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International
Journal
Of Modern Engineering Research (IJMER)

Optimising Health Research in Nigeria: Leveraging Pervasive Computing and Mobile Phone Data Collection for Enhanced Analysis and Dissemination

Popoola Olusegun Victor
Kingstar Institute of Management Science and Technology Oyo-State Nigeria.

Oyetunde Christian Oyedeji
BlueSky Citadel 193 Crayford Rd.London

Adebayo Adeyinka Victor
Electrical Department, University of Johannesburg, South Africa

Abstract
This paper ventures into optimising health research in Nigeria by integrating pervasive computing and mobile phone data collection. The study highlights these technologies' ground-breaking potential to enhance health information's accuracy, timeliness, precision, coverage, comprehensiveness, and comparability. This, in turn, can revolutionise policy formulation, planning, implementation, and management, leading to significant advancements in health research. The paper underscores the crucial role of these technologies in effectively addressing the current challenges in Nigeria's health research ecosystem, such as data accuracy and timeliness, by leveraging the widespread use of mobile phones and advancements in data collection technologies. The research focuses on the benefits of using mobile phone data for large-scale, cost-effective epidemiological studies and the role of pervasive computing in facilitating continuous data collection and analysis. Importantly, it stresses the crucial role of effective dissemination strategies in making research findings accessible, understandable, and actionable for policymakers, practitioners, and the public. The paper concludes by inviting the reader to actively participate in adopting these innovative approaches, which will significantly contribute to achieving the Sustainable Development Goals (SDGs), particularly SDG3, by ensuring healthy lives and promoting well-being for all ages, ushering in a new era of health research in Nigeria.

Keywords: *Health Research, Nigeria, Pervasive computing, Mobile phone data collection, Epidemiological studies, Data dissemination, Sustainable Development Goals (SDG3)*

Date of Submission: 01-07-2024 Date of acceptance: 12-07-2024

I. Introduction to Health Research in Nigeria

In conclusion, the Health Data Collaborative Nigeria plays a pivotal role in the innovation of pervasive computing, enabling Nigeria's health research ecosystem. The data collected would be enhanced accuracy, timeliness, precision, coverage, comprehensiveness, and comparability of health information at all levels, optimising policy formulation, planning, implementation, and management. Additionally, this innovation would support an evidence-driven decision-making culture at all levels for improved population health outcomes and more vital health institutions. The widespread adoption of the approach, with the active involvement of researchers, policymakers, and practitioners, will contribute directly to SDG3 by ensuring healthy lives and promoting well-being for all ages (Mbam et al., 2022). Research provides the foundation for building innovative medicines and foresight to address future health challenges. Health research provides evidence for sound policies and systems vital for well-functioning health systems. Nigeria is the most populous country in Africa, with an estimated population of 186 million people. It has a diverse mix of ethnic groups, including three major tribes – the Yoruba, Igbo, and Hausa – although there are over 500 languages spoken. Nigeria has a very young population with an average age of 16 years due to high fertility rates and low reliance on modern methods of contraceptive use. The population growth rate is 2.6%, one of the highest in the world (Hussaini et al., 2020). In

2015, world leaders adopted a new set of global goals, "Sustainable Development Goals" (SDGs), to be achieved by 2030. The SDGs are intended to end poverty, protect the earth, and ensure prosperity for all. Protecting the health of all people is a particular goal. However, achieving the 2030 SDG goals is threatened by Nigeria's current ill health burden (Akinyemi et al., 2021). In this paper, we describe the efforts of the Health Data Collaborative Nigeria to optimise health research in Nigeria by leveraging pervasive computing, and we invite you to join us in this crucial endeavour.

