The Role of Technology in Enhancing Public Health Initiative: Utilization of Technological Advancements, Such as Telemedicine or Health Apps, in Improving Healthcare Accessibility and Outcomes

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ABSTRACT

Introduction: The study explores the use of technology, specifically telemedicine and health apps, in improving public health initiatives in Nigeria. It focuses on their role in delivering quality healthcare services, highlighting the challenges and ways to overcome them to enhance healthcare accessibility and outcomes. **Method:** A descriptive survey design was used. The population of this study comprised all healthcare professionals (doctors and nurses) in the 2160 health centres in Anambra State. The sample size consisted of 500 healthcare providers using the multi-stage sampling technique. A structured questionnaire, the "Role of Technology in Enhancing Public Health Initiative Questionnaire" (RTEPHIQ), was developed and validated. The Cronbach Alpha Method was used to determine internal reliability, with coefficient values of 0.77, 0.82, and 0.75 for clusters I, II, and II respectively. Descriptive statistics were used to analyze data and determine homogeneity or heterogeneity. **Findings:** Healthcare professionals in Nigeria agreed that telemedicine and mobile apps such as Babylon Health, Ada Health, Safe Mother, and Pocket Doctor are essential for providing quality healthcare services. However, challenges like inadequate internet infrastructure, limited smartphone availability, and high data costs hinder access to these technologies. It was found that healthcare professionals agreed on the need for improved infrastructure and data availability to enhance public health initiatives in Nigeria. **Recommendations:** The Nigerian Government and healthcare institutions should invest in robust telemedicine infrastructure, including high-speed internet connectivity and secure platforms, to ensure widespread access to telemedicine services, especially in remote or underserved areas.

Keywords: Technology, Public Health, Telemedicine, Health Apps, Healthcare

INTRODUCTION

Healthcare is a growing concern in Africa due to the spread of diseases. In 2015, the United Nations Headquarters in New York introduced and adopted new global Sustainable Development Goals (SDGs), with Goal three focusing on ensuring healthy lives and promoting well-being for all ages. The goals include reducing global maternal mortality, preventing newborn and child deaths, ending epidemic diseases, reducing communicable diseases, reducing global deaths, ensuring universal access to reproductive healthcare services, and achieving Global Health Coverage (Ekanoye, Ayeni, Olokunde, Nina, Donalds & Mbarika, 2017). The authors reiterated that despite the benefits of information technology, it has been largely overlooked in the Nigerian health sector.

Preventable diseases and premature deaths continue to be prevalent in developing countries like Nigeria, with inequity in access to basic health services affecting different regions, communities, and social groups. Under-financing in the health sector has led to service delivery deficiencies and growing gaps in facility and

equipment maintenance. Inefficient resource allocation and lack of coordination among stakeholders have resulted in duplication of efforts, overlapping responsibilities, and resource wastage (Amit, 2023). Most countries are currently in the process of health sector reform to provide expanded access to quality services (Egbewande, Oladipo, Olowolagba & Iyiola, 2023).

However, ICTs have the potential to make a major contribution to improving access and quality of services while containing costs. Improving health involves improving public health and medical programmes designed to provide elective, emergency and long-term clinical care, educating people, improving nutrition and hygiene, and providing more sanitary living conditions (Egbewande, et al., 2023). These in turn ultimately involve massive social and economic changes, as many health challenges go well beyond the health sector. The health sector has always relied on technologies. According to Word Health Organization (2023), they form the backbone of the services to prevent, diagnose and treat illness and disease. ICTs are only one category of the vast array of technologies that may be of use.

ICTs can be powerful tools for improving health, provided the right policies, organization, resources, and institutions are in place. Advances in technology in the last quarter of the 20th century have enabled more accurate health risk profiling, better understanding of basic physiologic and pathologic processes, and revolutionizing diagnosis through new imaging and scanning technologies (Okezie, Ahukannah, Onuka, Omas, Kanu, Tega & Macaulay, 2021). However, this development requires increased responsibility from practitioners, managers, and policy-makers for assessing the appropriateness of new technologies. Communication methods have also changed significantly, with mobile telephony, electronic mail, and videoconferencing offering new perspectives (Mbunge, Muchemwa & Batani, 2022).

