Evaluating the Impact of Mobile Health Applications on the Management of Hypertension

in rural areas in Ghana. (- THESIS)

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INTRODUCTION (THESIS)

1.0 Background

The development of technology has been extremely fast in recent years. New innovations have come up to solve numerous problems that human beings could not previously tackle. Due to innovative technology in recent times, humanity has found a good stance in facing the fight against the issues in different sectors, such as the health sector, the agricultural sector, the finance sector, the mining sector, the educational sector, and others. This list could go on.

Focusing on Health, technology has played a pivotal role in developing critical solutions to previously incurable diseases. An excellent example of this is the COVID-19 pandemic. According to research (Saher & Anjum, 2021), technology has played a vital role in addressing the challenges caused by the COVID-19 pandemic. Minimising the scope, technology has also made an impact on the creation of drugs for preventable diseases such as malaria, respiratory infections, diarrheal diseases, and cardiovascular diseases such as Hypertension.

Hypertension is one of the prevalent chronic cardiovascular conditions affecting a large amount of the global population. It is a profoundly serious medical condition and can increase the risk of heart, brain, kidney, and other diseases (WHO, 2023). According to recent statistics, an estimated 1.28 billion people between the ages of 30 – 79 years worldwide have hypertension, with two-thirds of this population living in low- and middle-income countries (WHO, 2023). Out of this entire population, about 46% of these people are not aware of their condition (WHO, 2023). Additionally, despite the significant technological innovations with respect to finding solutions to medical conditions, less than 42% of adults in this population were diagnosed and treated. According to WHO (2023), there are many factors that increase the risk of having high blood pressure (hypertension). Some of them are older age, genetics, obesity, laziness, and excessive

alcohol intake. All of these contribute to the cause of hypertension among the estimated 1.28 billion people who have it globally.

The prevalence of hypertension in Ghana is rising. It has become a significant concern to the country's public health sector. According to a technical document by the World Health Organization (2023) on the hypertension profile of Ghana, the prevalence of hypertension in Ghana is about the same percentage as the global percentage, which is about 35% of the population in both cases. Of the 3.2 million adults ages 30 to 79 years with hypertension, 50% have been diagnosed, 37% treated, and 19% have been effectively controlled. From these statistics, it can be realized that the prevalence of hypertension in the country is high. In a study conducted by Tannor et al. (2022), 27.3% of 3080 participants who were screened during that study had hypertension. Out of this, two-thirds of the hypertensives were unaware of their condition, and only 49.5% of participants with a history of hypertension on medication were controlled. In another study by Atibila et al. (2021), it was realised that the burden of hypertension was slightly higher in the urban areas compared to the rural areas. However, the study concluded that the gap in hypertension prevalence between rural and urban populations is closing, especially in elderly populations.

1.1 Problem Statement

Hypertension is a global and national health risk. It serves as one of the causes of premature death globally. According to WHO (2023), an estimated 17.9 million people died from cardiovascular diseases (CVDs) in 2019, representing 32% of all global deaths. Of these deaths, 85% were due to heart attack and stroke. Hypertension contributes to a substantial number of diseases and increases the risks of heart attacks, stroke, and other serious cardiovascular diseases.

In Ghana, hypertension is a rising significant issue affecting the public health sector. The rising prevalence of hypertension in rural areas is a major concern for the health sector of the county. According to Atibila et al. (2021), urban environments have a higher prevalence of hypertension. However, the gap in hypertension prevalence rate in the urban and rural environments is closing. Showing that the prevalence rate in rural areas is increasing. This may be because the management of hypertension in these areas is poor due to poor infrastructure in rural areas, lack of resources to implement efficient hypertension management strategies or adaptation barriers in these areas. A study conducted by Nyaaba et al. (2020) identified three key themes underlying the poor control of hypertension:

First, health professionals' barriers included communication difficulties, poor collaboration and referrals among health professionals and limited training on Hypertension (HTN) and other non-communicable diseases (NCDs). Secondly, health system–related barriers included limited health personnel, drug shortages, inadequate facilities and equipment and challenges with National Health Insurance (NHIS). The third theme was patient-related barriers, including non-adherence, use of traditional treatments, sociocultural factors, and lack of appreciation (Nyaaba et al. 2020).

