HEALTHCARE DATA ANALYSIS ENHANCING HEALTHCARE IN AFRICA THROUGH INFORMATICS: TECHNOLOGY-DRIVEN DATA ANALYSIS, OPPORTUNITIES, CHALLENGES, AND STRATEGIES

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Abstract

Health informatics, which sits at the nexus of information technology and healthcare, is essential to improving public health outcomes via creative applications and data-driven approaches. The study used secondary data ranging from 2009 to 2023. The ordinary least square is employed to estimate the study data. The study revealed that domestic government expenditure on health has a positive significant impact on health outcomes. The study recommends that more health data analysis, better disease monitoring, and cutting-edge technologies like AI and IoT are significant hurdles. More investment should be made in health informatics by the concerned authority.

Keywords: Health Management, Africa, Review, Disease Surveillance, Artificial Intelligence, Health Informatics

1.1 INTRODUCTION

Public health prioritises community well-being via illness prevention, health promotion, and legislative change (Kemp & Fisher, 2022; Organisation, 2024). Its goals include keeping an eye on health trends, spotting health inequalities, and putting risk reduction and community health improvement initiatives into action. To safeguard the public's health and safety, public health initiatives include a broad range, from vaccination campaigns to environmental health laws (Adanma & Ogunbiyi, 2024).

The intersection of public health and health informatics is a synergistic approach to applying technological innovations to public health issues. Technology for health informatics may make it easier for public health professionals to collect, analyse, and use data. For instance, real-time disease monitoring systems can promptly detect outbreaks and take the necessary steps to contain them and prevent their spread. Health informatics also supports evidence-based decision-making in the development of public health policies and programs, leading to more targeted interventions and more effective use of resources (Adenyi, Okolo, Olorunsogo, & Babawarun, 2024; Fernandez-Luque et al., 2020).

Health informatics is a crucial field at the nexus of healthcare and information technology that is vital to modern healthcare systems (Yogesh & Karthikeyan, 2022). It involves organising and evaluating medical data using technology to improve patient care, productivity, and outcomes. Health technologies became so useful during the period of COVID-19 as social distance was the practice (Arisekola, 2023). From electronic health records (EHRs) to telemedicine platforms and advanced data analytics, health informatics equips healthcare professionals with the knowledge and skills they need to make informed decisions and enhance the standard of healthcare delivery (Ye, 2020).

The systematic use of information and communication technology to healthcare, which makes it easier to handle and analyse health data, is the main emphasis of the quickly developing discipline of health informatics. A branch of health informatics called artificial intelligence (AI) offers sophisticated computer algorithms and machine learning models that can analyse vast amounts of data, provide insightful results, and support the process of making evidence-based healthcare choices.

Medical professionals may distinguish between benign and malignant illnesses by using artificial intelligence technologies to detect diseases and identify certain problems from medical photos. This thorough research intends to provide practical knowledge that may help stakeholders realise the promise of AI to improve public health outcomes on the continent as we traverse the difficult terrain of integrating AI into health informatics in Africa.

The healthcare sector in Africa is being faced with significant challenges, and this include limited access to healthcare of good quality and poor management of data and this prevents making effective decisions and allocating resources effectively. During the growing availability of health data, the potential of this data still remains underutilized which is largely due to a lack of robust informatics frameworks and analytical tools. The lack of adequate healthcare data analysis hinders inefficiencies, suboptimal treatment outcomes and delays in diagnosis. More so, the dispairities in the accessibility of data and the adoption of technology across regions promotes the gaps in equitable healthcare delivery.

This research aims to provide an empirical study on Healthcare Data Analysis Enhancing Healthcare in Africa through Informatics: Technology-Driven Data Analysis, Opportunities, Challenges, and Strategies.

2.1 A REVIEW OF LITERATURE

2.1.1 Current State of Health Informatics in Africa:

Health information systems (HIS) in poor countries, particularly those in Africa, are finding it more difficult to provide high-quality data (Nguyen, 2023). The lack of reliable health-related data hinders the development of effective health policy (Mousavi Baigi et al., 2023). The lack of a national health information management strategy would always jeopardise the effectiveness of HIS in African countries (Namyalo et al., 2023). To engage in rigorous upstream thinking to improve HIS governance, it is helpful to create and propose a thorough conceptual framework that examines and guides the long-term growth and integration of digital applications into HIS.

