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# Enhancing Nigeria's health surveillance system: A data-driven approach to epidemic preparedness and response

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## Abstract

**Introduction:** Comprehensive health surveillance systems are needed to identify, monitor, and manage infectious disease outbreaks. Deficits in disease surveillance have resulted in poor resource allocation, high rates of morbidity and mortality, and delays in responding to epidemics in Nigeria. Incorporating cutting-edge technologies such as electronic reporting systems, mobile health (mHealth) applications, artificial intelligence (AI), and geospatial mapping offers a revolutionary chance to fortify Nigeria's health surveillance infrastructure in light of the expanding global adoption of digital health innovations. This article evaluates the advantages and disadvantages of Nigeria's present health surveillance system, examines the role of digital technology in epidemic planning and response, and suggests using digital technologies to enhance disease monitoring and control.

**Materials and Methods:** This study adopted a PRISMA-compliant systematic review technique to guarantee an organised and complete examination of available material. Data were sourced from multiple electronic databases, including Web of Science, Scopus, IEEE Xplore, ACM Digital Library, and Google Scholar, using targeted search terms such as "health system surveillance," "digital health innovations," "electronic reporting system," "data-driven approach," and "epidemic preparedness." Inclusion criteria comprised peer-reviewed journal papers, conference proceedings, and book chapters published in English between 2010 and 2020, concentrating on health monitoring, digital innovations, and pandemic preparation. Studies missing actual evidence or presenting just expert opinions were rejected. A total of 1,697 items were initially retrieved, with 1,375 remaining after duplication elimination. Through title and abstract screening, 798 articles were removed, and additional quality evaluation led to a final selection of 205 suitable sources. Data were retrieved using a standardized pro forma, collecting crucial data such as research objectives, procedures, findings, and consequences. The study employed theme synthesis and narrative synthesis methodologies, supported by the Critical Appraisal Skills Programme (CASP) and Mixed Methods Appraisal Tool (MMAT), to promote validity and reliability.

**Results:** Findings from the comprehensive study revealed that Nigeria's health monitoring system exhibits severe shortcomings, including insufficient infrastructure, inadequate digital reporting procedures, poor internet penetration in remote regions, and limited implementation of AI-driven predictive modeling. However, worldwide best practices reveal that digital technologies have considerably increased epidemic response in other nations. Notable examples include India's Aarogya Setu mobile surveillance system, AI-powered illness tracking in South Korea, and geospatial mapping tools utilised in the United States for the COVID-19 response. The paper also shows that Nigeria's Surveillance Outbreak Response Management and Analysis System (SORMAS), although promising, is underutilized owing to

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infrastructural limitations, poor health worker training, and policy inadequacies. The convergence of AI-driven analytics, cloud-based health surveillance, and mobile-based community reporting systems has the potential to overcome existing gaps and improve Nigeria's epidemic preparation.

**Discussion:** Comparative research with other countries highlights the importance of investing in digital infrastructure and implementing legislative changes to improve disease surveillance. Stronger epidemic response skills have been demonstrated by nations with interoperable digital platforms, AI-driven early warning systems, and contemporary electronic health records (EHRs). Effective disease monitoring and response have been hampered by Nigeria's digital divide, disjointed surveillance networks, and low rates of technology use. Notwithstanding these obstacles, the study points to a number of opportunities, such as public-private partnerships for internet expansion, training initiatives to raise health workers' digital literacy, and partnerships with international health organisations to improve real-time monitoring and data integration. The results highlight the necessity of a multi-stakeholder approach that combines community involvement, technology advancements, and government actions to modernise Nigeria's health monitoring system.

**Conclusion:** This study underlines the critical need for digital transformation in Nigeria's health monitoring system to improve epidemic preparedness and response. Strengthening electronic reporting, utilising AI for predictive modeling, integrating geographic mapping technologies, and increasing mHealth applications are crucial for building a strong surveillance framework. Policy changes should focus on boosting internet connectivity, standardizing data-sharing procedures, and promoting engagement with global health institutions. Future studies should examine the practicality of AI-driven health surveillance in resource-constrained contexts and analyse the long-term impact of digital health advances on epidemic management in Nigeria. Implementing these suggestions would strengthen Nigeria's capacity to recognise and respond to emerging health concerns effectively

**Keywords:** Data-driven; Disease; Surveillance; Health-Technologies; Nigeria

## 1. Introduction

Systems for health monitoring are essential for spotting, tracking, and reacting to disease attacks. In Nigeria, where cholera, malaria, and Lassa fever are still big public health problems, planning and reacting to cases needs an effective tracking system (Tomori, 2019). Conventional tracking systems have regularly failed to spot and handle outbreaks on time because they rely on human data gathering and delayed reports (World Health Organization, 2018). Data-driven efforts are becoming increasingly important for improving Nigeria's health tracking centres as digital health technology grows. This paper explores how Nigeria's health monitoring system may be upgraded by using digital technology, leading to better planning and response to epidemics.

Nigeria has had many disease cases in the last 10 years, showing significant flaws in its reaction and tracking systems. The 2014 Ebola epidemic made evident how crucial it is to react promptly, while barriers, including a lack of real-time data, a weak monitoring system integration, and a poor health infrastructure, still make it difficult to contain the outbreak effectively (Bedford et al., 2019). The COVID-19 pandemic also exposed Nigeria's health information system's shortcomings, notably in case records, data collecting, and prediction analytics. These problems show how important it is to have a solid, data-driven approach to health tracking that offers early warning systems, real-time monitoring, and data-driven decision-making.

To boost epidemic diagnosis and intervention, a data-driven health monitoring system prioritises geographical mapping, electronic reporting, and AI-driven predictive modeling. (Schwalbe & Wahl, 2020). Such systems, which leverage digital technology to acquire, assess, and disseminate health data in real time, have been efficiently applied in many industrialised nations. However, development in Nigeria has been hindered by remote data sources, a shortage of competent health informatics workers, and inadequate interoperability amongst health authorities (Adekunle, 2016). In order to expand health monitoring via digital technology, these obstacles must be overcome while raising finance, policy execution, and stakeholder involvement.

Despite Nigeria's embrace of some digital health initiatives, there is a major gap in the full-scale application of data-driven health surveillance. The absence of a centralized, real-time data system has contributed to prolonged reaction times and poor resource allocation during health crises (Attah, 2017). Furthermore, variations in data accuracy, limited health professional training, and poor public-private sector collaborations lead to inefficiencies in epidemic preparation (Owolabi, 2017). These concerns demand a full examination of existing health surveillance techniques to identify gaps and provide measures for improvement.

The inadequacy of Nigeria's health monitoring system to harness real-time data for epidemic identification and response has led to recurring public health problems (Oluwakemi, 2020). The country's dependence on old, paper-based reporting methods restricts the capacity to detect new dangers immediately. Without a data-driven strategy, health authorities struggle to make informed choices, distribute resources efficiently, and execute focused interventions (Opele, 2017). This project attempts to evaluate how Nigeria's health monitoring system might be strengthened utilising data-driven tactics to improve epidemic preparedness and response, providing better health outcomes for the population.