All these factors potentially explain the increasing trend of hypertension in rural Ghana and call for specific interventions to cope with the situation in such areas.

Another study conducted by Agyei-Baffour et al. (2018) was able to demonstrate an increased prevalence of hypertension, knowledge gaps, and misconceptions surrounding hypertension in rural communities in Ghana. These drivers may be extremely high and include limited access to healthcare, poor health education, and cultural misconceptions, all aggravating the challenges of managing hypertension. More specifically, a lack of awareness and

understanding of risk factors for hypertension and ways through which it could be effectively managed is an important reason for poor disease control and, thus, increased risks to health. Moreover, cultural misbeliefs about the reasons for hypertension and its treatment hamper effective management and prevention. These points underline the need for targeted interventions to improve knowledge, address misconceptions, and enhance rural health infrastructure for better hypertension management to decrease its prevalence.

The primary objective of this paper is to examine the implications of mobile health apps in improving hypertension management. Sim (2019) further explains that mobile health involves sensors, mobile applications, social media, and location-tracking technology, all in place to collect data relevant to wellness and the diagnosis, prevention, and management of diseases. Additionally, Gong et al. (2020) found in their study that the use of mobile health applications is effective in managing hypertension, promoting adherence to medication, and controlling blood pressure. Similarly, Osei et al. (2021) provided evidence that mobile health technologies can enhance healthcare delivery and improve patient outcomes, especially in diagnosis and support of treatment management. Still, disparities in most benefits among rural-based health professionals usually hamper access and availability.

While these studies show that mobile health applications are a potential solution in the management and treatment of diseases, it also emerges that these technologies and innovations are not being effectively used, in rural settings, for varied reasons. Most available research on potential barriers preventing the effective implementation of mobile health devices in rural Ghana is limited. This literature gap is what the current study seeks to fill by identifying the barriers to effective implementation and extending our understanding of how these devices would impact hypertension management in the rural Ghanaian community. The general knowledge base and support in

developing interventions to improve hypertension management in these areas are, therefore, what this study contributes to.

1.2 Research Objectives and Questions.

1.2.1 Research Objective

Examine the impact of mHealth applications on the management of hypertension in rural areas in Ghana.

Sub Objective

1. Identify barriers to the implementation of Mobile Health Applications for hypertension.

    a. Identify key barriers to proper mobile health applications for hypertension management in rural settings, which involve technological, infrastructural, socio-cultural, and economic barriers.

2. Measure the effectiveness of Mobile Health Applications.

    a. Evaluation of mobile health applications' effectiveness in enhancing medication adherence, blood pressure control, and overall management of hypertension in rural Ghanaian communities.

1.3 Research Questions.

1.3.1 Primary Research Question

What are the effects of using mobile health applications in managing hypertension in rural areas in Ghana?

Sub Questions

1. What is the level of acceptance and adoption of mobile health applications for hypertension management among rural communities in Ghana?

2. What are the primary barriers faced by rural communities in Ghana when using mobile health applications for hypertension management?

<center>**Literature Review**</center>

2.0 Introduction

This literature review aims to explore the impact of mobile health applications on the management of hypertension. The prevalence of hypertension in rural areas of Ghana is rising, just as the concern of the public health sector is. Mobile Health applications are one of the promising ways in which hypertension can be managed. Through the synthesis of related work, this section of the paper seeks to understand how mobile health applications affect factors like hypertension or blood pressure control, user engagement, patient monitoring, and general health outcomes related to hypertension in rural communities in Ghana. This section has been arranged into sections to ensure readers better understand the synthesis.

2.1 Conceptual/Operational Definitions.

    2.1.1   **Mobile Health (mHealth) Applications:** According to Li et al. (2020), mHealth is the use of mobile health devices – such as phones, smartwatches, and wireless devices- for medical support. This study stated that the benefits of mHealth are acknowledged globally and can contribute to achieving universal health coverage by overcoming geographical barriers, increasing access, and providing health services to remote populations and underserved communities. Since the first definition of mHealth by WHO in 2010, the technology has grown to be sophisticated and more available.