Health informatics is the study of how information technology (IT) is used in healthcare (Lee and Lu, 2023). According to Bellazzi et al. (2023), it encompasses a wide variety of activities, including developing and deploying electronic health records (EHRs), using data analytics to improve healthcare outcomes and quality, and developing mobile health (mHealth) apps to reach marginalised populations. It covers a broad variety of disciplines, such as bioinformatics, computing, medicine, and artificial intelligence. It also includes topics like telemedicine, telehealth, and decision support (Levy et al., 2023, Parvez, and Khan, 2023).

The current state of health informatics in Africa presents both opportunities and challenges (Alpi et al., 2023, Combi et al., 2023). Africa has many challenges in adopting and implementing health informatics systems, including a lack of funding, a shortage of skilled IT personnel, and a lack of infrastructure (Conte et al., 2023, Sinde et al., 2023, Ukoba et al., 2023, Al Meslamani, 2023). However, since the potential of health informatics to improve healthcare in Africa is being recognised, much effort is being made to remove the barriers and make use of the opportunities (Dougherty, Hobensack, and Bakken, 2023).

Africa's poor telecommunications infrastructure makes it difficult to connect healthcare facilities to the Internet and each other (Oughton, 2023, Haq et al 2023). This makes exchanging data and developing eHealth solutions difficult. Particularly in the medical sector, Africa needs skilled IT personnel (Horwood et al., 2023, Mamuye et al., 2023). Consequently, developing and putting into practice health informatics systems is difficult (Chilunjika et al., 2023). Funding for health informatics projects is limited and even expensive in Africa (Sato et al., 2023). This makes it difficult to grow health informatics initiatives (Mengiste et al., 2023).

There are signs of hope based on the possibilities that are accessible. Due of their widespread usage in Africa, mobile phones may be utilised to access mHealth applications. Applications for mHealth may be used for data collection, health education, and remote consultations. The wealth of health data in Africa can be used via data analytics to improve healthcare outcomes and quality. Data analytics enables targeted treatment planning, trend detection, and outcome prediction. As more and more African entrepreneurs develop health informatics solutions, innovation in Africa is flourishing. These solutions are often tailored to the particular needs of African healthcare systems.

Several initiatives are underway to address the challenges and use the promise of health informatics in Africa. These initiatives include the African Health Informatics Initiative (AHII) (Shi et al., 2023), the mHealth Alliance (Goldberg et al., 2023, Kola et al., 2023), and others. The African Union (AU) and the World Health Organisation (WHO) collaborated to develop the AHII to promote the use of health informatics in Africa. The non-profit mHealth Alliance aims to enhance health outcomes in developing countries by promoting the use of mobile technologies. The African Telemedicine Network (ATN) comprises medical facilities in Africa that provide remote telemedicine consultations (Geissbuhler et al., 2003; Wahba, Emara, & Elbokl, 2023).

These are just a few of the many initiatives being undertaken throughout Africa to promote health informatics. By encouraging the development and use of further health informatics technologies throughout the continent, these initiatives have the potential to enhance healthcare and its outcomes for all Africans significantly.

2.1.2 Examples of Innovative Applications in Health Informatics

Precision medicine, which combines genomic, clinical, and analytics data to customise medical therapies based on patient genetic profiles and environmental circumstances, is one innovative use of health informatics. Public Health Surveillance integrates data sources including EHRs, social media, and environmental sensors using health informatics to detect disease outbreaks and population health trends in real-time and provide prompt public health interventions (Olaboye, Maha, Kolawole, & Abdul, 2024b). This increases patient involvement in their treatment and promotes early intervention for the management of chronic diseases. To improve learning outcomes and treatment efficacy, the healthcare industry also makes use of augmented reality (AR) and virtual reality (VR) technologies for patient education, training, and therapeutic interventions. These technologies provide immersive experiences that mimic medical situations and procedures (O. B. Seyi-Lande, Layode, et al., 2024).

