcare providers in real-time. This not only improves the early detection of the disease but also allows for faster treatment in emergency situations.

Success of Innovation in Healthcare

Several examples of successful technological innovations in healthcare show the effectiveness of this technology in improving efficiency and accessibility. One successful example is the use of drones for the delivery of vaccines and medicines to remote areas of Rwanda and Ghana. By using drones, these countries have successfully overcome geographical constraints that are often a major obstacle in the distribution of health logistics. Drones also allow for rapid delivery in emergency situations, such as when blood is needed for transfusions.

AI has become a key technology in improving diagnostic accuracy, especially for chronic diseases such as cancer. In some cases, AI systems have shown a higher level of accuracy compared to human doctors in analyzing medical images. For example, AI-based algorithms are used to detect breast cancer tumors with a significant success rate, which allows for early intervention and improves patient survival rates.

Blockchain also plays a crucial role in ensuring the security and interoperability of health data. With this technology, patient data can be accessed by various healthcare providers without sacrificing privacy, which is a major challenge in the digital age. For example, blockchain-based electronic health record systems allow patients to move from one provider to another without losing their medical history, improving continuity of care.

Strategies to Increase Technological Innovation Globally

Although technology has provided significant solutions, its adoption still faces challenges, especially in developing countries. To increase technological innovation globally, a strategy is needed that includes investment in infrastructure, training of health workers, and the development of supportive policies.

a. Infrastructure Investment
   Adequate digital infrastructure, such as a stable internet network and compatible hardware, is the foundation for the adoption of health technology. The government and the private sector need to work together to ensure extensive connectivity, especially in rural and remote areas.
b. Training of Health Workers
   Technology is only effective if it is used by trained health workers. Intensive training programs on the use of telemedicine, AI, and IoT devices should be a priority. In addition, the digital literacy of the general public also needs to be improved to ensure that technology can be used optimally.
c. Global Collaboration
   International partnerships between developed and developing countries can accelerate the adoption of technology. Technology transfer, best practice sharing, and grants for technology implementation in low-income countries can accelerate global healthcare transformation.
d. Policy Support
   Governments should develop policies that support technology adoption, including incentives for tech companies focused on health innovation, as well as regulations that ensure the security and privacy of patient data. Policies should also include reducing cost barriers to technology implementation,

such as subsidies for telemedicine devices.

e. Focus on Locally-Based Innovation
   Technological innovations must be adapted to local needs. For example, in regions with limited electricity, energy-efficient or solar-powered medical devices can be a solution.

4. CONCLUSION

The conclusion of this discussion confirms that technology plays a very important role in improving access to health services, especially in remote areas or with limited infrastructure. Innovations such as telemedicine, the Internet of Things (IoT), artificial intelligence (AI), and blockchain have shown effectiveness in addressing traditional challenges, including geographical distance, lack of healthcare workers, and complex logistical needs. Successful examples such as the delivery of drones for drug distribution and the use of AI in diagnosis show that technology can provide real solutions to significantly improve the efficiency and effectiveness of healthcare services.

To ensure the sustainability and expansion of the benefits of this technology, a focused strategy is needed. Investments in digital infrastructure and training of healthcare workers are key to accelerating the adoption of technology globally. In addition, international collaboration and policies that support innovation, including subsidies and regulations that protect the security of patient data, are essential to creating a more inclusive health system. A focus on developing technology solutions tailored to local needs should also be a priority to ensure successful implementation in different regions with unique challenges. With an integrated and local needs-oriented approach, technology has the potential to not only improve access to healthcare but also create a more resilient, equitable, and sustainable global health system.

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