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Perspective

Digital innovation in maternal and child health in Nigeria: Impacts, challenges and opportunities – a perspective

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Abstract
Nigeria faces critical Maternal and Child Health (MCH) challenges, worsened by inadequate infrastructure and limited access to quality care. Digital health innovations like mHealth, artificial intelligence (AI), blockchain, and gamification can improve access, decision-making, and patient engagement. This paper examines their impact on MCH services, including immunization, prenatal care, and maternal education. However, poor infrastructure, high costs, and low digital literacy hinder adoption. Expanding digital healthcare requires investments, policy reforms, partnerships, and community initiatives. Scalable, affordable solutions can enhance MCH outcomes, supporting universal health coverage and sustainable development goals in Nigeria.
Keywords: Maternal health, Child health, Mobile application, Artificial intelligence, Gamification, Blockchain, Immunization, Health policy

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Introduction

Nigeria has one of the world's poorest indices of maternal health, with an infant mortality rate of 67 per 1000 live births and a maternal mortality ratio (MMR) of 512 per 100 000 live births.[1] Numerous social and economic factors, a weak healthcare system, and limited infrastructure make it difficult to improve maternal healthcare in the country and achieve optimal healthcare system performance.[2] The World Health Organization (WHO) acknowledges that the implementation of digital health initiatives is often a top priority across Africa.[3] However, most of these programs are still in the pilot or informal stages. Few of them create ventures that are sustainable and scalable. This opinion was confirmed by international health specialists who took part in a virtual round table discussion on increasing the use of digital technologies for maternal health in low-income nations.[4] The reductions in low birth weight, preterm birth, and maternal and neonatal death rates brought about by the adoption of digital healthcare technologies are indicators of the progress gained in mother and infant health in Nigeria over the past few decades. These technologies include short-message service (SMS)-based technologies, websites, mobile applications, and decision support systems for prenatal and maternal, neonatal, and child health care. This paper examines how digital innovations like mHealth, artificial intelligence (AI), blockchain, and gamification can improve maternal and child health (MCH) in Nigeria. It explores their potential to enhance healthcare access, delivery, and engagement while addressing challenges to implementation. The study also provides policy recommendations to ensure sustainable and equitable integration of these technologies into Nigeria's MCH system.

Impacts of digital innovation in maternal and child health in Nigeria

Numerous studies have proven the use of SMS text messages delivered to mothers in Nigeria to ensure timely completion of routine immunization (RI).[5,6] Additionally, using predefined codes that automatically fill a dashboard in the DHIS 2 platform, it has been utilized to send RI data sessions via text to offer real-time updates of the performance of the RI services at the health facility (HF).[7] The use of digital innovation in healthcare has been applied in HF to enhance the service delivery of facility health workers (FHWs) through improved standards of care, increased adoption of e-health in the performance of duties, and increased staff confidence in performing healthcare roles in the MCH setting. This was accomplished through the use of video training applications, decision support, and point-of-care data

capturing tools for FHW teaching and training.[8] This reiterates the improved efficiency encountered when digital innovation is adopted in healthcare.

Furthermore, there has been some growing interest in recent years to investigate the possible application of AI in various areas of MCH care delivery, outside of the primarily focused efforts of technical advancements to patient record administration and HF staff education.[9] The use of AI chatbots for prenatal services has been investigated for its potential advantages in easing the time and pressure for high-quality care on HF staff and patients. A positive step toward bettering healthcare systems, this possible application of the technology in MCH goes beyond its extensively used applications in marketing, education, and business. It merits more research.[9]

Additionally, the area of advocacy in MCH has also been impacted by advancements in technological innovation. Social media has been a crucial tool in Nigeria's MCH advocacy efforts. The fact that the entertainment industry has become so powerful that it is now second only to Hollywood and Bollywood explains why superstars receive so much attention. They accomplish the objectives of the advocates who involved them in the advocacy process since celebrity advocacy has been shown to be very successful, and their messages are more widely disseminated due to their status and the size of their social media following.[10]