These technologies demonstrate the wide-ranging effects of health informatics on several healthcare domains, tackling contemporary issues in public health management and healthcare delivery while fostering innovation and enhancing patient outcomes. Technology advancement also helps improve production activities including supply chain (ARISEKOLA & RUFUS, 2022). To improve healthcare and increase fairness, efficacy, and patient-specific treatment, it will be crucial to use and integrate these emerging technologies (Johnson, Seyi-Lande, Adeleke, Amajuoyi, & Simpson, 2024).
In conclusion, major technical developments that have revolutionised the management and provision of healthcare have coincided with the emergence of health informatics. The delivery, monitoring, and optimisation of healthcare are being revolutionised by health informatics, from the early adoption of EHRs to the present-day frontier of AI and big data analytics. In the years to come, the continued use of new technology should improve accuracy, effectiveness, and patient-centered treatment, solidifying health informatics as a fundamental component of contemporary healthcare systems.

2.1.3 Impact of Health Informatics on Public Health

Health informatics is essential to transforming public health programs because it enhances illness monitoring, health data collection and analysis, research facilitation, and policymaking. This section provides case studies of successful initiatives and looks at how health informatics impacts public health in three key areas.

2.1.3.1 Enhanced Disease Surveillance and Outbreak Detection

Improving disease monitoring and early outbreak detection is one of the main advantages of health informatics in public health. The manual reporting techniques used in traditional illness monitoring approaches were labour-intensive and sometimes imprecise. Public health institutions may benefit from using health informatics techniques like real-time data analytics and predictive modelling to better track illness patterns (O. Seyi-Lande & Onaolapo, 2024).

For instance, doctors may quickly notify public health authorities about incidents thanks to electronic health records (EHRs) and health information exchanges (HIEs). Faster epidemic identification and prompt reaction actions are made possible by this real-time data sharing. Using digital contact monitoring applications and AI-driven epidemiological models, nations throughout the world monitored the COVID-19 pandemic's spread and carried out targeted public health interventions (O. B. Seyi-Lande, Johnson, Adeleke, Amajuoyi, & Simpson, 2024a).

2.1.3.2 Improved Health Data Collection and Analysis

Health informatics improves the quality and efficiency of data collection and processing, which is essential for evidence-based public health decision-making. Electronic data capture solutions reduce the errors associated with human record-keeping by simplifying data entry. Additionally, contemporary analytics techniques enable public health professionals to quickly analyse large datasets and identify patterns or correlations that might inform preventive health interventions (Abdul, Adeghe, Adegoke, Adegoke, & Udedeh, 2024e).

Population health management systems, for instance, integrate data from several sources (such as clinical records, environmental sensors, and socioeconomic variables) to create comprehensive health profiles. By using these profiles, public health professionals may identify at-risk populations, prioritise efforts, and distribute resources more effectively. These evidence-based tactics have been shown essential for reducing disparities, managing chronic diseases, and enhancing general community health outcomes (Olaboye, Maha, Kolawole, & Abdul, 2024c).

2.1.3.3. Facilitating Public Health Research and Policymaking

By giving researchers access to large datasets and advanced analytical tools, health informatics speeds up public health research. Using big data analytics and machine learning algorithms, researchers may find trends in illness, treatment results, and population health dynamics.

For instance, health informatics-enabled genetic data analysis has drastically changed our knowledge of hereditary illness susceptibilities and tailored treatment strategies. Additionally, data-driven modelling and simulation tools enhance decision-making processes by assisting policymakers in assessing the possible results of certain actions and policies before their adoption (Adekugbe & Ibeh, 2024b).

2.2. Case Examples of Successful Health Informatics Initiatives in Public Health

Several initiatives demonstrate the transformative impact of health informatics on public health:

• Global Polio Eradication Initiative: Health informatics was needed to monitor polio cases worldwide and coordinate vaccination campaigns. Real-time data monitoring and GIS (Geographic Information System) mapping enabled rapid outbreak response. It made it possible to conduct focused vaccination campaigns in high-risk areas (Thompson & Kalkowska, 2021).

• Networks of health information: Programs like the Indiana Health Information Exchange (IHIE) have improved patient outcomes and care coordination in the United States by enabling the secure exchange of patient data across healthcare providers. IHIE's expertise in data analytics is useful for population health and chronic illness management programs (Overhage & Kansky, 2023).