This project will undertake a quantitative evaluation of literature from 2010 to 2020, examining the usefulness of data-driven health monitoring in epidemic control. By reviewing best practices from global health systems and examining Nigeria's present surveillance capabilities, the research intends to give evidence-based suggestions for increasing health monitoring using digital technologies. Findings from this project will contribute to policy debates on enhancing Nigeria's epidemic preparedness and response utilising real-time health data and predictive analytics.

### 1.1. Research Questions

A data-driven health monitoring system is critical for Nigeria to improve its preparation and reaction to outbreaks. Given the downsides of current surveillance methods, including delayed reports, scattered data sources, and limited prediction analytics, it is necessary to explore how digital technologies might improve disease tracking and outbreak management. The goal of this study is to find out how well data-driven methods may improve Nigeria's health monitoring system. The following study questions are created in order to do this:

- What are the main hurdles to disease preparation and reaction that Nigeria's present health tracking system must overcome?
- How have other countries improved health monitoring and disease control using data-driven approaches?
- What technological advances, such as regional maps, AI-driven analytics, and electronic reports, may be added to Nigeria's health tracking system?
- What are the possible benefits of using a data-driven approach for Nigeria's pandemic preparedness?
- What infrastructure and policy changes are needed to improve Nigeria's real-time data-based health tracking system?

### 1.2. Research Objectives

This project intends to evaluate how Nigeria's health monitoring system might be upgraded using data-driven techniques to improve epidemic planning and response. One significant purpose is to identify the primary difficulties influencing the country's present health monitoring system. Nigeria has long relied on traditional systems of sickness monitoring, which are often slow, inefficient, and prone to errors. Understanding these restrictions is crucial for designing a more adaptable and technology-driven monitoring system.

Another purpose is to examine how other nations have effectively deployed data-driven health monitoring systems. Many governments have used digital technologies such as real-time electronic reporting, predictive analytics, and geographic mapping to efficiently identify and react to epidemics. By studying worldwide best practices, this research will find techniques that can be applied to the Nigerian situation.

The research also intends to analyse the significance of digital technologies in boosting Nigeria's health monitoring system. Innovations such as artificial intelligence, big data analytics, and cloud-based reporting systems can potentially improve disease monitoring and intervention operations. Evaluating these technologies would aid in establishing their feasibility, scalability, and effectiveness in the Nigerian healthcare landscape.

Additionally, this study intends to illustrate the potential advantages of adopting a data-driven strategy to pandemic preparation in Nigeria. A well-integrated digital monitoring system may improve early warning systems, boost resource allocation, and promote greater collaboration among health institutions. By establishing these benefits, the research will give evidence to justify the move to a more technology-driven monitoring regime.

Finally, the research will assess the policy and infrastructural prerequisites essential for effectively adopting a data-driven health monitoring system in Nigeria. Effective surveillance systems involve not just technology investments but also legislative frameworks, personnel capacity-building, and inter-agency coordination. By identifying these essential characteristics, the study will give practical suggestions for boosting Nigeria's pandemic preparation via digital health technologies.

## 2. Review of The Literature Sources

### 2.1. Understanding Health Surveillance Systems

A health monitoring system is an organised method of receiving, analysing, and understanding health-related data to track disease trends, identify clusters, and lead public health actions. According to Majumder et al. (2017), a successful monitoring system allows quick reaction to new health risks, lowering illness and death. These systems are vital in disease prevention and control by giving real-time information to lawmakers, healthcare workers, and academics. Many countries combine monitoring systems with national health policies to ensure a proactive approach to outbreak preparation and reaction (Ponikowski et al., 2014).

Health monitoring systems work through multiple components, including case identification, data collection, analysis, explanation, and results sharing. The World Health Organization (WHO, 2018) categorizes monitoring into inactive, active, sentry, and syndromic types. Passive surveillance relies on regular reporting from healthcare facilities, while active surveillance includes focused efforts to find cases through field investigations. Sentinel surveillance focuses on watching specific diseases within chosen groups, whereas syndromic surveillance uses real-time symptom data to identify possible cases (Chow & Leo, 2016). Each monitoring type has strengths and limits based on the public health goals and available resources.

The success of a health tracking system rests on its ability to provide correct, fast, and valuable data. Hazen et al. (2014) noted that a successful tracking system should ensure accuracy, data quality, and quick reporting methods. However, many low- and middle-income countries, including Nigeria, face problems such as poor buildings, limited human resources, and weak data management methods (Opele, 2017). These hurdles hinder the quick finding and response to public health threats, increasing the risk of broad disease breakouts.

With the development of digital health tools, health monitoring systems are increasingly adopting data-driven methods to improve efficiency. Electronic reporting systems, artificial intelligence, and geographic maps have improved the ability to follow disease trends and identify outbreaks (Kamel-Boulos & Geraghty, 2020). Countries with advanced surveillance systems, such as the United States and Canada, have successfully combined big data analytics and real-time tracking tools to improve outbreak preparation (Simonsen et al., 2016). Nigeria's shift to a data-driven monitoring system needs significant investment in digital health innovations, capacity-building, and inter-agency cooperation.

A well-functioning health monitoring system is essential to protecting public health and reacting effectively to new illnesses. As Nigeria continues to face repeated cases of contagious illnesses, boosting its monitoring system is important for better epidemic preparation and reaction. By leveraging digital technologies and solving current challenges, Nigeria can improve its health monitoring skills and ensure better health results for its people (WHO, 2018). Future studies should explore merging artificial intelligence, mobile health apps, and cloud-based reporting systems to improve disease monitoring and control methods.

### 2.2. Overview of Global Best Practices in Health Surveillance

Health monitoring systems worldwide have grown to combine complex data gathering, analysis, and response processes to successfully track and control disease breakouts. Countries with strong public health infrastructures have adopted integrated disease surveillance and response (IDSR) systems that promote fast data sharing and coordination across health groups. According to the World Health Organization (WHO, 2018), global best practices stress real-time electronic reporting, sharing across health information systems, and a multi-sectoral approach to disease tracking. These methods have greatly improved outbreak discovery, reaction time, and resource sharing in places with well-developed monitoring systems.

One of the most effective health surveillance models is the Centers for Disease Control and Prevention (CDC) in the United States, which employs a comprehensive system that integrates laboratory networks, electronic health records (EHRs), and artificial intelligence for predictive analytics (Richards et al., 2017). The U.S. CDC's Epidemic Intelligence Service (EIS) is vital in tracking disease trends and responding to health problems via a network of skilled field epidemiologists (Birkhead et al., 2015). This approach has proved important in lowering disease outbreaks such as H1N1 influenza and COVID-19, showing the efficiency of real-time disease tracking and quick reaction methods.

In Europe, the European Centre for Disease Prevention and Control (ECDC) has built a complex health-tracking network that includes cross-border data sharing and early warning tools (Dąbrowska-Kłosińska, 2019). The European Surveillance System (TESSy) gives real-time health data, allowing countries to organise reactions to infectious

sicknesses such as measles, TB, and COVID-19. The success of the ECDC plan lies in its focus on data standardisation, digital sharing, and teamwork among partner countries. By utilising big data and artificial intelligence, the system promotes early disease identification and public health reactions (Bragazzi et al., 2020).