1.1. Overview of the Current Landscape

Research and data collection in Nigeria have relied heavily on face-to-face interviews for data collection, requiring a considerable logistics effort for the fieldwork, particularly if the target interviewees are in the remote rural areas where most of the Nigerian population reside (Turke et al., 2021). Typically, data collection and analysis are performed languidly, sometimes due to logistics challenges if the interviewers travel from one end of the country to the other. Data duplication and manipulation risk is high, mainly if inexperienced enumerators are used. With the simultaneous enrollment and data recordings, long-term participant monitoring is minimal. Data analyses are performed, and papers are written at the convenience of the researchers and, in most cases, not available for policy change. Over the years, conducting research in Nigeria has become increasingly difficult and complex (Gourlay et al., 2021). With the pervasive growth of mobile phone and broadband networks in Nigeria, can a more accessible, cheaper, and faster way for clinical care and research enablement genuinely come to fruition? To address health disparities in Nigeria and improve population health, considerable effort has been invested in research and programs in the country, both by local institutions and the international community. Generally speaking, research efforts have aimed at deeply understanding underlying causes perpetuating the poor state of health care in a developing context and identifying the health care delivery model most appropriate for successful implementations and scale-up. In recent years, many studies have focused on the efficacy of mobile phones, telemedicine, and pervasive computing on healthcare delivery in remote areas, hoping to validate the reported improvements observed in the financial, agricultural, and governance sectors (Banda et al., 2024). Furthermore, the review process has issues with lax ethics and the challenge of sustaining long-term longitudinal care.

1.2. Challenges and Opportunities

Data from the digital IDSR form is transmitted via mobile networks on the public health database PHPD and reviewed during WHO's web-based health emergencies program services daily and weekly roundtables (Adeke et al., 2021). The full potential to modify and analyse massive data sets optimised for public health research and emergency response awaits integrating existing tools within high-bandwidth communication networks, enabling parallel and real-time input and output. While the current infrastructure has flaws and would benefit from increased support and oversight, these open-source tools lay the foundation to significantly improve Nigeria's disaster and public health research. While the various strategies are beneficial, often, they are limited by the burden of resource collection and access. Cloud architecture has tremendous potential for research optimisation. A comprehensive, interconnected surveillance system embedded within a robust research monitoring and evaluation framework is essential to achieve the full potential for large-scale data collection and analysis. The Nigeria Field Epidemiology and Laboratory Training Program (NFELTP) is continuously building the capacity to identify and respond to health needs (Ajayi et al., 2020). This EOC-ward engagement model established the Integrated Disease Surveillance and Response (IDSR) program and monitored routine surveillance indicators. These data form the bulk of information used during the response, post-analysis, and evaluation (Adewuyi et al., 2022).

II. Pervasive Computing in Health Research

Consequently, the silos created by the difficulties of data collection and the lack of seamless ways to access and re-use health data for research and practice result in lost opportunities for development. Connective technologies can weave together all the research involved in the characteristics of human growth, encompassing the integration of mobile systems, data networks, and remote access to data storage. Personal health data no doubt have the potential to provide the missing links in understanding the relationship between living conditions and disease. By strategically harnessing personal health data from the myriad of mobile data collection efforts in society, researchers can help answer critical questions to advance the health of citizens in Nigeria. Scientists believe that the widespread availability of digital mobile phone data may generalise the potential to monitor diseases and provide parameters that can be used to predict disease outbreaks (Alsunaidi et al., 2021). One promising avenue for achieving this is using pervasive computing technologies to collect health status and indicators data. Pervasive computing, a widely acknowledged and revolutionary paradigm supported by a plethora of devices and systems that are unobtrusive, intuitive, and part of our everyday lives, holds the promise to radically transform health research globally. Devices and systems enabling pervasive monitoring of an

individual's health and bio-behavioural patterns and acting to enhance health and safety are engineering the field of pervasive health. The widespread utilisation of these pervasive computing systems, which hail from different areas such as embedded systems, mobile systems, and networked sensor systems, coupled with the seamless integration of computational elements into human life, promises to significantly enhance health research globally (Ahn et al., 2021).