Challenges and barriers

Despite the fact that digital health programs are being created and executed globally to enhance mother and child health,[11] they have not been widely adopted or implemented in Sub-Saharan African nations.[12] The few studies that concentrate on providers highlight issues such as phone maintenance, internet connection, electricity, and technical issues.[13] Research shows that variables impacting adoption among healthcare professionals include risk-benefit analyses, convenience of use, cost, time, privacy/security concerns, and technological familiarity.[14] Other studies' findings have demonstrated that even if they are prepared to use mHealth technology to provide services, certain healthcare professionals—especially nurses and midwives—may find the expense of the airtime and internet data required to be too onerous.[14-16] Additionally, Nigeria's poor electrical supply has a significant impact on the adoption of digital health technology. Health care providers' enthusiasm and readiness to embrace new technologies are dampened by this and a host of other factors.[17] Cognitive, motivational, accessibility, educational, and trust-related barriers are examples of individual and personal barriers that can affect how consumers, particularly non-healthcare professionals, relate to and accept these technologies.[18] Environmental and organizational barriers that continue to impede the country's adoption and scaling of digital health innovations include things like organizational structures, political obstacles, financial concerns, national policies and laws pertaining to the use of digital health technology applications, inadequate leadership, management, and governance, and the current government's attitude.[17]

Opportunities of digital innovation in maternal and child health in Nigeria

Expansion of mHealth services

Integrating mHealth tools offers significant potential to bridge MCH gaps, especially in Nigeria's underserved and rural areas. Mobile applications are now effectively addressing critical health challenges by offering expert guidance, community support, and access to healthcare professionals in low- and middle-income countries.[19] These tools empower expectant mothers to monitor their health by recording vital metrics like weight, blood pressure, and foetal movements, aiding in the early detection of conditions such as preeclampsia.[20] Wearable devices add another layer of support by offering continuous monitoring of vital signs and delivering real-time alerts, which is invaluable in areas where access to healthcare facilities is limited.[21] The ability to schedule appointments, adhere to medication plans, and engage with educational resources ensures that even the most geographically isolated women have access to essential prenatal and postnatal care.

The educational content on mHealth platforms equips mothers with actionable knowledge about nutrition, vaccinations, and neonatal care, fostering informed decision-making and reducing preventable health complications. Additionally, virtual consultations and forums connect users with healthcare professionals and peers, addressing logistical and cultural barriers that might hinder in-person interactions.[22] In Nigeria, where healthcare access is often constrained, mHealth platforms bridge gaps in health literacy and care delivery by providing essential knowledge about MCH. These tools help reduce malnutrition, preventable diseases, and pregnancy complications while enabling virtual consultations and fostering supportive communities. By addressing logistical and cultural barriers, mHealth platforms enhance MCH outcomes, particularly in underserved areas.

Integration of artificial intelligence

AI is transforming MCH by addressing gaps in traditional systems, particularly in rural areas. Platforms like Ada Health and Baby Scripts exemplify innovative solutions for early risk detection and personalized care.[23] These platforms can significantly enhance the early identification of maternal health risks in underserved regions, which is crucial for reducing maternal and child mortality rates through timely interventions. Additionally, AI-driven tools are improving analytics, risk assessment, and

patient engagement, offering personalized care plans and better outcomes.[24] Such tools are particularly valuable in regions with limited healthcare access, where they can help address the shortage of healthcare professionals by automating risk assessments and providing data-driven care plans.

AI algorithms that analyse extensive patient data, including medical histories and real-time health indicators, are able to detect high-risk conditions like preeclampsia, gestational diabetes, and preterm labour.[25] In contexts like Nigeria, these algorithms allow healthcare providers to identify complications earlier, even in remote areas, facilitating timely referrals and interventions that prevent adverse outcomes.