• Electronic Disease Surveillance Systems: Countries such as South Korea and Singapore have implemented sophisticated electronic disease surveillance systems that combine data from laboratories, medical facilities, and immigration records. These technologies played a crucial role in controlling epidemics such as SARS and MERS by enabling early identification,

contact tracing, and targeted quarantine measures (Raghavan, Demircioglu, & Taeihagh, 2021).
In summary, by enhancing disease monitoring, promoting research and policymaking, and enhancing data collection and analysis, health informatics is a powerful tool for enhancing public health. Digital technology may help public health organisations respond to medical crises more quickly, effectively, and efficiently. The success of these projects demonstrates how health informatics has the potential to transform healthcare delivery and improve population health outcomes globally. As the technology advances, more infrastructure investment and capacity building will be required to apply health informatics in public health successfully.

2.3 Challenges and Barriers

Health informatics, while promising significant benefits for healthcare and public health, faces several challenges and barriers that must be addressed to realize its full potential. This section examines key challenges, including data privacy and security concerns, integration and interoperability issues, technological disparities, and ethical considerations.

2.3.1 Data Privacy and Security Concerns

One of the foremost concerns in health informatics is protecting sensitive patient data. Electronic Health Records (EHRs) and health information systems contain highly personal information, including medical history, treatment plans, and genetic data. Ensuring robust data privacy measures is crucial to prevent unauthorized access, breaches, and misuse of patient information. Instances of data breaches in healthcare have underscored vulnerabilities in current systems. Cyberattacks targeting healthcare organizations can compromise patient confidentiality and disrupt healthcare delivery. Therefore, stringent security protocols, encryption standards, and access controls are essential to safeguard patient data against unauthorized access and cyber threats (Adekugbe & Ibeh, 2024b; Olaboye, Maha, Kolawole, & Abdul, 2024e).

Moreover, compliance with regulations such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States and the General Data Protection Regulation (GDPR) in Europe imposes legal obligations on healthcare providers and technology vendors to protect patient privacy and uphold data security standards.

2.3.2 Integration and Interoperability Issues

In order to enable integrated patient care and public health activities, health informatics often comprises of several platforms and systems that must transmit data smoothly. However, when several systems use disparate data formats, standards, and protocols, interoperability issues occur.
For example, mismatched EHR systems make it hard for medical professionals to share patient information, which might result in mistakes and unequal treatment. Try to close these gaps by using health information exchanges, or HIEs, to enable safe data flow across healthcare facilities. But reaching complete compatibility is still a difficult and continuous task. The goal of standardisation initiatives like Fast Healthcare Interoperability Resources (FHIR) and HL7 (Health Level 7) is to provide uniform frameworks for data transmission. However, to enhance care coordination and facilitate seamless interoperability across

healthcare settings, organisational, regulatory, and technological hurdles need to be eliminated (Olaboye, Maha, Kolawole, & Abdul, 2024d; Vorisek et al., 2022).

2.3.3 Technological Disparities and Access in Different Populations

The equitable application of health informatics for all populations is severely hampered by disparities in digital literacy and access to technology. Computers, smartphones, and a dependable internet connection—all necessary for the implementation of digital health solutions—may not be available in underserved and vulnerable areas, such as low-income individuals and rural areas (Abdul, Adeghe, Adegoke, & Udedeh, 2024d). Technical disparities may also be made worse by variations in healthcare facilities and resources. For example, telemedicine or remote monitoring would not be feasible in areas with inadequate medical facilities or bad internet access (Olaboye et al., 2024e; Simpson, Johnson, Adeleke, Amajuoyi, & Seyi-Lande, 2024).

To lessen technology disparities, targeted interventions are required, such as digital literacy programs, infrastructure upgrades, and culturally aware healthcare delivery models. Collaboration between the government, healthcare providers, technology developers, and community organisations is essential to bridging these gaps and ensuring equitable access to health informatics solutions (Ilori, Nwosu, & Naiho, 2024a).

2.3.4 Cultural beliefs

Health informatics is being significantly affected by cultural beliefs as it creates challenges in inclusive digital health interventions. Varied cultural values and norms may lead to differences in access and the use of digital health tools which potentially exclude underserved groups. To address this, systematic cultural adaptations are important to align antiprevention with the cultural context of the target audience (Nittas et al., (2024).