Several low- and middle-income countries have also made substantial improvements in health tracking via new digital health solutions. Rwanda, for example, has built an electronic Integrated Disease Surveillance and Response (eIDSR) system that allows healthcare workers to report events using mobile technology (Fall et al., 2019). Similarly, India's Integrated Health Information Platform (IHIP) has improved disease tracking by providing real-time health data via a cloud-based system available to healthcare workers throughout the country (Balsari et al., 2018). These models suggest that with the right investments in technology and facilities, even resource-constrained countries may boost their health tracking skills.

For Nigeria to improve its health monitoring system, it needs to adopt global best practices such as real-time electronic reports, predictive analytics, and greater cross-agency communication. Lessons from countries with advanced monitoring systems show the importance of governmental backing, technology investments, and staff training in public health informatics. Strengthening Nigeria's health-tracking infrastructure needs a multi-sectoral approach that blends digital technologies, improves data quality, and supports quick decision-making in outbreak planning and reaction (WHO, 2018). By adopting these best practices, Nigeria may improve its ability to track disease cases, share resources efficiently, and protect public health.

### 2.3. Key Challenges in Nigeria's Health Surveillance System

Nigeria's health monitoring system faces multiple challenges that limit its ability to successfully identify, monitor, and react to public health threats. One big issue is the lack of real-time disease reports due to weak infrastructure and limited digital integration. Many health facilities still rely on paper-based reporting, which slows down data gathering, analysis, and distribution (Oluwakemi, 2020). The lack of a unified computer reporting system makes it challenging to track disease trends effectively, leading to outbreak discovery and reaction delays.

Another important problem is insufficient funds and resource sharing for surveillance operations. The country's health budget remains insufficient to support the growth of digital monitoring tools, staff training, and inter-agency cooperation (World Health Organization [WHO], 2018). Many basic healthcare sites, especially rural areas, lack the necessary tools and staff to report disease cases correctly. This financial constraint restricts the adoption of new data-driven methods that could improve the efficiency of the tracking system.

Human resource issues also pose major roadblocks to Nigeria's effective health monitoring system. There is a lack of trained epidemiologists, data scientists, and public health workers who can easily handle and understand monitoring data (Makinde, 2019). Many healthcare workers are not properly trained in digital health tools, lowering the accuracy and speed of disease reports. Furthermore, the high turnover rate among healthcare workers due to poor pay and working conditions exacerbates this issue, leaving gaps in monitoring operations (Oono, 2018).

Data separation and lack of interoperability among health information systems present another big issue. Various government and private health institutions run separate monitoring systems that do not interact successfully with one another (Usman, 2018). This lack of unification results in incomplete or unclear data, making it difficult for lawmakers to make informed choices. Without a unified digital health monitoring system, information gaps remain, lowering the country's ability to respond to new public health risks.

Security worries and political turmoil further weaken Nigeria's health-tracking efforts. Ongoing difficulties such as violent conflict, terrorism, and strikes on healthcare facilities in certain areas make data collection tough (WHO, 2018). Insecurity in parts of the country limits access to affected people, leading to underreporting of disease cases (Olumade et al., 2020). Additionally, lies and public suspicion in health officials' lower participation in monitoring efforts affect the truth of reported data (Makinde, 2019). Addressing these issues requires a multi-sectoral approach prioritizing investment in digital health technologies, staff capacity-building, policy changes, and better security measures to boost outbreak preparation and reaction.

### 2.4. The Role of Digital Innovations in Epidemic Response

Digital innovations have changed outbreak reactions by boosting disease monitoring, better data collection, and allowing real-time decision-making. The merging of electronic health records (EHRs), artificial intelligence (AI), and big data analytics has greatly improved public health systems globally (Khan & Alotaibi, 2020). These tools help health officials to identify cases faster, track disease spread, and manage resources effectively. During the COVID-19 pandemic,

digital tools such as mobile health apps and cloud-based data-sharing platforms played a key part in real-time case tracking and reaction planning (Shafqat et al., 2020; Radanliev et al., 2020).

Artificial intelligence and machine learning are among the most powerful digital advances in outbreak reaction. AI-driven prediction modeling helps find possible hotspots by studying large datasets, including movement trends, social interactions, and environmental factors (Shafqat et al., 2020). AI-powered apps and automatic systems have also been used to spread public health information, reducing confusion and improving community engagement (Ndiaye et al., 2020). These innovations improve early warning systems, allowing governments and healthcare providers to respond proactively rather than reactively to disease breakouts.

Geospatial technologies and digital mapping tools have transformed outbreak reactions by giving visual representations of disease spread. Geographic Information Systems (GIS) allow health officials to track disease trends, identify high-risk areas, and apply focused measures (Scotch et al., 2018). For example, GIS was crucial in controlling the Ebola spread in West Africa by tracking affected people and improving resource placement (Saran et al., 2020). In Nigeria, better geographic mapping can enhance outbreak preparation by improving the country's ability to identify affected areas and distribute medical materials effectively.

Mobile health (mHealth) apps and telemedicine platforms have played a crucial part in the outbreak reaction by expanding access to healthcare services. Mobile apps allow people to report symptoms, receive online advice, and access certified health information, lowering hospital crowds and lessening disease spread (Ming et al., 2020). In many African countries, mHealth solutions have improved monitoring by allowing field health workers to report disease cases using mobile devices (Källander et al., 2013). These digital solutions are beneficial in resource-limited situations where access to healthcare equipment is limited.

For Nigeria to fully leverage digital innovations in outbreak reaction, it must invest in digital health infrastructure, improve public-private relationships, and ensure substantial data control. Adopting AI-driven monitoring systems, geographic maps, and mobile health tools can improve Nigeria's ability to identify and handle outbreaks successfully. Policymakers should consider combining these digital solutions into national health policies to build a more adaptable and flexible public health system (WHO, 2018). By adopting digital innovations, Nigeria can improve its disease preparation, reduce reaction times, and save lives.

### 2.5. Data-Driven Strategies in Health Monitoring

Data-driven strategies have become important in health tracking, allowing governments and healthcare groups to track disease trends, improve patient results, and increase outbreak preparation. These methods involve the organised gathering, analysis, and evaluation of health data to guide decision-making and resource sharing (Alamo et al., 2020). With improvements in big data analytics, artificial intelligence (AI), and machine learning, health systems can now handle vast amounts of information in real time, allowing for more accurate forecasts and early discovery of disease cases (Adiga et al., 2020). By leveraging data-driven methods, Nigeria can increase its health-tracking skills and improve its reaction to public health risks.