AI-powered tools also enhance diagnostic capabilities, such as analysing ultrasound images to detect foetal abnormalities, enabling early diagnosis and personalized care. This ensures prompt and targeted interventions, improving both maternal and foetal health outcomes.[19] These advancements are particularly beneficial in rural hospitals and clinics in Nigeria, where access to specialized diagnostic services is often limited. AI-enabled virtual assistants provide remote consultations, health education, and real-time support, streamlining care and increasing patient engagement.[26] These virtual assistants can expand access to health education and consultations, especially in remote areas where healthcare infrastructure is inadequate, empowering women to manage their health more effectively

Furthermore, AI systems that integrate patient health histories, genetic profiles, and current conditions can offer tailored care recommendations, improving diagnostic accuracy and customizing treatment plans.[27] This integration optimizes care delivery for diverse populations, ensuring responsiveness to individual needs, particularly in high-risk pregnancies among the Nigerian population.

Blockchain integration for health records

Blockchain technology offers transformative potential for managing MCH data through decentralization, transparency, and security. However, high implementation costs and the need for robust digital infrastructure present significant barriers.[28] Overcoming these barriers could revolutionize healthcare management in Nigeria by ensuring secure, transparent, and efficient systems to manage MCH data, particularly in rural areas with fragmented healthcare infrastructure.

By storing data in encrypted blocks linked via a distributed ledger protocol, blockchain ensures data integrity and accessibility across various healthcare providers.[29] In Nigeria, where healthcare providers often face challenges accessing and sharing patient data, blockchain could facilitate seamless integration across facilities, enhancing care coordination, especially in underserved regions.

Blockchain's decentralized nature prevents unauthorized control and allows secure sharing of sensitive health data, such as prenatal care records and vaccination schedules, among healthcare providers.[30] In the Nigerian context, this capability could safeguard MCH data, ensuring that sensitive information is shared securely across healthcare facilities while preventing data breaches or unauthorized access.

Cryptographic hash functions protect patient confidentiality, granting access only to authorized individuals, such as medical professionals involved in care.[31] For Nigeria, this can strengthen patient privacy, particularly in rural areas where access to secure health information systems may be limited. This would empower healthcare professionals to manage MCH data with confidence, knowing it is protected from unauthorized use.

Smart contracts can automate consent management, empowering mothers to control access to their health data and its use.[32] In Nigeria, where informed consent and patient autonomy may not always be adequately emphasized, blockchain-powered smart contracts can enable mothers to make informed decisions about their health data and its sharing, promoting trust and autonomy in healthcare.

Furthermore, blockchain ensures the traceability and security of healthcare supplies like vaccines and prenatal vitamins, improving their sourcing, storage, and distribution.[33] In Nigeria, this capability could address issues of counterfeit medicines and vaccine shortages, ensuring that MCH interventions are based on safe, effective, and properly sourced supplies, ultimately improving healthcare quality.

Gamification

Gamification, or the use of game design elements to enhance learning, engagement, and knowledge retention, can improve MCH outcomes. For instance, apps like BabyCenter and My Pregnancy Today incorporate rewards and educational games to boost engagement.[34] These types of gamified apps can help overcome challenges related to low literacy levels and limited access to healthcare in Nigeria by providing accessible, engaging, and educational content that encourages proactive participation in maternal health and child care, especially in remote areas where traditional healthcare delivery is limited.

By incorporating elements such as rewards, challenges, and leader boards, gamification boosts motivation and participation in prenatal education, monitoring, and postnatal care.[35] In Nigeria, where attendance at antenatal clinics may be inconsistent due to distance, cost, or cultural factors, gamified apps can incentivize pregnant women to engage in regular healthcare activities, improving health outcomes by promoting consistent monitoring and early detection of risks.