It is important to note that technology has been instrumental in improving healthcare accessibility and outcomes in Nigeria, addressing challenges such as geographical barriers, limited infrastructure, and disparities in healthcare services. Authors such as Adenuga, Iahad, and Miskon (2020); Monaghesh and Hajizadeh (2020) addressed technological advancements such as telemedicine, and mobile health (health apps) as improving accessibility, enhancing patient engagement, and improving health outcomes. These technological advancements contribute to addressing healthcare challenges, promoting preventive care, and creating a more inclusive and efficient healthcare system.

Telemedicine is a subset of telehealth, which distributes health services using information and communication technologies (ICT) (Mbunge, et al., 2022). The authors stressed further that telemedicine supports and promotes long-distance healthcare, and such innovations can reduce routine physical interaction and direct hospitalization while significantly enhancing the delivery of high-quality healthcare services. Studies have found willingness to adopt telemedicine in countries like Nigeria with resource-poor settings and hard-to-reach populations (Akintunde, Akintunde, Musa, Sayibu, Tassang & Reed, 2021). However, using telemedicine in Nigeria is still nascent, possibly due to some critical factors.

Mobile health (mHealth) applications, commonly known as health apps, present a viable alternative option for delivering quality healthcare services in Nigeria. Given the widespread adoption of mobile devices and increasing internet connectivity, leveraging health apps can enhance accessibility, efficiency, and overall healthcare outcomes. These apps can enhance health education, facilitate remote consultations, streamline appointment scheduling, manage medication, support chronic disease management, integrate with wearable devices for continuous health monitoring, provide emergency services, offer telepsychiatry and mental health support, and support maternal and child health (Adeloye, David, Olaogun, Auta, Adesokan & Gadanya, 2017). They can also provide pregnancy tracking, postnatal care guidance, and child vaccination schedules, thereby improving overall well-being. Additionally, health apps can incorporate chatbots to provide instant responses to health-related queries. Overall, health apps can significantly improve healthcare accessibility, efficiency, and overall outcomes in Nigeria.

Telemedicine and health apps play a significant role in public health initiatives, but they face several challenges. These include limited infrastructure, digital divide, regulatory and legal challenges, healthcare provider resistance, user engagement, data security, equity, interoperability, cultural and behavioral factors, emergency and critical care limitations, reimbursement and financial barriers, quality of care concerns, integration with traditional healthcare, resistance from traditional providers, and educational and training gaps (Aregbeshola, 2019). Overcoming these challenges is crucial for maximizing the benefits of technology in healthcare.

To improve healthcare accessibility and outcomes with telemedicine and health apps, a multifaceted approach is needed. Strategies include infrastructure improvement, digital inclusion programs, policy and regulatory frameworks, healthcare provider training, user-friendly interfaces, data security measures, equitable access programs, public-private partnerships, and cultural sensitivity in health apps (Akmal & Pritchett, 2019). Infrastructure improvements include investing in internet connectivity, providing technology subsidies, and implementing digital literacy programs. Digital inclusion programs target all age groups and engage local communities in awareness campaigns. Clear regulations and cross-border collaboration are essential for legal compliance and seamless provision of telemedicine services. Therefore, this study explores the technological advancement such as mobile health as alternatives option for delivering quality healthcare services in Nigeria, the challenges hindering the utilization, and ways to overcome those challenges.

Statement Problem

In the 21st century, effective public health interventions include standard healthcare delivery, affordability, and access to health information. However, Nigeria's health status is concerning, with high maternal mortality rates and a low life expectancy. The WHO (2023) reports that maternal mortality is 608 per 100,000 live births, twice as high as South Africa's 300 per 1,000 and almost 10 times higher than Egypt's 66 per 1,000. Healthcare is a crucial and expensive sector in any economy, and Nigeria is yet to fully adopt technology in healthcare delivery. The successful implementation of telemedicine and health apps necessitates a certain level of technological literacy among both healthcare providers and the general population. Gaps in digital literacy may hinder effective utilization and lead to disparities in technology-driven healthcare. Thus, in order to provide Nigerians with high-quality healthcare, this study investigates technology advancements like mobile health. Specifically, the study seeks to:

1. Explore the roles of telemedicine and mobile apps for delivering quality healthcare services in Nigeria

2. Determine the challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria

3. Ascertain ways to overcome these challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria

Research Questions

1. What are the roles of telemedicine and mobile apps for delivering quality healthcare services in Nigeria?

2. What are the challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria?

3. What are the ways to overcome these challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria?

REVIEW OF LITERATURE

Overview of Nigeria's Telemedicine Infrastructure

In 2003, the Nigerian Communications Satellite Limited (NIGCOMSAT LTD) and China Great Wall Industry Corporation (CGWIC) signed a contract for the design, manufacture, and launch of the NigComSat-1 satellite (Molefi, 2015). The satellite provided links for Nigerian caregivers to consult with medical providers worldwide. In 2007, the National Space Research and Development Agency (NASRDA) and the Nigerian Ministry of Health began a pilot project using telemedicine to improve care in rural areas (Akintosin, 2015). However, the satellite failed due to technical errors from its northern solar array in 2008, leading to a delay in operations. In 2009, Nigeria signed another contract with the Chinese government for the launch and delivery of a replacement satellite called NIGCOMSAT 1R (Krebs, 2016). The new satellite was delivered and launched in December 2011.

Technology advancements have helped overcome the challenge of designing and sustainability of telemedicine systems in developing countries. ZYcom GlobalMed, a US-based corporation, partners with Zycom GlobalMed to leverage fiber optic infrastructure around Africa, specifically Nigeria, to integrate a wireless fiber optic NODE network backhaul. This has revolutionized telemedicine by creating a stable network for video conferencing and providing an effective telemedicine solution at an affordable cost. Nigeria is one of the most populated and economically developed nations on the African Continent, with telemedicine delivering over $6 billion a year in healthcare savings to U.S.-based corporations (Watson, 2014). Employers are expected to offer telemedicine consultations as a low-cost alternative to emergency room or physician office visits for nonemergency health issues. Telemedicine equipment used includes telemedicine carts, kiosks, digital cameras, kits, software, and mobile medical devices (Awosanya, 2015).

Overview of Health Apps in Nigeria's Healthcare System

Health apps have become essential tools in the healthcare landscape, providing personalized resources and enhancing healthcare outcomes. They help manage chronic conditions like diabetes, heart health, and hypertension, as well as medication adherence. Fitness and wellness apps track physical activity and provide nutritional guidance for improved well-being (Aginam, 2015). Mental health support apps help users monitor emotional well-being and manage stress and anxiety. Telemedicine apps facilitate remote consultations with healthcare professionals, while prescription renewal apps enable users to request and receive digital prescriptions for non-emergency situations (Mugglestone, 2016).

Women's health apps track menstrual cycles, ovulation, and fertility for family planning and pregnancy. Electronic Health Record (EHR) apps store and access health records, fostering better communication with healthcare providers. Symptom checker apps help users assess symptoms and provide initial guidance on seeking medical attention. Condition-specific education apps offer information and resources for managing specific health conditions (Benson & Cole, 2011).

Wearable device integration allows for real-time health data collection and continuous monitoring of vital signs, supporting preventive care and early detection of health issues. All-in-one health platforms integrate fitness tracking, health records, and telemedicine services for a holistic approach. Personalized health plans provide tailored health plans based on user data and preferences. Benefits of health apps include accessibility, personalized features, patient empowerment, preventive care, data-driven insights, and challenges such as data security, digital divide, and regulatory compliance (WHO, 2015). However, health apps play a pivotal role in improving healthcare outcomes by empowering individuals, promoting preventive care, and facilitating better communication between users and healthcare providers. As technology advances, the integration of health apps into healthcare ecosystems is expected to further

enhance patient engagement and overall healthcare effectiveness (VSee, 2016).

METHODOLOGY

This study adopted a descriptive survey research design. This study was conducted in Anambra State. The population of this study comprised all healthcare professionals (doctors and nurses) in the 2160 health centres in Anambra State (https://hfr.health.gov.ng/facilities/hospitals-list?page=155). The sample size consisted of 500 healthcare providers using the multi-stage sampling technique. A structured questionnaire was developed by the researcher. The questionnaire was comprehensive, culturally sensitive, and designed to capture a wide range of perspectives. The questionnaire was titled **"Role of Technology In Enhancing Public Health Initiative Questionnaire"** (RTEPHIQ). This questionnaire was divided into two sections; A and B. Section A comprised of demographic information of the respondents while section B was sub-divided into three clusters. Cluster I contained items on the roles of telemedicine and mobile apps; cluster II contained items on the challenges hindering the utilization of telemedicine and mobile apps; cluster III contained items on ways to overcome these challenges hindering the utilization of telemedicine and mobile apps. The instrument was structured on a 4-point Likert scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) with values 4, 3, 2 and 1 respectively.