One of the most successful data-driven tactics in health tracking is the use of electronic health records (EHRs) and real-time disease detection tools. EHRs help healthcare workers to record and share patient information across different medical organisations, ensuring continuity of care and better disease tracking (Rinner et al., 2016). Integrated disease surveillance and response (IDSR) systems utilize digital tools to gather and analyse health data from multiple sources, providing quick alerts for possible outbreaks (WHO, 2018). For example, during the COVID-19 pandemic, digital health screens and real-time data display tools helped officials track infection rates and apply focused measures.

Another important method is geographic mapping and Geographic Information Systems (GIS), which provide visual images of disease spreads and healthcare resource distribution. GIS technology allows health officials to identify high-risk areas, track disease spread, and transfer resources effectively (Saran et al., 2020). In Nigeria, adding GIS into health monitoring can improve epidemic preparation by finding neglected areas and improving vaccine programs. The use of geographic data has been important in controlling cases such as Ebola and malaria, allowing for data-driven decision-making in disease control methods (Manheim et al., 2016; Espey & Dahmm, 2020).

Predictive analytics and machine learning models have further changed health tracking by allowing proactive rather than reactive reactions. AI-driven prediction models examine past health data to forecast disease trends, assess risk factors, and suggest preventive steps (Pal et al., 2020). For example, AI-based systems have been used to identify the spread of infectious diseases such as influenza and COVID-19, helping health officials adopt early treatments (Allam et

al., 2020). In Nigeria, investment in prediction analytics can improve the country's ability to expect disease breakouts and manage healthcare resources more effectively.

To successfully adopt data-driven health tracking methods, Nigeria must handle issues related to data quality, interoperability, and staff capacity. Ensuring correct and uniform data collection is important for effective research and decision-making (WHO, 2018). Additionally, merging different health information systems and teaching healthcare workers about data analytics will improve the efficiency of data-driven methods. By adopting advanced digital health technologies and encouraging teamwork between government agencies, research institutions, and private sector partners, Nigeria can build a more resilient health monitoring system capable of reacting quickly to new public health risks.

## 3. Theoretical Framework

This study is grounded on the Health Belief Model and the

### 3.1. The Health Belief Model (HBM)

The Health Belief Model (HBM) is a psychology theory devised in the mid-20th century to analyse and predict health-related activities by concentrating on the attitudes and beliefs of individuals. Initially postulated by Rosenstock in the 1950s and expanded by specialists such as Becker and Janz, HBM has proven significant in understanding why individuals accept or reject preventative health treatments. At its foundation, the model believed that an individual's decision to participate in health behavior is determined by their beliefs of susceptibility to a health hazard, the gravity of that threat, the advantages of adopting a specific action, and the difficulties associated with that action. (Janz & Becker, 1984)

In HBM, perceived vulnerability relates to an individual's view about the likelihood of having a health issue. In contrast, perceived intensity concerns the perceived relevance of the disease and its probable implications. These two components combined constitute a person's believed threat, which is a primary motive for taking action. Additionally, perceived advantages comprise the individual's appraisal of the positive consequences of a certain health practice, and perceived barriers address the problems that would prevent them from doing that behavior. The model also addresses signals to action—triggers that motivate the initiation of behavior—and self-efficacy, which is the faith in one's capacity to accomplish the activity (Champion & Skinner, 2008).

When applied to the uptake of digital tracking tools in public health, the HBM offers a useful view through which to understand partner behavior. In the context of epidemic readiness and response, if public health officials and other stakeholders perceive a high risk of epidemic crises (high perceived susceptibility) and understand the possibly severe implications of neglect (high perceived severity), they are more likely to view digital surveillance as a necessary and beneficial tool. Moreover, if these parties think that digital technologies can greatly improve early diagnosis and action (perceived benefits) and if the technological, financial, or practical challenges (perceived hurdles) are properly handled, the chance of adoption rises.

The development of HBM might be primarily attributed to its early proponents, notably Rosenstock (1974), who laid the foundation for comprehending preventative measures of health behaviors, and subsequently to researchers like Janz and Becker (1984), who broadened the model by integrating additional dimensions like as self-efficacy and cues to action. These efforts have created HBM as the foundation in health behavior research, affecting a wide spectrum of public health initiatives—from immunisation campaigns to chronic illness management. Its continued importance shows its usefulness in studying how views of risk and reward drive health-related decision-making.

In improving Nigeria's health monitoring system through digital developments, the HBM offers a theoretical framework for studying how players assess and react to the danger of outbreaks. By understanding that stakeholders are more likely to accept digital monitoring technologies when they perceive a major risk and evident benefits, lawmakers and public health leaders can design focused measures to reduce hurdles and improve the effectiveness of these systems. Ultimately, HBM helps explain current usage habits and leads strategies to promote the growth of digital health solutions in efforts to improve disease planning and reaction.