2.1. Definition and Concepts

The latest attention of health experts postulated that the health of each person is not only determined by that person's inherited individual determination but also by the environment around that person. The principle is that society is a significant determinant of individual health. However, society in the form of a neighbourhood, community, city, or society can contain the keys that contribute to the health of individuals in it. For example, the society we live in can determine whether we have access to healthy things or not. These include nutritious food stores, feasible outdoor and indoor physical activity opportunities, a clean environment, resources to support positive social relationships, the accessibility of high-quality medical care, reliable and affordable transport systems, and a good environment. Any of these factors can contribute to making or breaking health. Epidemiology is the study of the distribution and determinants of health-related states or events (including disease) and the applications of this study to control diseases and other health problems. The science can also be considered to study the interaction of host, agent, and environment. We have two types of health determinants: social and population determinants of health, also called public health determinants. There is not much difference between the two; both face the health of humans in society, but the public health factor covers the population's health, while the social health factor covers that person's health. However, the balance between the two determines the current health status and significant public health challenges in different communities (VanderWeele et al., 2020; Sullivan & Thakur, 2020).

2.2. Applications in Healthcare

At over 140 million strong, Nigeria has one of the largest populations in Sub-Saharan Africa but one of the lowest physician-to-patient ratios. In Nigeria, there are more physicians per thousand people in urban areas than in rural areas. The consequence of this exodus of skilled healthcare personnel is that the few available hospitals and clinics are overcrowded with patients. Presently, a challenge facing Nigerian healthcare services is the diagnosis and treatment of chronic and lifestyle diseases such as heart disease, hypertension, obesity, and diabetes that are prevalent among urban city dwellers. Due to the high demand for healthcare services from a small pool of doctors, patients have long waiting times before they can be attended to, thus increasing the associated costs of services. Consequently, fewer patients can be seen on a typical day, and the practitioners are often overworked. This dwindling supply of physicians and the fragile healthcare infrastructure make mobile health (mHealth) an exciting research area for patents and product development. With the proliferation of mobile phones and computers combined with the wide-reaching World Wide Web, applying pervasive computing in healthcare is bound to generate profound impacts and significant benefits. There are numerous potential benefits to communities and nations when applying pervasive computing systems in developing healthcare applications, particularly in Nigeria, where deficiencies in infrastructure are well documented. Pervasive computing in healthcare could enable patients living in underserved areas to benefit from services that would not have otherwise been available through remote monitoring, diagnosis, or treatments and help ameliorate the problems of overworked healthcare professionals and double their efficiency. It can also help streamline and re-engineer existing healthcare business processes. Here, we provide healthcare examples relevant to Nigeria, where the residents often have limited or no physician access (Onu et al., 2021; Bernard et al., 2023; Halle et al., 2020).

III. Mobile Phone Data Collection in Health Research

In the developing world, the rapid deployment of telecommunication infrastructure, such as mobile phones by service providers, offers new opportunities for the conduct of large-scale, cost-effective epidemiological research. The acceptable first step to data collection is using a mobile phone's short text (SMS: short message service) functionality, allowing the bidirectional exchange of messages that fit into less and more literate populations(Rotondi et al., 2020). Unless the population has access to computers (or access to paper and pen to complete a survey and subsequent capture of data into a computer), the ability to send hundreds, if not thousands, of questionnaires and receive them back can be labour-intensive and time-consuming. With a relatively short questionnaire and timely analysis, mobile phone data collection theoretically allows results that can inform on steps to be taken within the study period. It could also provide study results to the study population and other stakeholders in real time. In the developed world, sending and receiving text messages and browsing the internet have become standard applications on current devices, and people of all socioeconomic and educational levels use them in their daily business(Khan et al., 2020). These capabilities make mobile

phones an ideal tool for health research that can reach across communities to collect primary data promptly(Oladejoet al., 2014). Recent advances and increased sophistication of mobile device capabilities have thrown up opportunities for innovative applications across various public sectors, including health and health research. Over 5 billion people worldwide have access to a mobile phone, and this device's data extraction capabilities are vast and frequently underused(Salih et al., 2020). Available datasets could be leveraged for various health research topics, ranging from disease monitoring and surveillance to research that informs healthcare practice and makes systems more effective.

Health research in Nigeria faces numerous challenges, including limited resources, inadequate infrastructure, and a shortage of trained personnel. However, the increasing availability of mobile phones and advancements in pervasive computing offer significant opportunities to overcome these barriers. The attached figure illustrates how mobile phone data collection can be integrated with pervasive computing to optimise health research in Nigeria. Integrating mobile phone data collection and pervasive computing presents a powerful approach to optimising health research in Nigeria. Researchers can overcome many existing challenges by leveraging these technologies, enabling more effective and efficient health interventions. However, addressing technological, privacy, and infrastructure barriers is essential to fully realising the potential of this approach. Figure 1 visually represents how these technologies can be harnessed to enhance health research and improve public health outcomes in Nigeria.