2.3.5 Religious beliefs

Religion shows some key challenges in health informatics, which mainly concerns the accurate representation of different religious beliefs that are within the database of healthcare. A work that is analysing Medline's content on end-of-life care across major monotheistic religions is found to be significant selection biases, and this includes an overrepresentation of authors from America and an underrepresentation of Islamic perspectives.

2.4 Ethical Considerations in Health Informatics

Health informatics raises several ethical concerns, such as data privacy, algorithmic decision-making fairness, patient autonomy, and consent. Ethical frameworks are needed to direct the appropriate use and management of health information as it becomes increasingly digitalised and accessible (Abdul, Adeghe, Adegoke, & Udedeh, 2024c). For instance, concerns of transparency, bias, and accountability are brought up by the use of AI and machine learning algorithms in clinical decision support. If algorithms created utilising biassed data are not adequately tracked and evaluated, disparities in healthcare outcomes and delivery might continue (Ilori, Nwosu, & Naiho, 2024b). Whether gathering and using health data for research or public health monitoring, it is equally critical to respect patient autonomy and informed permission. Patients' rights to confidentiality and privacy must be upheld throughout the whole data lifecycle, and they must be fully informed about the use of their data (Abdul, Adeghe, Adegoke, Adegoke, & Udedeh, 2024b).

2.5 Future Directions and Suggestions

Future advancements in health informatics might significantly affect public health outcomes and healthcare delivery. This section describes how different stakeholders contribute to the development of health informatics, examines possible future paths, looks at ways to solve present issues, and offers suggestions for maximising the use of technology in public health.

2.6 Potential Future Developments

Given how quickly technology is developing, there are a lot of possible future advancements in health informatics:

• Machine learning and artificial intelligence: AI systems will develop further, improving diagnosis accuracy, forecasting illness trends, and tailoring treatment regimens based on patient health information. Big data sets will be easier for machine learning models to analyse, yielding insights that public health agencies and medical professionals can use.

• Internet of Medical Things (IoMT): As wearable technology and sensors become more widely used, it will be possible to continuously monitor patient health indicators outside of clinical settings. The integration of IoMT devices with EHR systems will provide real-time data analytics, allowing for early intervention, chronic illness management, and remote patient monitoring.

• Blockchain Technology: Health informatics data security, integrity, and interoperability might all be enhanced by blockchain technology. It may enable medical professionals to safely and openly share patient data while protecting patient confidentiality and permission.

• Virtual and Augmented Reality: In addition to training and simulation, these technologies will improve surgery planning, rehabilitation therapy, and patient education. Immersion experiences made possible by VR and AR technologies will enhance patient involvement and treatment results.

2.7 Current State of AI Policy and Regulation in Africa: Formal Education Programs: Include artificial intelligence (AI) courses at the graduate and undergraduate levels. Professional Development Courses: Provide instruction to professionals who want to advance their AI skills. Learning environments and online courses: Make use of educational environments and internet resources to provide chances for independent study and skill improvement. On-the-job training programs and mentoring: Provide employees with opportunities for experiential learning and mentoring so they may use their AI expertise in practical settings. Seminars, conferences, and workshops: To promote professional networking, exchange best practices, and increase knowledge about artificial intelligence, plan conferences and events.

Technical personnel, including developers, engineers, data scientists, and everyone else engaged in the technical aspects of AI research and implementation, are the target of initiatives for capacity development and training. Managers, executives, and decision-makers are among the other business professionals who must comprehend how AI may affect their companies and sectors. Government leaders and regulatory organisations entrusted with developing AI laws and frameworks are known as policymakers and regulators. It is the duty of educators and trainers, including instructors, training specialists, and teachers, as well as the general public, to include AI into educational pursuits. raising public knowledge and comprehension of AI in order to encourage thoughtful deliberation and decision.

Training and capacity building programs need to include specialist teaching methods and experience learning. Create specialised training curricula that consider the target audience's unique requirements and proficiency levels. Using case studies, simulations, and practical projects, allow students to put what they have taught about artificial intelligence into practice. cooperation between business and academics. Form alliances between companies and educational establishments to guarantee that training curricula satisfy industry demands. Supporting and promoting lifelong learning and skill development is essential to keeping up with the rapid advances in AI technology. multilingual education that takes cultural differences into consideration. To guarantee accessibility and diversity, provide training materials and resources in several languages while taking cultural sensitivity into consideration.