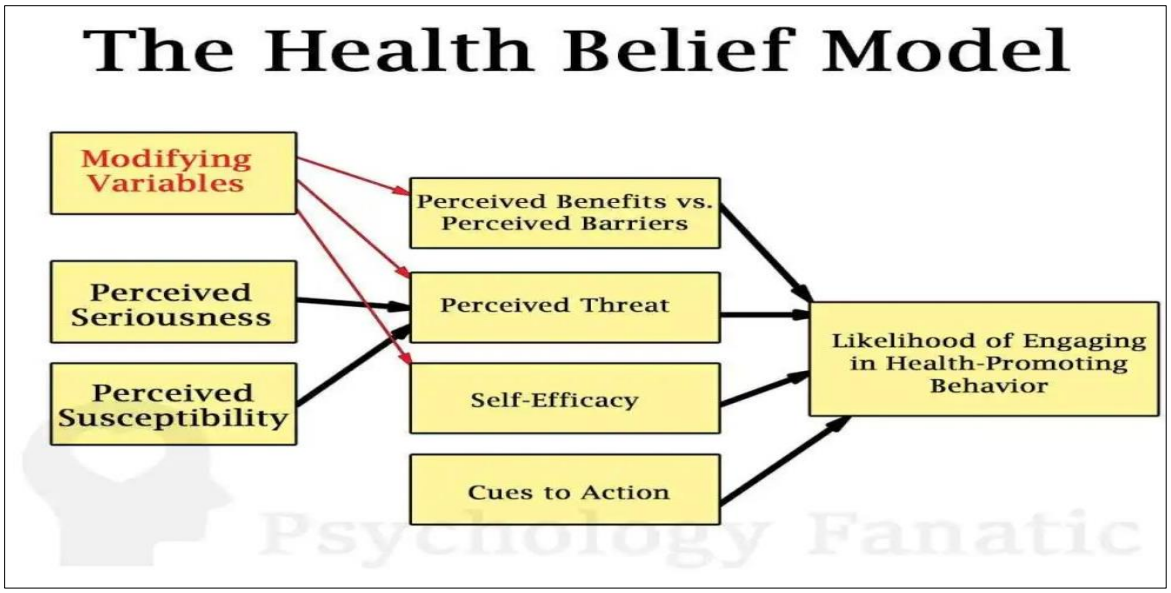



**Figure 1** The Health Belief Model. Accessed from https://psychologyfanatic.com/health-belief-model/

Figure 1 above shows the Health Belief Model (HBM), which explains how individual views affect health-related actions. In the context of improving Nigeria's health surveillance system through digital innovations, the model can be applied to understand stakeholders' acceptance of digital surveillance tools. Perceived importance and perceived vulnerability relate to how public health officials, healthcare workers, and lawmakers assess the danger of infectious disease breakouts. If they understand the high risk of outbreaks and their profound effects, they are more likely to participate in preventative digital tracking measures. Perceived benefits vs. perceived hurdles affect whether stakeholders will accept digital tools like SORMAS, AI-driven prediction models, and mobile health apps. Growth may be hampered if they view digital monitoring as effective in controlling cases but face hurdles like inadequate infrastructure, cost, or lack of training. Self-efficacy shows trust in using these tools, stressing the need for training and capacity-building programs. Cues to action, such as past outbreaks (e.g., COVID-19, Lassa fever) and government policies, can serve as triggers to improve digital monitoring adoption. Ultimately, the chance of participating in health-promoting behaviors, such as adopting real-time digital reporting systems, improves when these factors match, supporting the importance of planned interventions to address hurdles and enhance digital health integration in Nigeria.

### 3.2. The Data-Information-Knowledge-Wisdom (DIKW) model

The Data-Information-Knowledge-knowledge (DIKW) model is a mental structure that delineates the change of raw data into usable knowledge. Initially promoted by Ackoff (1989), this model has been widely accepted in various areas, including computer science and knowledge management. The DIKW hierarchy offers an organised method for understanding how raw facts (data) can be honed into useful information, further examined into knowledge, and eventually turned into wisdom that supports educated decision-making.

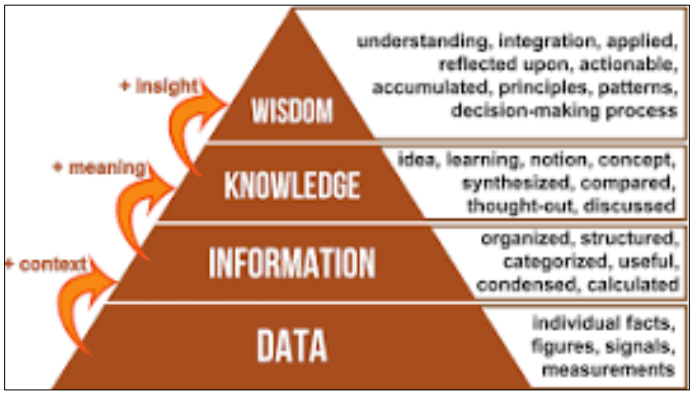
At the base of the DIKW model lies data—raw, jumbled facts that in their original form, may lack meaning or importance. When this data is handled and given context, it becomes information, which gives insights into trends and connections. Further study and evaluation of this material lead to the growth of knowledge, defined by a better understanding of the underlying events. Finally, wisdom marks the peak of the order, where gathered knowledge is applied carefully to guide strategic actions and solve complex problems (Rowley, 2007).

The DIKW approach is particularly important for improving Nigeria's health monitoring system. A data-driven approach to outbreak preparation relies on the organised collection of vast amounts of health-related data from diverse digital sources, such as electronic health records, mobile reporting systems, and real-time tracking devices. This raw data must be turned into clear information through data cleaning, labeling, and environmental analysis. Such information then forms the base for building knowledge about disease trends, outbreak patterns, and risk factors, which is important for informed decision-making in public health.

Furthermore, the DIKW framework serves as a guide for turning the wealth of digital data produced in modern health monitoring into knowledge that influences policy and practice. In Nigeria, where digital innovations are gradually being

integrated into health systems, adopting the DIKW model ensures that collected data does not remain an unused resource. Instead, through organised analysis and integration, this data can be turned into knowledge that supports successful outbreak reaction tactics. The final aim is to achieve wisdom—making choices that address current health threats and predict and prevent future breakouts.

The proponents of the DIKW model, such as Ackoff (1989) and Rowley (2007), stress its usefulness in closing the space between raw data and practical insights. In a health monitoring context, this model is crucial in leading stakeholders—from data scientists to public health policymakers—in the organised use of digital technologies to improve outbreak preparation and reaction. By deploying the DIKW framework, Nigeria can improve its health monitoring skills, ensuring that digital innovations translate into effective, data-informed strategies that protect public health.




Accessed from https://www.researchgate.net/figure/The-DIKW-Data-Information-Knowledge-Wisdom-model-shows-how-the-human-mind-can-move_fig1_221437134

**Figure 2** Data-Information-Knowledge-Wisdom (DIKW) model

The Data-Information-Knowledge-knowledge (DIKW) model provides an organised framework for understanding how raw data is turned into practical knowledge, making it highly important to Nigeria's health monitoring system. In this context, data reflects real statistical figures, such as disease recurrence rates, test results, and case counts received from healthcare centres. When these data pieces are handled and organised, they become information, giving trends on illness rates, regional spread, and population patterns. As health experts and officials evaluate this information, compare trends, and produce insights, it is turned into knowledge, allowing for educated choices on disease control and reaction strategies. Finally, understanding is gained when this information is applied strategically—such as using AI-driven prediction models, real-time digital monitoring, and geographic maps to forecast and prevent future outbreaks. The DIKW order underlines the importance of combining digital health breakthroughs to improve disease monitoring, ensuring that essential health data is received and turned into helpful information for outbreak preparation in Nigeria.

## 4. Materials and Methods

This study applied a PRISMA-compliant systematic review method to ensure a well-structured and exact inquiry into improving Nigeria's health monitoring system using a data-driven approach to outbreak preparation and reaction. This detailed approach permitted the discovery and collection of important data, enabling a clear grasp of both the obstacles and potential in modernising public health monitoring systems.

An initial literature search was undertaken utilising numerous online sources, including Web of Science, Scopus, IEEE Xplore, ACM Digital Library, and Google Scholar. The search technique was carefully devised by merging subject-specific phrases with Boolean operators to improve the reach of available articles. Key search phrases were "health system surveillance," "digital health innovations," "electronic reporting system," "data-driven approach," and "Epidemic preparedness." This approach helped obtain a wide array of studies pertinent to the research goals.

The selection factors for the study were clearly outlined to ensure the applicability and quality of the chosen literature. Only peer-reviewed journal articles, conference papers, and book chapters written in English and released between 2010 and 2020 were considered, thereby combining the most recent advancements and ideas related to health tracking and outbreak reaction. Studies that stated views without factual proof or did not directly focus on health monitoring and outbreak preparation were removed. The initial search returned 1,697 possibly relevant papers; after removing duplicates, 1,375 records were ready for screening. Following a review of titles and descriptions by two judges, 798

articles were removed for failing to meet the inclusion criteria, and an additional 372 publications were deleted during a later assessment for quality and usefulness, resulting in a final set of 205 sources.

A uniform pro forma was employed to gather and record essential details from each study, including research goals, scientific processes, subject traits, key results, and effects for improving Nigeria's health tracking system. Both theme and story synthesis methods were applied to examine the found material. The mix of qualitative and quantitative research methodologies allowed for finding repeated themes, new trends, and critical patterns throughout the literature, giving a strong platform for understanding the obstacles and potential improvements in outbreak planning.