    2.1.2   **Telemedicine:** Telehealth was defined in a study by Harris et al. (2021) as a virtual mode of communication between a patient and a healthcare provider through telecommunications such as mobile phones. Telecoms may be synchronous, meaning real-time communications such as phone calls or video conferencing, or asynchronous,

meaning the use of text messages or emails or recorded information shared between the two parties (Harris et al., 2021).

2.1.3 **Patient Monitoring;** is the observation of a patient's disease, medical condition, and other vital parameters over time (CIO Whitepepers Review, 2018). This is usually used in remote patient monitoring, which is a telehealth innovation that offers significant opportunities to increase the timeliness of care, enhance health outcomes, and potentially reduce hospitalisations and associated healthcare costs (Thomas et al., 2021).

2.1.4 **User Engagement:** the rate at which users in the specified demographic engage with implemented solutions regarding mHealth applications for hypertension management.

2.1.5 **General Health Outcomes:** The impact of a healthcare service or intervention that results in (1) Patient health status or quality of life, (2) Patient, provider, and population attitudes and behaviour, and (3) New evidence, research, prevention strategies, treatments, and care models (*Outcomes | Agency for Healthcare Research and Quality*, n.d.).

2.2 Theoretical Framework

The aim of this section is to lay the foundation that can help in understanding how mobile health applications influence the management of hypertension among rural communities within Ghana. This will be done using a developed model that provides a sound theoretical basis for this research.

In this study, the Diffusion of Innovation Theory by Everett Rogers, 1962, and the Technology Acceptance Model by Fred D. Davis, 1989, will be the guiding theories. The Diffusion

of Innovation theory is focused on innovation acceptance and adoption by large groups usually a society or a given population; the Technology Acceptance Model predicts the individual adoption and use of new technology in a particular given context. The theory of diffusion of innovation actually originated in communication, explaining how an idea or product, over time, picks up speed and diffuses—spreading through a particular population or social system(LaMorte, 2022). Moreover, the Technology Acceptance Model explains individuals' acceptance of technology. TAM suggests that the acceptance of technology is predicted by the users' behavioural intention, which is, in turn, determined by the perception of technology's usefulness in performing the task and the perceived ease of its use (Marikyan & Papagiannidis, 2023). Simply put, the TAM believes that people decide to use modern technology based on its usefulness and ease of use.

Using the Technology Acceptance Model, this study aims to understand individual-level factors that affect the acceptance and use of mobile health applications for the management of hypertension in rural areas of Ghana. While TAM is easy to understand, it provides high predictiveness in various contexts. Meaning, it can be applied to various aspects of technologies and settings. That is an advantage it brings to this study. This model is good for this study because it sets a platform for understanding how individual perceptions affect the use of mHealth applications for hypertension management in rural areas. It helps the study shed light on why Ghanaian rural hypertensives may or may not adapt to using mHealth devices to manage their conditions.

On the other hand, using the DoI theory, the study aims to understand how the use or adoption of mHealth applications expands or contracts in rural areas in Ghana. The DoI theory is suitable for this because, as mentioned earlier, the DoI theory seeks to understand how novel products, practices or ideas are adopted by members of a society (*Diffusion of Innovations |*

Sociology, n.d.). In assessing the impact of mHealth applications in hypertension management in rural areas in Ghana, the DoI theory will help the study understand the acceptance rate of mHealth applications in these rural areas. It will help identify the specific population of hypertensives in rural areas that use mHealth applications for the management of their condition. While the DoI theory will help the study understand the overall adoption rate of mHealth applications, it will not help the study get a deeper understanding of these adoption rates, and that is where the TAM will be used.

2.2.1 *Integration of the Diffusion of Innovations Theory and Technology Acceptance Model*

These two theoretical frameworks fit perfectly in this study, where the Diffusion of Innovation theory provides a broader understanding of the adoption of mHealth applications in rural areas of Ghana, and the Technological Acceptance Model provides further depth of understanding at an individual level. While DoI will help focus the study on a more community-based view of how mHealth is being adopted, TAM will provide an understanding of the adoption of mHealth in rural Ghana at an individual level. This dual-theoretical approach ensures that both the broader and more specific contexts of rural environments in Ghana are covered.