The instrument was subjected to face validation by three experts. Crobach Alpha Method was used to determine the internal reliability of the instruments and co-efficient values of 0.77, 0.82 and 0.75 were obtained for clusters I, II and II respectively. The researcher used Google form to send the copy of the questionnaire to some of the healthcare professionals while on-the-spot delivery was used to retrieve copies of the questionnaire for respondents available. Descriptive statistics of mean was used to analyze data to answer the research questions while standard deviation was used to determine the homogeneity or heterogeneity of the respondents' mean. The criterion mean score was the basis for decision making; a threshold of 2.50 formed the benchmark for decision making. Any mean score below 2.50 benchmark is rated disagreed while mean scores above 2.50 is rated agreed.

RESULTS

Research Question 1: What are the roles of telemedicine and mobile apps for delivering quality healthcare services in Nigeria?

Table 1: Respondents' ratings on the roles of telemedicine and mobile apps for delivering quality healthcare services in Nigeria

S/N	Items on the roles of telemedicine and mobile apps for delivering quality healthcare services in Nigeria	X	SD	Remarks
1	I believe that telemedicine can improve the efficiency of healthcare delivery in Nigeria	2.98	0.87	Agree
2	Telemedicine is a valuable tool for reaching remote and underserved areas in Nigeria	2.66	1.14	Agree
3	The integration of telemedicine can enhance the overall quality of healthcare services in Nigeria	2.95	1.06	Agree
4	Mobile healthcare apps contribute to better health awareness and education in Nigeria	3.33	1.03	Agree
5	I believe that health-related mobile apps can facilitate preventive care and lifestyle management	2.55	1.02	Agree

6	I feel confident in the accuracy of health information provided by mobile healthcare apps	2.31	0.96	Disagree
	Cluster Mean	**2.68**		**Agree**

Data in Table 1 reveals that item 6 with mean score 2.31 was rated disagreed by the respondents. This could mean that not all mobile healthcare apps undergo rigorous validation or adhere to medical standards. Healthcare professionals may be skeptical about the accuracy of information provided by apps that lack proper validation or are not developed by reputable sources. The result revealed that items 1 – 5 with their respective mean scores of 2.98, 2.66, 2.95, 3.33, and 2.55 were rated agreed by respondents. The cluster mean of 2.68 explained that healthcare professionals agreed on the roles of telemedicine and mobile apps for delivering quality healthcare services in Nigeria.

Research Question 2: What are the challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria?

Table 2: Respondents' ratings on the challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria

S/N	Items on are the challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria	X	SD	Remarks
7	Inadequate internet infrastructure in some regions hinders telemedicine and mobile app access	2.78	1.01	Agree
8	Limited availability of smartphones and digital devices poses a barrier to accessing telemedicine and mobile healthcare apps	2.79	1.04	Agree
9	The cost of data for using telemedicine and mobile healthcare apps is prohibitive for many individuals	2.67	1.03	Agree
10	Lack of awareness about the existence and benefits of telemedicine services and healthcare apps	2.86	0.96	Agree
11	Concerns about the accuracy of diagnoses and treatment provided through telemedicine	2.66	0.99	Agree
	Cluster Mean	**2.75**		**Agree**

Data presented in Table 2 reveals that all items (7 – 11) with mean scores 2.78, 2.79, 2.67, 2.86 and 2.66 were rated agreed by respondents. The cluster mean of 2.75 summarized that healthcare professionals agreed on the challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria.

Research Question 3: What are the ways to overcome these challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria?