Results of capacity-building and training programs, such the increase in the application of AI. enabled people and organisations to embrace and use AI into their operations and procedures with confidence. increased production and inventiveness. promoted creativity and increased productivity in a variety of industries via the effective use of AI. improved results via the use of fact-based and well-informed decision-making procedures. economic expansion and the generation of jobs. promoted the development of AI-driven sectors and skill sets, which strengthened the economy and contributed to employment creation. Progress and Social Integration. using AI to address social issues and empower underprivileged people to promote inclusion and improve society.

2.8 Strategies to Address Current Challenges and Barriers

To overcome the present health informatics difficulties, certain strategies and actions are required:

i. To guard against data breaches and cyber threats, healthcare organisations need to have strong cybersecurity measures in place, such as encryption, access restrictions, and frequent security audits.
ii. Enhancing the digital skills and health literacy of patients and healthcare professionals is necessary to reap the full benefits of health informatics.
iii. In order to ensure that all groups have equal access to and comprehension of digital health technology, training programs and instructional materials must be customised for each group.
iv. For smooth data transmission and interoperability across various health information systems, ongoing attempts to standardise data formats, interoperability protocols (like FHIR), and medical language are essential.

2.9 The Role of Stakeholders in Advancing Health Informatics for Public Health

Governmental organisations, medical facilities, IT companies, and educational institutions are some of the key stakeholders in the development of health informatics.

• To encourage innovation in health informatics, governments should pass laws, provide funding for infrastructure and research, and set up suitable regulatory frameworks. Governmental organisations are essential in making sure that data privacy rules and regulations are followed.
• Clinical use of health informatics technology are overseen by medical professionals. To successfully utilise digital health solutions, they must support user-friendly systems, take part in technological review and approval procedures, and strive for ongoing professional development. Technology developers are responsible for creating and improving health informatics solutions that satisfy the requirements of patients and medical practitioners. Usability, interoperability, and data security should be given top priority while developing new products, and they should keep up with industry standards and technological developments.
• Through research, instruction, and business partnerships, academic institutions promote the field of health informatics. They must conduct in-depth research, present the results at conferences, and educate the next generation of informatics experts in order to assess the efficacy and impact of health informatics projects.

2.10 Theoretical Review of the Study

This study is based on Health Belief Model (HBM) as the theory provides a framework for how the perceptions of individuals and systematic factors that affect health decision making. While it is traditionally employed in studying health behaviour, the HBM can be employed in exploring the health informatics integration and the analysis of data. This theory shows the essence of perceived benefits, self-efficacy in the adopting new health practices and self-reliance and technologies. Adapting this to the context of health care analysis in Africa, the HBM shows how the stakeholders, providers of healthcare and policy makers have to perceive the value of informatics system to improve the outcomes in supporting the adoption of healthcare. In an attempt to address the barriers that are perceived that include technological innovations, concerns of data privacy, and gaps in infrastructure that promote the benefits that are perceived through education, successful case studies etc. This theory underlies the need to align technological advancement with systematic realities and social content.

2.11 Empirical review

Cahyo and Astuti (2023) reviewed the literature on the use of artificial intelligence (AI) technology in hospital information management for the early identification of health risks. The research found that to encourage the early detection of health problems, the most successful hospital service quality subsystems need to make it easier for patients to use an integrated hospital management information system. Artificial intelligence (AI) is being used more and more in clinical care. Diagnostics has historically been one of the main areas in which AI has been used in medicine. Artificial intelligence will have a big influence on medical imaging diagnostic and predictive analysis in the years to come. Studies in the fields of pathology and dermatology have shown that artificial intelligence (AI) can accurately detect and classify a wide variety of cancer types, surpassing human diagnosis. According to the study's results, artificial intelligence (AI) may be used to assess the risk of mental illness and suicide in people with mental health issues or in certain populations, such as prisoners and military members. Allowing physicians to get information about illnesses more quickly and to diagnose ailments more precisely, shortens the time required to cure illnesses.