To verify the reliability and robustness of the review, the Critical Appraisal Skills Programme (CASP) checklist was employed for systematic studies, while the Mixed Methods Appraisal Tool (MMAT) was applied for empirical publications. Several precautions were taken to eliminate bias and increase the validity of the review process, including the computation of inter-rater agreement using Cohen's κ coefficient and the involvement of two distinct reviewers in both screening and selection evaluation. In cases of disagreement, talks were held until a decision was made, with a third judge being contacted if necessary. Additionally, running searches across various databases helped to reduce publication bias, thereby improving the general accuracy of the systematic review approach.

### 4.1. Trends in Nigeria's Health Surveillance from 2010–2020

From 2010 to 2020, Nigeria's health monitoring system witnessed significant changes driven by changing public health issues, technological advances, and policy improvements. Early in the decade, health tracking in Nigeria heavily relied on human data gathering and reporting tools, which limited real-time monitoring and reaction capabilities. The Nigeria Centre for Disease Control (NCDC) became fully active in 2011 and was vital in improving disease monitoring by managing national efforts to identify and react to infectious disease outbreaks (Olumade et al., 2020). However, weak infrastructure, unreliable data sharing, and limited inter-agency cooperation hampered the efficiency of health monitoring systems in the early years.

One major pattern noticed during this time was the growing uptake of digital tools for health monitoring. By the mid-2010s, Nigeria began integrating electronic health reporting systems, such as the Integrated Disease Surveillance and Response (IDSR) structure, to improve the speed and correctness of data gathering (WHO, 2018). The introduction of mobile health (mHealth) solutions further improved monitoring efforts, allowing healthcare workers to report disease breakouts and other public health issues more effectively. These digital solutions addressed issues such as delayed outbreak discovery and underreporting, which were chronic problems in the Nigerian healthcare system.

The 2014–2016 Ebola spread in West Africa greatly affected Nigeria's approach to health monitoring, leading to more powerful emergency reaction systems. Nigeria's success in controlling the virus through fast case recognition, contact tracking, and organised reaction efforts showed the value of effective health monitoring (Ogunleye et al., 2020). This time also saw greater spending in laboratory facilities and public health disaster preparation, strengthening the role of data-driven monitoring in handling new health risks. Following the Ebola experience, Nigeria improved its monitoring systems by growing laboratory networks and improving staff training to improve disease detection capabilities.

The latter part of the decade was marked by the rise of COVID-19, which further tested Nigeria's health tracking system. In reaction to the pandemic, the country quickly built up digital health technologies, including the Surveillance Outbreak reaction Management and Analysis System (SORMAS), to enable real-time data collection and outbreak management (Okunromade et al., 2019). The pandemic also showed the importance of combining artificial intelligence and big data analytics in disease monitoring, with efforts directed at better prediction models and outbreak forecasting.

Despite these developments, hurdles such as poor funds, weak health facilities, and data separation stayed common in Nigeria's health monitoring system. While digital innovations and policy changes have improved monitoring powers, viability, and ongoing growth remain critical. Moving forward, improving data control, growing digital health spending, and promoting inter-sectoral cooperation will be important in ensuring a more resilient health monitoring system in Nigeria.

### 4.2. Impact of Digital Innovations on Epidemic Preparedness

Digital developments have considerably changed outbreak planning by raising disease monitoring, reaction coordination, and resource distribution. One of the most significant effects of digital technology is the ability to gather, examine, and assess real-time health data, which improves early warning systems for dangerous breakouts. Traditional paper-based reporting methods usually lead to delays in the discovery of disease outbreaks. However, digital health platforms, such as electronic reporting systems and mobile health apps, have addressed this gap by providing fast data-

sharing capabilities. This has been especially useful in nations like Nigeria, where rural areas have difficulties in quick illness reports (Oluwakemi, 2020).

Artificial intelligence (AI) and big data analytics have further transformed epidemic planning by giving predictive models of disease spreads. AI-driven algorithms study huge databases to find trends and potential disease hotspots, allowing public health workers to take preemptive measures before a full-scale breakout unfolds. For instance, during the COVID-19 pandemic, AI-powered methods were applied to predict the spread of the virus, improve contact tracking, and identify high-risk groups (Olumade et al., 2020). These predictive abilities enhance the reaction speed and boost resource allocation by providing actions to the most sensitive places.

Another key benefit of digital breakthroughs is the rise of contact and teamwork during outbreaks. Cloud-based data-sharing technologies, telemedicine, and digital screens allow health officials, states, and foreign parties to communicate effectively. Digital tools such as the Surveillance Outbreak Reaction Management and Analysis System (SORMAS) have played a crucial part in Nigeria's reaction to disease outbreaks by mixing data from multiple sources and allowing real-time decision-making (Olumade et al., 2020). The ability to share disease data across different levels of the healthcare system ensures that responses are quick and well-coordinated.

Additionally, digital developments have boosted public health data by allowing online tracking and self-reporting of disease signs. Mobile health (mHealth) apps allow users to share problems, get health standards, and access virtual talks, lessening the pressure on healthcare institutions. Wearable technology and Internet of Things (IoT) devices have also boosted pandemic preparation by constantly measuring crucial health signs and spotting patterns that might herald the beginning of an outbreak (Becker et al., 2014). These methods have been especially helpful in treating chronic illnesses and watching viral disease signs in real-time.

Despite these developments, difficulties, including data privacy concerns, insufficient digital infrastructure in low-income regions, and resistance to accepting new technology remain hurdles to successfully harnessing digital breakthroughs for outbreak planning. To improve their impact, states and health groups must participate in digital health capacity-building, allow sharing across health information systems, and address moral issues linked to data consumption. Ultimately, bringing digital technologies into health tracking and emergency reaction systems will lead to more flexible public health frameworks capable of decreasing future disease risks.

### 4.3. Strengths and Weaknesses of Nigeria's Surveillance System

Nigeria's health monitoring system has witnessed substantial changes during the last decade, spurred by legislative reforms, technological breakthroughs, and international alliances. However, it still confronts key challenges that restrict its complete utility in disease preparedness and response. Understanding the strengths and shortcomings of the system is vital for determining areas of development and creating a more secure public health infrastructure.

One of the key advantages of Nigeria's tracking system is the development of the Nigeria Centre for Disease Control (NCDC) as the national planning agency for incident response. Since being fully operational in 2011, the NCDC has strengthened monitoring efforts via the Integrated Disease Monitoring and Response (IDSR) strategy, which aligns with global health security requirements (NCDC, 2017). The IDSR structure allows organised data gathering, analysis, and distribution, improving the discovery and control of contagious disease cases. Furthermore, real-time sickness tracking has risen, and a unified reaction to public health issues has been made possible by introducing digital monitoring systems such as the monitoring Outbreak Response Management and Analysis System (SORMAS) (Adepoju, 2020).