Table 3: Respondents' ratings on ways to overcome these challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services

S/N	Items on ways to overcome these challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services	X	SD	Remarks
12	Improving internet infrastructure in underserved regions to enhance access to telemedicine and mobile healthcare apps.	3.41	0.54	Agree

13	Conducting awareness campaigns to educate the public about the benefits of telemedicine services and healthcare apps	3.18	0.69	Agree
14	Implementing protocols and standards to ensure the accuracy and reliability of diagnoses through telemedicine	2.72	0.99	Agree
15	Allocating funding and resources for the development and maintenance of sustainable healthcare apps	2.67	0.88	Agree
16	Expanding access to comprehensive medical examinations and tests through technological advancements.	3.18	0.89	Agree
	Cluster Mean	**3.03**		**Agree**

Data analysis in Table 3 reveals that all the items mean scores 3.41, 3.18, 2.72, 2.67 and 3.18 were rated agreed by the respondents. The cluster mean of 3.03 summarized that healthcare professionals agreed on the ways to overcome these challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria.

DISCUSSION OF FINDINGS

The finding in research question one revealed that healthcare professionals agreed on the roles of telemedicine and mobile apps for delivering quality healthcare services in Nigeria. This means that healthcare professionals acknowledge and recognize the value that telemedicine and mobile apps bring to the healthcare system. They see these technologies as important tools that can enhance the delivery of healthcare services. This finding agreed with the finding of Akintosin (2015) that there is acceptance and openness among healthcare professionals toward adopting and integrating telemedicine and mobile apps into their practices. They may view these technologies as complementary to traditional healthcare methods. The finding of Amit (2023) supported that healthcare professionals may believe that telemedicine and mobile apps can contribute to the efficiency of healthcare delivery by streamlining processes, reducing wait times, and providing convenient options for both healthcare providers and patients.

The finding in research question two revealed that healthcare professionals agreed on the challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria. This means that healthcare professionals are collectively aware of the specific challenges that impede the effective utilization of telemedicine and mobile apps. This suggests a shared understanding of the complexities involved in implementing these technologies. This finding was in line with the study of Amit (2023) that challenges for telemedicine include inadequate communication between physicians and patients: Factors such as a shortage of doctors, busy schedules, and limited time contribute to strained doctor-patient relationships. Disparities in health-care services based on location, ethnicity, and social status worsen the issue. The study of Gajarawala and Pelkowski (2021) agreed that limited access to reliable internet connectivity and electricity in rural areas hinders the widespread adoption of telemedicine. There is also a shortage of trained health-care professionals who can effectively use telemedicine technologies.

The finding in research question three revealed that healthcare professionals agreed on the ways to overcome these challenges hindering the utilization of telemedicine and mobile apps for delivering quality healthcare services in Nigeria. This means that healthcare professionals have identified and agreed upon practical solutions to address the specific challenges hindering the use of telemedicine and mobile apps. This suggests a proactive approach to overcoming obstacles rather than mere acknowledgment. This finding was in tandem with the finding of Haleem, Javaid, Singh and Suman (2021) that healthcare professionals have engaged in strategic planning. They have identified actionable steps and devised a plan for implementing these solutions to enhance the utilization of telemedicine and mobile apps.

CONCLUSION

The role of technology, particularly the utilization of advancements such as telemedicine and health apps, plays a pivotal role in enhancing public health initiatives by improving healthcare accessibility and outcomes. The examination of technological advancements in this context reveals a transformative impact on the way healthcare services are delivered and experienced. Based on the findings of the study, it was concluded amongst others that healthcare professionals agreed on the roles of telemedicine and mobile apps for delivering quality healthcare services in Nigeria.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made:

1. Nigerian Government and healthcare institutions should invest in robust telemedicine infrastructure, including high-speed internet connectivity and secure platforms. This will ensure widespread access to telemedicine services, particularly in remote or underserved areas.
2. Nigerian Government should implement digital literacy programs to educate both healthcare professionals and the general population on effectively using telemedicine and health apps. This will empower individuals to leverage technology for better health outcomes and enhance the efficiency of healthcare providers in utilizing these tools.
3. Health apps should be designed with a user-centric approach, considering the diverse needs and preferences of the user base. Incorporate features that enhance user engagement, provide personalized health information, and encourage adherence to healthy behaviors.
4. Nigerian Government should implement incentive programs for healthcare providers to encourage the adoption of telemedicine practices. This could include financial incentives, professional development opportunities, or recognition for successful integration of technology into their healthcare delivery.

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