In 2023, Singh et al. conducted a cutting-edge assessment of the use of AI to rotating industrial machine failure diagnostics. Their research concentrated on the use of AI-based defect detection algorithms that have shown success when applied to a range of industrial equipment (i.e., 2000 to 2020) by analysing important literature from the last 20 years. Support vector machines (SVM), fuzzy logic (FL), deep learning (DL), and artificial neural networks (ANN) were among the AI techniques examined in the research. We looked at research on AI-based diagnostics for a variety of industrial equipment, such as induction motors, gears, bearings, and centrifugal pumps. They concluded that industrial machine diagnostics and fault monitoring are essential to the industry 4.0 transformation, even if they are often challenging and labour-intensive. Artificial intelligence (AI) technology is becoming more and more relevant for condition monitoring.

3. Methodology

The study made use of the normal least square method for the analysis of the data of the study. The method of least square minimizes the sum of the square differences between predicted and observed values which ensures the best-fit line for data. It is commonly used for making predictions that are accurate and for the analysis of relationships in regression models. The data is a panel data with scope that range from 2009 to 2023. Below is the functional model of the study and it is stated as follows;

$$LFE_{it} = \beta_0 + \beta_1 NFMATICS_{it} + \beta_2 PI_{it} + \beta_3 GEXPPC_{it} + \mathcal{E}_{it}$$

Note: LFE is life expectancy at birth,

INFORMATICS = This was proxied by Mobile cellular subscriptions (per 100 people)

GEXPPC = Domestic General Government Expenditure on Health per capita, Current USD.

β_0= Constant,

$\beta_1 - \beta_3$ = the slopes of the independent variables of the study.

4. RESULTS AND DISCUSSION

Table 4.1: Descriptive Statistics

The statistics in table 4.1 show the mean of the data, the median, the minimum, maximum, standard deviation and Kurtosis as it gives more information on the data used for the study.

	LFE	MCS	GEXPPC	PI
Mean	61.03799	75.89262	55.08558	2456.228
Median	60.83200	73.73358	12.54271	1143.672
Maximum	77.23659	185.5593	610.7978	19141.51
Minimum	44.03400	4.576366	0.904166	199.0976
Std. Dev.	5.515965	36.33385	97.75705	3234.954
Skewness	0.270617	0.480729	2.829510	2.591895
Kurtosis	3.945287	2.667227	11.70343	10.16267
Jarque-Bera	28.87155	25.18836	2622.504	1902.270
Probability	0.000001	0.000003	0.000000	0.000000
Observations	584	584	584	584

Source: Source: Computed by the Author, 2024

Statistical summaries of 584 observations for the four variables PI, GEXPPC, MCS, and LFE are included in the dataset. LFE has an average mean of 61.04 and a modest standard deviation of 5.52. With a Kurtosis value of 3.95, which is close to normal, its distribution is somewhat skewed to the right (Skewness = 0.27). MCS has a higher mean (75.89) and greater variability (Std. Dev = 36.33), indicating a wider range of values. Its skewness (0.48) and kurtosis (2.67) indicate that its distribution is balanced and somewhat flat. In contrast, GEXPPC has significant positive skewness (2.83), a heavy-tailed distribution (Kurtosis = 11.70), and a high degree of variability (Std. Dev = 97.76). It indicates outliers or concentrated high values since its median (12.54) is much lower than the mean (55.09). Outliers are also detected by PI, which has the largest variability (Std. Dev = 3234.95), a median (1143.67) that is much lower than the mean (2456.23), and a substantial positive skewness (2.59). All variables seem to be non-normal based on the Jarque-Bera test (p-values < 0.00001).

Table 4.2: Pairwise Granger Causality Tests

This table shows the relationship between the dependent variable and the independent variables.

Pairwise Granger Causality Tests

Sample: 2009 2023

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
INFORMAT does not Granger Cause LFE	554	5.28803	0.0043
LFE does not Granger Cause INFORMAT		0.11467	0.8917
GEXPPC does not Granger Cause LFE	508	0.79628	0.4516
LFE does not Granger Cause GEXPPC		6.09732	0.0024
PI does not Granger Cause LFE	558	21.6378	9.E-10
LFE does not Granger Cause PI		4.25672	0.0146
GEXPPC does not Granger Cause MCS	496	4.13984	0.0165
MCS does not Granger Cause GEXPPC		0.45831	0.6326

Source: Computed by the Author, 2024

The results in the table above show that informatics granger causes health outcomes in Africa. On the other hand, health outcomes do not granger cause informatic as this shows a unidirectional relationship between the two variables.