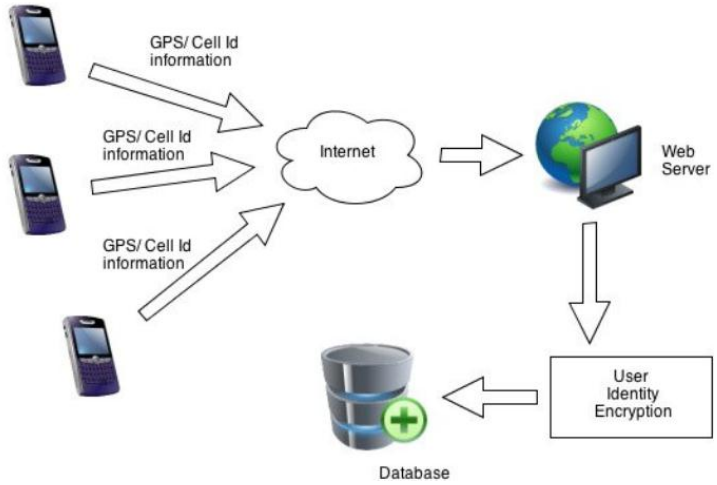

Figure 1: Active Data Pool from Mobile Phones

3.1. Advantages and Limitations

Statistical analysis methods are at the heart of many software solutions for health research. These methods are the tools by which we hope to draw objective and transparent conclusions from health research. We can use such tools to summarise and display key outputs of health interventions to support decisions related to resource allocation. By transferring the power of pervasive computing to group analysis, vast amounts of data already gathered can even be good surrogates for the effects of neglected actions (Olamoyegun et al., 2020). Regarding the basic features of data, population estimates from data samples are well understood and discussed in elementary statistics courses. Innovative rapid analysis methods were the main driver behind the widespread use of telemedicine applications today. Put, pervasive computing-associated rapid analysis tools will make up an essential portion of the corresponding toolkit in health research. The current health designs and survey building applications are mainly designed for personal computers and not for distribution by mobile phones or to supply the ability to insert results into instantly created end-user documents automatically. Tables 1 and 2 below show the advantages and limitations of statistical analysis methods in health research and some critical examples.

In addition to the widespread use of mobile phones, they have continued to provide easy access to data collection and the automation of results reports. In other words, pervasive computing and mobile phone data collection can serve as game changers for the constraints associated with public health research in Nigeria. Another consideration for conducting such research in Nigeria is that most of Nigeria's population, mainly those in rural areas, does not have the necessary expertise in fundamental statistical analysis using personal computers and cannot pay a data analyst (Harris et al., 2021). Thus, it takes too long for most Nigeria-based researchers to prepare their data. For researchers, some advantages of pervasive computing include the ability to harness large and multifaceted data sets, rapid and automated data analysis, development and deployment of software for problem-solving, and the ability to automatically observe a system under study and extract valuable features in real time. Optimising public health research in large low- and middle-income countries like Nigeria cannot be

overemphasised. However, public health research in these parts of the world tends to be limited in scope and relevance because they are poorly planned, has insufficient sample sizes, is conducted over short durations, and is not conducted meaningfully at multiple levels (Iliya and Ononiwu2021).