2.3 Review of Empirical Literature and synthesis of literature findings.

This review will critique literature that is closely associated with the application of mHealth in the management of hypertension in rural Ghana. The review will primarily be based on two major thematic areas: the effectiveness of mobile health applications in hypertension management, and barriers to mHealth applications' use and implementation.

2.3.1 *Effectiveness of Mobile Health Applications in Hypertension Management.*

There have been several papers investigating the efficacy of mHealth applications on the management of hypertension. Results from Butzner and Cuffee, 2021; Li et al., 2020; Boima et al., 2024 will increase the understanding of answering questions associated with the use of mHealth applications for hypertension management in different contexts. Collectively, these studies used various methods to achieve their goal of measuring the effectiveness of mHealth. Randomised controlled trials (RCTs) were used to employ mHealth applications' effectiveness on hypertension management in different contexts. Systematic reviews and meta-analyses were used to aggregate and analyse the findings from the multiple RCTs. This provided a robust foundation for the assessments of these trials.

The data collection section of the studies was collected using surveys and questionnaires to gather quantitative data on blood pressure control and medication adherence. Some studies reviewed medical health records to study the changes in hypertension management outcomes in patients. Regression models and meta-analysis techniques were used to evaluate the data collected through these various techniques.

The findings from the studies referenced earlier show that mHealth applications significantly impact hypertension management. According to research by Boima et al. (2024) on the Effectiveness of digital health interventions on blood pressure control, lifestyle behaviours and adherence to medication in patients with hypertension in low-income and middle-income countries, digital health interventions led to a reduction in systolic blood pressure and improved blood pressure control. The study by Li et al.

(2020) corroborates this finding, stating that mHealth self-management interventions were effective in BP control.

The study by Butzner and Cuffee (2021) highlighted the integration of telehealth into current health applications in rural settings. The study found that Telehealth models were associated with positive outcomes for patients and healthcare professionals, suggesting these models are feasible and can be effective (Butzner & Cuffee, 2021).

These and other literatures point to a promising trend: mobile health applications may have a good impact on the management of hypertensives in the rural areas of Ghana. Most of these studies, including RCTs and systematic reviews, have shown that these digital interventions can help hypertensives control their blood pressure and improve medication adherence. It has been realised that the mHealth application is generally a good solution for hypertension management, particularly in low-resource settings such as those in rural areas.

2.3.2   Barriers to Implementing and Adopting mHealth Applications.

Rural areas in Ghana are very underdeveloped areas. Thus, there are many factors that prevent the implementation and functioning of mHealth applications. Studies by Feroz et al. (2020), Peprah et al. (2020) and Gafane-Matemane et al. (2023) explored and found some of the barriers that bring challenges to the implementation of mHealth in different contexts. These papers highlight the potential and challenges of using mHealth applications for healthcare and healthcare delivery in Sub-Saharan Africa (SSA) and rural Ghana. The main research focus across the studies is whether telemedicine and mHealth technologies can support hypertension management and

increase access to healthcare. Specifically, they seek to find ways through which digital tools may influence BP control, medication adherence, and the dispensation of healthcare services in resource-constrained environments.

The primary methodologies used in those studies are qualitative and quantitative approaches. Most of the related literature reviewed used systematic reviews, meta-analyses and exploratory qualitative assessments. The qualitative data collected involved bloop pressure measurements, medication adherence data, and health outcomes, which were then analysed using statistical methods like regression models and other analysis techniques.

In the study by Gafane-Matemane et al. (2023), they found out that although infrastructural and digital literacy challenges militate against the process, telemedicine holds promise for improving the management of hypertension in SSA. Put simply, it reiterates calls for telemedicine programs that are contextual, cost-effective, and sustainable—in other words, equitable—to scale up these barriers to improve hypertension control in SSA. The other study by Peprah et al. (2020) also found that main challenges like illiteracy, language barriers, faith, and mobile network connectivity have been noted. The study concludes that developing efficient, localised, and user-friendly mobile phone-based health programs could improve healthcare access in rural areas. Both studies acknowledge the presence of barriers such as illiteracy, language barriers, mobile network connectivity, and lack of modern resources for implementation in rural areas. These are what may be hindering the implementation of mHealth in rural Ghana for the implementation of hypertension.