Nigeria's experience in handling earlier cases, such as COVID-19 in 2020 and Ebola in 2014, has also added to better preparation processes. Nigeria's quick health worker activation, effective contact tracking, and team cooperation were key factors in successfully controlling Ebola (Ajisegiri et al., 2019). Nigeria's reaction to the COVID-19 outbreak was affected by these experiences, which improved case finding and tracking via digital contact tracing, expanded laboratory capacity, and more community involvement. Nigeria's tracking skills have been further improved by foreign relationships with institutions like the World Health Organisation (WHO) and the Africa Centres for Disease Control and Prevention (Africa CDC), who have given financial and professional help.

Notwithstanding these successes, Nigeria's tracking system has significant flaws, especially concerning funds and facilities. Many healthcare centres, especially in rural areas, lack the necessary tools for effective disease monitoring, including testing technology, stable internet connection, and trained staff (WHO, 2018). This causes delays in data gathering and hinders the ability to quickly identify and react to breakouts. Additionally, uneven government funding

has limited the longevity of key monitoring programs, making them highly reliant on private support. Keeping and updating digital health systems is a struggle without stable financial support.

Another key weakness is data separation and communication problems among different health information systems. Different agencies and health institutions often use different data collection tools, leading to duplication of efforts and gaps in disease reports. The lack of interaction between electronic health records, test data, and field monitoring systems makes it challenging to track disease trends thoroughly (Adepoju, 2020). Furthermore, the underreporting of cases due to weak community-based monitoring and fear of stigmatization affects the quality of surveillance data, making it difficult to adopt effective public health measures.

In conclusion, while Nigeria's health monitoring system has made notable progress, weaknesses in facilities, funds, and data handling remain major hurdles. Addressing these issues will take a planned approach, including growing local investment in health monitoring, strengthening digital health infrastructure, and better collaboration between health agencies. By leveraging its strengths and solving these flaws, Nigeria can build a more adaptable monitoring system capable of effectively controlling future outbreaks.

### 4.4. Comparative Analysis of Nigeria's Health Surveillance System with Other Countries

Health monitoring systems differ between nations depending on their degree of growth, healthcare facilities, technological acceptability, and legislative frameworks. Comparing Nigeria's health monitoring system with other nations, particularly those with well-established frameworks, gives insights into areas of development and best practices that might boost outbreak planning and responsiveness. This research focuses on parallels with the United States, South Africa, and India—three nations with varied health monitoring approaches that provide crucial lessons for Nigeria.

The United States has one of the most advanced health monitoring systems globally, principally maintained by the Centers for Disease Control and Prevention (CDC). The U.S. system integrates numerous digital platforms, such as the National Notifiable Diseases Surveillance System (NNDSS), enabling real-time data collection and delivery from statewide healthcare institutions (Magnuson et al., 2020). A fundamental aspect of the U.S. strategy is its use of big data analytics and artificial intelligence (AI) for predictive modeling, enabling early detection of illness cases. Compared to Nigeria, where monitoring leans primarily on human reporting in certain places, the U.S. system wins from broad digitisation and communication across health data. However, Nigeria may learn from the U.S. strategy via improved coordination between multiple monitoring systems and employing AI-driven predictive analytics to strengthen early warning mechanisms.

South Africa provides a greater parallel to Nigeria, considering its comparable socio-economic background and health challenges. The government has a robust tracking system under the National Institute for Communicable Diseases (NICD), which conducts illness surveillance and incident response. South Africa has effectively integrated computer reporting systems, such as the Notifiable Medical Conditions Surveillance System (NMCSS), which allows real-time reporting by healthcare personnel (Silenou et al., 2020). One of South Africa's assets is its robust laboratory network, which enables speedy testing and evidence of cases, particularly during epidemics like COVID-19 and TB (WHO, 2020). Nigeria, in contrast, confronts severe difficulties in scientific facilities, particularly in rural locations. To bridge this gap, Nigeria might adopt South Africa's way by enhancing laboratory networks and ensuring that digital reporting tools are accessible at all phases of healthcare treatment.

India presents another major case study owing to its vast population and many healthcare concerns comparable to Nigeria's. India's Integrated Disease Surveillance Programme (IDSP) has strengthened outbreak planning via real-time data collecting from hospitals, laboratories, and community health workers (Mahapatra et al., 2020). One of India's primary initiatives has been harnessing mobile technology to increase community-based monitoring, particularly in rural regions where internet connection is restricted. During the COVID-19 epidemic, India effectively deployed smartphone applications like Aarogya Setu for digital contact tracking and health monitoring. Nigeria, which also has significant rural populations with limited healthcare access, can benefit from India's mobile surveillance approach by expanding the use of digital tools such as the Surveillance Outbreak Response Management and Analysis System (SORMAS) to enhance disease tracking at the community level.

Despite these capabilities, each of these nations nevertheless has its obstacles. The U.S. contends with data privacy difficulties and fragmented health information systems across several states, while South Africa and India continue to confront budgetary restrictions and inequities in healthcare access. Nigeria shares some of these difficulties but has further restrictions on cash, equipment, and skilled workers. By incorporating best practices from these countries—

such as the U.S.'s predictive analytics, South Africa's laboratory networks, and India's mobile surveillance strategies—Nigeria can construct a more effective and robust health monitoring system.

In conclusion, Nigeria has made tremendous progress in disease monitoring, but there is still potential for improvement in automation, laboratory capacity, and community-based surveillance. Lessons from the U.S., South Africa, and India illustrate the necessity of integrating technology, enhancing laboratory networks, and employing mobile monitoring to enhance outbreak planning. By implementing these strategies, Nigeria may establish a more effective and efficient health monitoring system capable of reacting to future public health risks.

## 5. Conclusion and Recommendations

The study studied the improvement of Nigeria's health monitoring system using a data-driven method for outbreak preparation and reaction. By studying literature from 2010 to 2020, the research offered insights into the strengths, flaws, and comparative gaps in Nigeria's health tracking system compared to global best practices. The study stressed the important role of digital innovations in better real-time disease tracking, prediction models, and outbreak reactions. However, Nigeria's monitoring system still confronts issues relating to physical defects, insufficient budgets, restricted sharing of health data systems, and human resource restrictions. Addressing these gaps involves a multi-pronged strategy, including legislative reforms, technology-driven solutions, and capacity-building efforts.

### 5.1. Summary of Key Insights

Several major outcomes resulted from the investigation. First, Nigeria's health monitoring system has altered over the years but still depends mainly on human and paper-based reporting, which hinders illness identification and response. Second, global best practices, particularly from countries like the United States, South Africa, and India, demonstrate the effectiveness of integrating digital health innovations, including electronic reporting systems, artificial intelligence, and mobile health applications, in strengthening surveillance. Third, while Nigeria has made progress in digital surveillance through platforms like the Surveillance Outbreak Response Management and Analysis System (SORMAS), its full potential remains unrealized due to poor infrastructure, weak health information system integration, and inadequate training for health workers. Additionally, financing restrictions and management difficulties impede the effectiveness and durability of health monitoring activities.