Table 1: Advantages of Statistical Analysis Methods in Health Research

Advantages	Examples
Objective and Transparent Conclusions	Statistical methods allow researchers to analyse a new drug's effectiveness objectively, providing clear evidence of its benefits and side effects. This transparency helps in gaining regulatory approval and public trust.
Resource Allocation Support	Health interventions can be evaluated using statistical tools to determine where resources should be allocated most effectively, such as identifying areas with the highest disease prevalence.
Data Summarization and Display	Visualisations like graphs and charts can help summarise complex health data, making it easier for decision-makers to understand trends and outcomes.
Handling Vast Amounts of Data	Pervasive computing can manage large datasets from multiple sources, such as electronic health records, to identify patterns and correlations that might be missed with smaller datasets.
Rapid Analysis and Telemedicine	Innovative rapid analysis methods facilitate the quick assessment of patient data in telemedicine, allowing for timely interventions and remote monitoring of health conditions.
Automation and Real-Time Observation	Automated data collection and analysis tools can continuously monitor patient vitals, providing real-time feedback to healthcare providers and enabling proactive health management.
Access and Usability via Mobile Phones	Mobile health apps can collect and analyse patient data, making healthcare more accessible, especially in remote areas where traditional healthcare infrastructure is lacking.

Table 2: Limitations of Statistical Analysis Methods in Health Research

Limitations	Examples
Technological Barriers	In regions like rural Nigeria, there may be limited access to personal computers and the internet, hindering the use of advanced statistical tools and software.
Lack of Expertise	Many individuals in low- and middle-income countries lack the necessary training in statistical analysis, making it challenging to analyse and interpret health data without professional assistance.
Poor Research Planning	Health research in low-resource settings often suffers from insufficient planning, resulting in studies with limited scope, small sample sizes, and short durations, reducing the validity and applicability of findings.
Limited Mobile Phone Distribution	While mobile phones can enhance data collection, not all health research applications are designed for mobile platforms, limiting their usability and effectiveness.
Data Privacy and Security Concerns	Handling large health datasets, especially mobile devices, raises significant concerns about data privacy and security, which must be addressed to protect patient information.
Infrastructure Challenges	In many developing regions, the necessary infrastructure to support pervasive computing and rapid data analysis may be lacking, affecting the implementation and effectiveness of these methods.
Financial Constraints	Many researchers in low- and middle-income countries cannot afford advanced statistical software or the services of data analysts, limiting their ability to conduct comprehensive health research.

Integrating statistical analysis methods and pervasive computing in health research offers numerous advantages, such as enhanced data analysis, resource allocation, and real-time monitoring. However, challenges like technological barriers, lack of expertise, and infrastructure limitations must be addressed to realise their potential, particularly in low-income- and middle-income countries.

3.2. Best Practices

Survey participant identification will include matching against the service centre patient database. Geographic Information Systems analysis will inform the establishment of survey boundaries. The project will augment its data collection with facility and client data verification and procedure audit focused on increasing the quality of survey data. All data collection efforts beyond logistical data will benefit from development implementation testing (DIT) and validation through in-service centre activities (Stephenson et al., 2021). The collaboration will inform the data analytics required post-visit versus data collected/analyses done during the visit. The mobile survey data productive capacity of each site or data centre becomes a vital selection strategy at the anterior phase of the project. However, contingencies in capturing volumes of analytics are necessary during project implementation (Challen et al., 2021). Data capture from clients will be integrated into a standard data processing scheme. The data capture scheme will have minimal impact on project participants but credibly link survey findings to site data for further analysis. Best practices to be observed in any survey featuring pervasive computing and mobile phone applications should include the stakeholder validation meetings with existing and potential data service centres in the organisations/regions with significant data on project priority conditions (Levis et al., 2020). The meetings will present knowledge transfer as a model for increasing impact, resolving voiced concerns, and linking project objectives to organisational and regional health data priorities. The project will conduct a robust survey design with daily data analyses. The survey materials will be selectively loaded into service centre data infrastructures to initiate data processing once they leave the mobile devices. In collaboration with service centres, the project will leverage post-visit data analyses, facility and participant data verification, and participant audit capabilities available in the data centre advanced analytical tools to

merchandise service or covered activities and conduct real-time data analysis for further data-dependent survey design improvements.

IV. Enhanced Analysis Techniques

We need to start using the information available on individuals for measurement and intervention. This includes sensor data and ecological momentary assessment collected from various devices. This applies in particular to mobile devices, which are becoming the primary gateway to the internet, and these activities are creating large amounts of data. Issues such as consent, confidentiality, privacy, the use of passive data collection techniques, and the volume, velocity, and variety of big data need to be addressed in ways that do not stifle the scientific exploration that can be addressed. We need to take systems biology even further by combining the scientific proof of the impact of social and behavioural factors on health outcomes with prevention and promotion (Ochoa et al., 2022). To do this, we will need to understand the role of the individual within their social network. The widespread use of the internet and the introduction of social media platforms (to name just two examples) have created social connections and online relationships that have never before been possible. These developments offer unique opportunities to influence health at the health promotion and disease prevention levels that are not dependent entirely on local resources (Leo & Clement, 2022).