Table 3: Regression Results

Dependent Variable: LFE

Method: Panel Least Squares

Sample (adjusted): 2009 2021

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFORMATICS	0.051053	0.007134	7.156665	0.0000
GEXPPC	2.62E-05	0.004137	0.006333	0.9949
PI	0.000418	0.000112	3.724379	0.0002
C	56.13612	0.514176	109.1767	0.0000
R-squared	0.260994	Mean dependent var		61.03799
Adjusted R-squared	0.257172	S.D. dependent var		5.515965
F-statistic	68.27948	Durbin-Watson stat		0.034911
Prob(F-statistic)	0.000000			

Source: Computed by the Author, 2024

The results of the panel least squares regression analysis look at life expectancy (LFE), the independent variables INFORMATICS, GEXPPC (domestic general government expenditure on health per capita, current USD), and PI (an extra independent variable). The positive and statistically significant coefficient for INFORMATICS (0.051053, p = 0.0000) indicates a positive correlation between higher informatics values with longer life expectancies. Similarly, increasing PI seems to improve life expectancy, as shown by its statistically significant positive effect on LFE (0.000418, p = 0.0002). However, GEXPPC does not seem to have a significant effect on life expectancy, as shown by its near-zero coefficient (2.62E-05) and high p-value (0.9949). The constant component (C), which denotes a baseline level of life expectancy, is also quite significant when all other variables are held constant.

R-squared = 0.260994 indicates that the model has a moderate level of explanatory power, accounting for around 26.1% of the variance in life expectancy. The low Durbin-Watson score (0.034911) suggests that potential issues with autocorrelation in the residuals may affect the reliability of the estimations. The F-statistic (68.27948, p = 0.0000), which shows that the independent variables together explain a significant portion of the variation in life expectancy, validates the model's overall statistical significance. Despite the model's significance, the lack of relevance of GEXPPC raises doubts about the specific nature of the relationship between health expenditure and life expectancy in this context, suggesting that other factors may have a greater impact on life expectancy.

5.1 Conclusion

To sum up, this study has examined several aspects of health informatics and how it relates to public health, bringing to light important problems and difficulties in the area. We looked at how health informatics supports public health research and policymaking, improves disease monitoring via real-time data analytics employing cutting-edge technology, and strengthens health data collecting and analysis for evidence-based decision-making.

It is impossible to overestimate the importance of technology utilisation in health informatics. By improving the effectiveness, precision, and accessibility of healthcare services, it presents previously unheard-of chances to revolutionise healthcare delivery. Artificial intelligence (AI), machine learning, and the Internet of Things (IoT) have the potential to transform remote patient monitoring, personalised therapy, and diagnosis, therefore enhancing the health and well-being of both people and communities.

Health informatics has a bright yet challenging future. Technological developments will impact healthcare by providing creative answers to persistent public health issues. To fully use health informatics, however, it will be essential to manage concerns like data security, interoperability, and fair access to technology. Collaboration between academics, government organisations, healthcare professionals, and technology developers is necessary to incorporate health informatics into public health practice. A long-term framework for using technology to enhance population health outcomes may be established by fostering multidisciplinary cooperation, investing in digital infrastructure, and endorsing regulations that prioritise patient privacy and data security.

5.2. Recommendations

To fully utilise health informatics, politicians and public health officials should consider the following recommendations:

- Governments and healthcare organisations should prioritise investments in digital infrastructure, such as interoperable EHR systems, telehealth platforms, and internet connectivity. Strong frameworks must be developed to guarantee data security, protect patient privacy, and preserve ethical norms in health informatics. Many communities can now more easily access digital health services because of this infrastructure, which also makes data transfer easier. Policymakers should collaborate with interested stakeholders to develop specific regulations for the collection, archiving, sharing, and use of data in healthcare settings.
- Collaboration among academics, policymakers, technology developers, and healthcare professionals promotes innovation in health informatics. The development and use of innovative technologies that effectively address public health concerns may be the responsibility of interdisciplinary teams.

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