2.4 Conceptual Framework

The conceptual framework for this study pays attention to how variables such as mHealth application will have an effect on other variables such as general health outcomes or hypertension management outcomes. mHealth applications, which comprise medication reminders, blood pressure monitoring, and health education, are likely to improve management outcomes for hypertension, such as medication adherence, blood pressure control, and overall management. Undoubtedly, a number of barriers will inevitably moderate the effectiveness of such an application: technological challenges, infrastructural constraints, socio-cultural factors, economic challenges, and limitations within the healthcare system. The challenges of adopting and being effective in using mHealth applications may lower their potential to improve hypertension management.

Independent Variable: mHealth Applications

Dependent Variable: Hypertension Management Outcomes

2.5 Conclusion

While other related papers succeed in exploring the impact of mHealth on the management of hypertension in different contexts, there has been little to no effort to pay attention to rural areas in Ghana. Most research papers, such as the study conducted by Boakye and Babatunde Olumide (2020) on "the role of the Internet of Things in supporting health services in rural communities. A case study of Ghana and Sierra Leone", focus on other interventions and health factors. This presents a notable knowledge gap in the existing knowledge on the impact of mHealth application in the management of Hypertension in rural areas. This literature review has explored other papers and found a gap in knowledge that this study seeks to fill.

METHODOLOGY

This chapter outlines the chosen research methodology that will be used to evaluate this study's objective. It is structured to provide a good understanding of the research design, sampling approaches, data collection instruments, and analysis methods. This study will be based on a mixed-methods research design in order to gain an in-depth understanding of the effectiveness of mHealth applications for hypertension management within the rural areas of Ghana.

3.2 Research Design.

3.2.1 Research Philosophy

Due to the nature of this study, it will adopt a pragmatist approach. Pragmatism is best for this study as it will allow the study to pay more attention to practical outcomes and real-world applications of the findings. The chosen philosophy will help the study view standard organisational processes as social activities. Providing a richer understanding of how these activities work. For instance, through insight into the ways in which community health workers and patients bargain for the use of these applications within their daily routines, researchers will better understand pragmatic issues and advantages incumbent on an effective strategy of implementation.

3.2.2 Reasoning Approach

The abductive reasoning approach chosen for this is the abductive reasoning approach. Such an approach will be helpful in generating hypotheses based on observed phenomena, guiding further exploration and refinement of the research questions. Abductive reasoning comes in very handy in exploratory research where existing theories or knowledge may be limited. It starts with an incomplete set of observations and seeks the most likely explanation that is simplest. This current study takes as a starting point some

general observations regarding the use and effects of mobile health applications in shaping hypotheses and probing further.

3.2.3 Research Design

The chosen research design for this study is a mixed-methods design, more specifically, an explanatory sequential design. This design involves collecting and analysing quantitative data first, followed by qualitative data to help explain the findings of the analysis of the quantitative data collected before. This research design fits this study because it provides the study with a comprehensive understanding of the research problem by integrating numerical data collected from the quantitative step with the qualitative data, which deals with the experiences and in-depth insights from participants. The quantitative step explores trends in relation to the use of mHealth in hypertension management in rural Ghana. The qualitative is then employed to seek a deeper understanding of the underlying factors responsible for the trends identified.

3.3 Population and Sampling

3.3.1 Population

The target population for this study includes men and women living in rural areas of Ghana. This heterogeneous population includes people of various characteristics, including age, gender, and education level. The focus on rural areas is critical because rural health faces challenges different from what is obtained in urban centres, a factor that contributes to the research into how mobile health applications can bridge this important issue.

3.3.2 Sampling Approaches

To obtain the study population, this study will use the **stratified random sampling approach** for the quantitative part of the research design, and the **purposive sampling approach** will used for the qualitative portion of the data to be collected. The use of purposive sampling for the qualitative side of the research design will ensure that detailed and relevant information is obtained from individuals who are knowledgeable about the subject under study. Purposive sampling works well in qualitative research, where the objective is to gain insight rather than generalise to a population.