4.1. Data Mining and Machine Learning

Exploratory Data Analysis (EDA) visualisations could have been used with the data presented byFalodun et al. to explain the rate of missingness characteristics of the micro-level data before health policy decision-makers used it. These visualisations would have utilised simple graphs to communicate a qualitative at-a-glance understanding of the missingness characteristics of the data, which health policy decision-makers would have engaged in the process of optimising research that contributes to positive outcomes for individuals who are at the subject population level within the targeted country location level. As an example, the exploratory analysis within just one template in R software called ExPanD, created by Guido Schwerdt and Verena Zimmert, could have been used to display the distribution properties of the missingness for the variables specified and to illustrate differences in missingness for different subgroups. After the analyses from the data mining process, communication could have involved explaining the results using non-specialist language because of the critical importance that the results had in either disproving the hypothesis, thereby initiating a chain reaction leading to further changes made upstream of health information presented and interpretation based on its content.

Future work could invest in evaluating the proximity of external risk factors relentlessly labelled as "missing" by comparison with held-out external data sources that have identified these as significant risk factors for COVID-19 case severity. Using similar conceptual premises, such as those of a systematic literature review, data mining and machine learning could also extract helpful information from myriad health reports and databases or patient records to scale evidence-based health policy analysis 'cliff walls'. Bi et al. attempted to identify and classify noise complaints in an airport community by deriving a method that accurately locates noise complaints throughout days in the community using Twitter data. Nearly 100k complaints were collected from 3 Chinese social media platforms (Sinaet al.), and these complaints were then classified using a classification model based on a random forest. The model achieved high scores for the importance measures (0.96 and 0.80) for classifying noise complaints and determining the relationship between complaints and specific operations at the airport (Adebayo et al., 2022). Their approach highlights the capability of data mining social network source data for civil infrastructure applications where accurate and frequent complaints could be used to identify and mitigate social impacts.

4.2. Spatial Analysis

Spatial methods for human health research are critical for generating evidence for informing infectious and non-communicable diseases, injuries, and toxic exposure policies. Quantifying hazard levels for local areas is central to understanding the contribution of the environment to health and identifying environmental equity issues. It is also a fundamental aspect of risk communication studies. Such knowledge is helpful for public health decision-making and health policy. This chapter reviews the key areas of health research where spatial data help answer health research questions. It summarises the diverse types of spatial analysis methods used and their limits. Spatial analysis refers to studying spatial relationships, interactions, and patterns to overcome location-dependent issues common in health research (Wang, 2020). Spatial analysis involves the integration of critical spatial attributes in designing research questions, data collection protocols, and analysis techniques. However, spatially explicit individual data could leverage a more holistic understanding of the mechanisms governing the distribution and spread of diseases, the nature of interactions, and the forces determining infectious disease outbreaks. Understanding such spatiotemporal dynamics becomes more significant for diseases transmitted via close-contact networks (Labib et al., 2020). The evolution of communicable diseases in

structured host populations strongly depends on the spatial characteristics of the population. In the case of vectors (mosquitoes, tsetse flies, and flies), the emergence of diseases is also a question of movement in the host-host network, as movements trigger new infections. Understanding where infectious diseases are and where they are likely to be is critical to disease control and eradication intervention decision-making (Sallis et al., 2020).