### 5.2. Policy Implications for Strengthening Surveillance Systems

To strengthen Nigeria's health monitoring system, lawmakers must prioritize changes that enable data merging, enhance real-time reporting, and improve inter-agency cooperation. First, the government should adopt a national health data strategy that requires sharing among all health monitoring systems. This strategy should ensure smooth data sharing between federal, state, and local health institutions, preventing information walls that delay outbreak reactions. Second, budget amounts for health monitoring must be raised and maintained, with specific resources for building development, training, and technology improvements. Third, governmental backing is needed to ensure mandatory digital disease reporting by public and private health centres, ensuring prompt data gathering and analysis. Fourth, Nigeria should create a unified epidemic reaction unit with advanced analysis powers, similar to the CDC's Epidemic Intelligence Service, to improve quick spread discovery and control.

### 5.3. Recommendations for Integrating Digital Health Innovations

Based on the findings, the following recommendations are advanced:

#### *5.3.1. Expand the Use of Electronic Reporting Systems*

Scaling up the monitoring Outbreak Response Management and Analysis System (SORMAS) nationwide should be a top goal for Nigeria's health monitoring system. This requires ensuring that all healthcare sites, including basic health centers in distant areas, have access to the platform. Healthcare workers must be appropriately trained to use SORMAS successfully, and interaction with other digital health tools should be allowed to create a smooth reporting environment. Additionally, interoperability with international disease monitoring systems, such as those controlled by the World Health Organization (WHO) and the Africa Centres for Disease Control and Prevention (Africa CDC), would improve Nigeria's ability to respond to global health risks.

#### *5.3.2. Improve Internet Connectivity and Digital Infrastructure*

A significant problem in increasing digital health monitoring is the limited access to effective internet connection, especially in rural and impoverished areas. To solve this, the government should spend in broadband growth projects,

especially deploying satellite internet services where fiber-optic infrastructure is not possible. Collaborations with private telecom companies and global tech firms could support the adoption of low-cost, high-speed internet solutions, ensuring that health centres and community health workers can access real-time disease monitoring systems. Moreover, providing a backup power supply through solar-powered systems would lessen the effect of Nigeria's frequent power blackouts on digital health operations.

#### *5.3.3. Leverage Mobile Health (mHealth) Applications for Community-Based Disease Reporting*

Mobile health (mHealth) applications can greatly improve grassroots-level disease monitoring and community involvement. Nigeria could build a mobile-based monitoring app designed for its special health needs, similar to India's Aarogya Setu, which was important in COVID-19 contact tracing. Such an app should allow citizens and healthcare workers to report symptoms, access real-time public health alerts, and receive disease prevention and management instructions. Additionally, Unstructured Supplementary Service Data (USSD) choices should be included to ensure usability for people without cell phones or internet connectivity.

#### *5.3.4. Adopt Artificial Intelligence (AI) and Machine Learning for Predictive Analytics*

AI-driven technologies can examine big datasets, spot trends, and create early signs for possible disease breakouts. By combining AI with current monitoring systems, Nigeria could improve its ability to forecast outbreaks based on trends in health data, climate factors, population movement, and genetic analysis of microbes. AI-powered robots could also be applied in local languages to help with public health education, condition tracking, and vaccine marketing. Collaboration with research institutions and global AI firms would help in building models geared to Nigeria's unique health issues.

#### *5.3.5. Integrate Geospatial Mapping Technologies for Disease Tracking and Resource Allocation*

Regional Information Systems (GIS) can track the regional spread of infectious diseases, watch high-risk zones, and improve resource sharing. By combining statistical data with demographic and environmental factors, health officials can find transmission areas and apply measures more effectively. Using satellite-based remote sensing technologies could further improve Nigeria's ability to track natural factors causing disease cases, such as floods, temperature changes, and pollution levels in real-time. Additionally, combining GIS with drone technology could aid the fast transfer of medical supplies and medicines to rural areas during public health situations.

#### *5.3.6. Establish a Cloud-Based National Health Surveillance System*

A centralized cloud-based national health monitoring system would allow real-time data gathering, sharing, and analysis across different levels of the health sector. This tool should combine data from hospitals, labs, community health centers, and mobile monitoring units to provide a complete view of Nigeria's disease environment. Nigeria could build a flexible and safe cloud system that supports fast reaction efforts by working with foreign groups such as WHO, Africa CDC, and the Bill & Melinda Gates Foundation. Data control systems should also be created to protect patient secrecy and ensure compliance with international health data security standards.

#### *5.3.7. Enhance Workforce Capacity and Digital Literacy Among Health Professionals*

Effective integration of digital health innovations depends on the healthcare staff's digital expertise and technical competency. Nationwide training programs should be developed to guarantee that health professionals at all levels, including physicians, nurses, laboratory technicians, and community health workers, are adept in utilising digital monitoring systems. Regular capacity-building sessions should be arranged, concentrating on topics such as data management, AI usage in public health, and hacking best practices. Establishing agreements with universities and technology training centres would further improve Nigeria's human resource ability in digital health tracking.

#### *5.3.8. Strengthen Policy Frameworks and Legal Regulations for Digital Health Surveillance*

The Nigerian government must develop clear policies and legal systems to guide the ethical application of digital health developments. Policies should handle data protection, hacking, cross-border data sharing, and interoperability of digital health platforms. Establishing a national governing body responsible for overseeing digital health monitoring activities would guarantee that technologies are implemented in an open, accountable, and successful manner. Collaboration with stakeholders—government agencies, international health organizations, private-sector technology enterprises, and civil society groups—is vital to developing a good policy environment.

#### *5.3.9. Future Research Directions*

Although this study has given important insights, further research is necessary to improve knowledge and application methods. First, research studies should be performed on the usefulness of digital monitoring tools currently in use in Nigeria, such as SORMAS and DHIS2, to find gaps and areas for growth. Second, the study should focus on the socio-cultural factors affecting the acceptance of digital health innovations, especially in rural areas where traditional health-seeking habits may affect involvement in digital reporting. Third, future studies should explore cost-effective digital solutions suited to Nigeria's economic facts, ensuring that planned technology measures are financially sustainable. Fourth, continuous studies on Nigeria's health tracking measures are needed to assess the effect of policy changes and digital integration over time. Lastly, a comparison study involving various African countries could provide insights into regional best practices, enabling cross-border cooperation in disease monitoring.

#### *5.3.10. Final Thoughts*

Strengthening Nigeria's health monitoring system is important for better outbreak preparation and reaction. By accepting data-driven strategies, combining digital innovations, and following global best practices, Nigeria can build a sturdy monitoring system capable of reacting quickly to public health risks. Implementing the suggestions described in this study will take strong political will, multi-sectoral teamwork, and continued spending on health technology. With a well-structured and technologically improved monitoring system, Nigeria can be a star in disease outbreak preparation and add to global health security.

## Compliance with ethical standards

### *Disclosure of conflict of interest*

The authors declare no conflicts of interest related to this review article. The research was conducted with full independence, and no financial or personal relationships influenced the design, methodology, or interpretation of its findings.

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