Gamified apps can provide immediate feedback and rewards for healthy behaviours, such as attending antenatal clinics or adhering to recommended health practices, while also detecting risks like early preeclampsia. Additionally, virtual communities can support postnatal care and breastfeeding, and gamified tools can assist with child immunization tracking, ensuring timely notifications.[36] In Nigeria, virtual communities and gamified tracking systems can enhance postnatal care by supporting breastfeeding and ensuring timely immunizations, improving child health outcomes. These tools also encourage timely prenatal check-ups and adherence to medical recommendations, helping to identify complications early and reduce maternal mortality. By addressing barriers to consistent healthcare access, gamification can significantly improve MCH outcomes in the country

Gamification can also aid in maternal mental health through mood tracking and relaxation exercises, while educating parents on essential infant care practices, reducing risks such as malnutrition and sudden infant death syndrome (SIDS).[35] In Nigeria, where mental health resources may be scarce, gamified tools can offer essential support for maternal mental health, promoting emotional well-being and improving infant care knowledge, which helps reduce preventable risks such as malnutrition and SIDS.

Recommendations and future directions

To enhance MCH outcomes in Nigeria, it is essential to prioritize the integration of AI and mobile health (mHealth) tools into rural healthcare systems. Policymakers should address funding challenges by providing subsidies and tax incentives to healthcare providers adopting these technologies. Additionally, establishing public-private partnerships can attract investments and facilitate resource-sharing to scale up digital health solutions.

Infrastructure challenges, such as limited internet connectivity and inadequate energy supply in underserved areas, should be tackled through targeted investments in telecommunications, renewable energy solutions, and healthcare facility upgrades. Governments must also create policies encouraging rural healthcare providers to adopt these technologies while setting robust data management and technology use standards to ensure privacy and security.

Capacity-building initiatives should focus on equipping rural healthcare workers with the skills to effectively use AI-powered tools, mHealth apps, and wearable devices. Community education programs are crucial to raising awareness about the benefits and functionalities of these technologies, fostering trust, and ensuring proper utilization. Training local teams in developing, deploying, and maintaining these solutions is vital for long-term sustainability.

Collaborative efforts among stakeholders, governments, non-profits, private organizations, and local communities are necessary to drive innovation, share best practices, and ensure inclusivity in digital health interventions. Community engagement in co-designing tools can improve adoption rates, while participatory platforms for feedback will help refine these technologies based on user experiences.

Continuous research and development are needed to improve the effectiveness of AI and mHealth technologies in addressing MCH challenges. Innovations such as predictive analytics, maternal health apps, and wearable devices should be tailored to the cultural and contextual needs of rural populations. Gamification techniques can make these solutions more engaging and enhance health literacy, while robust monitoring systems can track their impact and guide improvements.

Sustainability requires long-term funding from public and private sectors to support infrastructure and operational needs. Evaluating the cost-effectiveness, scalability, and long-term impact of digital health solutions is essential for informed decision-making. By addressing barriers such as cultural resistance and economic constraints, these interventions can become more accessible and impactful.

With strategic investments, policy reforms, and collective action, Nigeria can create a conducive environment for the adoption of digital health innovations. Empowering local communities through digital literacy programs and ensuring inclusivity will further enhance the success of these initiatives. By leveraging technology effectively, Nigeria can significantly improve MCH outcomes, contributing to universal health coverage and sustainable development goals.

Conclusion

The integration of mHealth, AI, and blockchain technologies into MCH holds immense potential to transform health outcomes by improving risk assessments, supporting personalized care, and ensuring secure data management. These innovations can address critical healthcare challenges in underserved regions by providing timely and accurate information. However, their success depends on overcoming barriers such as poor infrastructure, high costs, limited literacy, and policy gaps. Strategic investments in infrastructure, affordability, digital literacy, and comprehensive policy frameworks are essential. By focusing on scalable, affordable, and culturally appropriate solutions like mobile health apps and telemedicine, Nigeria can significantly enhance MCH and bridge healthcare gaps in underserved areas.

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