V. Dissemination Strategies

Pervasive computing, in the form of mobile phone data collection and the use of project-specific kiosks and community-based interactive learning centres, coupled with locally relevant health research that has the potential for timely answers to essentialhealthcare and health system transformation questions, can be used to motivate local populations to become data collectors (Firchow& Mac Ginty, 2020). Data collection tools should also be able to serve as training vehicles to enhance community-based participatory research capacity. Furthermore, verifiable, persistent identification systems for people, places, and things should be anchored with highly accessible data storage and analytical tools that explicitly support longitudinal data structure within temporal-sourced multi-level modelling contexts and also include real-time, online analysis and displays (Malik et al., 2022). In addition to posting results in formats that allow for high-level graphical rendering presentation, capabilities for stakeholders and participants to become involved via online visualisation and analysis should be developed. The high costs associated with traditional dissemination channels like print media and oral presentations have necessitated the search for cost-effective dissemination methods such as multimedia web interactions. At a minimum, a long-term health research dissemination strategy in developing countries should be sustainable and extensible. Research dissemination must also be one component of an interconnected system infrastructure that provides various ways to access, integrate, and use health research data and results. Core aspects of such a system include data collection, storage, validation, analysis, results visualisation and interpretation, and feedback/input mechanisms (e.g., soliciting, archiving, and utilising research questions from stakeholders and target populations) (Maddikunta et al., 2021).

5.1. Importance of Effective Dissemination

The utilisation of one or many of these strategies should, therefore, be factored into the implementation plan of every research project, as the globe is now a global village where happenings anywhere affect everywhere. We desire this input to enable the public good at the core of funding research to be actualised. While universities worldwide increasingly emphasise the importance of outcome assessment and the need to share those outcomes with others, evaluation of public dissemination of research evidence remains limited (Murunga et al., 2020). This is because research is criticised for not fulfilling its societal obligations or because individuals and groups outside the research community decry the findings as useless. Meanwhile, scholars justify tenure requirements that underpin such research endeavours in institutions of higher learning, as well as intentional "research for research's sake" (Chukwu et al., 2020). Given the degree of research investment and the potential to bring about positive change in many aspects of human activity, this is a matter of concern.

Another stage in the health research cycle is dissemination, arguably its most significant outcome. Irrespective of the nature and value of the research, evidence is useless unless it changes the minds and actions of those who need to know about it, that is the research consumers—whether policy, practice, the media, the broader public or further research. However, disseminating health research findings is inadequate since findings from most studies are never systematically shared (Orok et al., 2022). The importance of disseminating health research findings that are understandable and beneficial—mainly if the research is funded by government or otherwise public- and philanthropic support—is evident and evidence-based. Over the years, the vast body of scholarly literature on the subject has established the relative merits of a range of media in disseminating research findings, namely, brokerage, newsletters, online journals, databases, research summaries, conferences, presentations, workshops, display booths, hospitable calls, and social networking sites.

5.2. Utilizing Social Media and Online Platforms

The availability of these millions of health-related documents can be valuable to the larger research community. In particular, summarisations of public sentiment are often needed by health-related businesses in evaluating the effectiveness of public health marketing campaigns, credit monitoring service companies assessing broader social impacts of particular health topics, and the health community at extensive seeking to understand how the public perceives the importance of various health concerns (Adebisi et al., 2021). Social media documents have been aggregated to determine general public sentiment in two related domains. In each case, this aggregated sentiment has been used as a proxy for the public's sentiment toward health, identifying common universal health concerns. However, while there is evidence in the literature of how Twitter can be

used to "reflect public sentiments of a population about health," it is only qualitative. It has not been verified by Indian studies (Adekugbe&Ibeh, 2024).

There is limited prior work exploring the full spectrum of health topics discussed in online forums or their importance. With Nigerians spending significant time on social media, aggregated and analysed social media data can provide faster, wide-ranging, and cost-effective surveillance. Social media use has surged in recent years, and the data generated from these platforms have been used in various domains, from marketing to security. However, social media is still a relatively untapped resource for health research, especially in resource-limited countries. Platforms with user-generated content (UGC), such as Twitter, Facebook, and blogging/microblogging sites, can provide a rich data source for tracking and understanding health research. They consist of millions, if not billions, of user-produced data. With Nigerians spending significant amounts of their time on social media, aggregating and analysing such data can provide a real-time lens through which public opinion about events, medical sentiments about health conditions and disease outbreaks, and social attitudes toward health and safety can be tapped, summarised, and tracked over time (Adenyi et al., 2024). This is increasingly important as health information dissemination becomes increasingly quick and wide-ranging.

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