In the other part of the study, stratified random sampling will be used to ensure that various subgroups of the population are represented. For example, different age groups, genders, and different locations. This design ensures more precision and generalizability of the findings across the rural population. Using this method, the population is divided into strata and random samples within each stratum are selected to ensure adequate representation of all relevant sub-groups.

3.4 Data Collection Instruments

3.4.1 Quantitative Data Collection Instruments

3.4.1.1 Structured Surveys

These will yield numerical data on the prevalence of hypertension and the use of mobile health applications, with an emphasis on practical results. Being relatively cheap and having the potential to contact a large number of respondents, the survey becomes suitable for collecting general, broad, and generalisable data.

Also, survey data can be used to formulate hypotheses concerning the effectiveness of mobile apps in managing hypertension. For example, results from the survey may show trends in the use of apps that would prompt the probing of certain features or user behaviours.

3.4.1.2 Health Records Review

The health records will provide insight into concrete health outcomes related to hypertension management, focused on real-world impacts. Scanning the record, the study will be able to formulate a number of patterns regarding the potential ways in which mobile apps might impact health outcomes

3.4.2 Qualitative Data Collection

3.4.2.1 In-depth Interviews

Interviews will help the study understand the true experiences participants have had with mHealth applications and the challenges they have with respect to it. Through interviews, the study aims to collect deep data that will help this research understand the true challenges both normal citizens and hypertensives in rural Ghana face.

3.4.2.2 Participant Observation

Observations will represent real-life management of hypertension by using mobile apps. It will allow the study to learn how these apps are used in life in general and offer the possibility of detecting practical barriers or facilitators. They also contribute to awareness of how context and behaviour are related to the success

of mobile health interventions. Observational data might give a hint of the way in which various settings or situations affect the use and effectiveness of apps.

3.5 Data Analysis

3.5.1 Concepts Explored in Demographic Analysis

Age: How age influences awareness of hypertension and adoption of mobile health apps.

Gender: Differences in healthcare-seeking behaviour and app usage between males and females.

3.5.2 Types of Data

Categorical Data: Gender (nominal), Location (nominal), Education Level (ordinal).

Numerical Data: Age (years), Number of healthcare visits, Mobile app usage frequency.

3.5.3 Analysis Approach

Demographic features: It summarises descriptive statistics with mean age and gender distribution. Descriptive statistics provide a foundation for understanding the sample and point toward basic patterns.

Cross-tabulations: This involves the relationship between two categorical variables. For example, it could be between gender and usage of an application. Cross-tabulation may capture a relationship of variables, indicating key trends.

Regression Analysis: This will be done to establish the relationships between demographic factors, considered as the independent variables, and health outcomes, which are the

dependent variables. Regression analysis will help identify health outcome predictors and quantify their impact.

3.6 Limitations

The study declares some limitations to the work: it accepts that it may suffer from a small sample size, which may impact its power of generalisation. This may further be subjected to response biases likely to capture the findings. Variability in access to technology and language barriers may impact data accuracy and engagement of subjects. These would have an effect on the general effectiveness and applicability of mobile health applications in hypertension management in rural Ghana.

3.7 Ethical Considerations

This research will be underpinned by some ethical considerations: participants' confidentiality and anonymity will be guaranteed, informed consent sought, and data collection and analyses integral. Ethical protocols will be strictly adhered to upon approval by the relevant ethical review boards. Participants will be fully informed about the purpose of the study, procedures, and likely risks and benefits, and that participation is voluntary.

3.8 Summary

The chapter provided an overview of the methodological framework for evaluating a mobile health application's impacts on hypertension management in the rural areas of Ghana. Drawing from a mixed-method approach and robust sampling techniques, this study is designed to tease out comprehensively the barriers and the effectiveness of mHealth interventions in this context. In the following chapters, the results of the analysis will be presented and further discussed in relation to their implications for healthcare practice and policy. This approach ensures that the results of this

study will be both scientifically sound and relevant for use in practice; hence, able to make a contribution to the literature on mobile health and hypertension management.

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