British Journal of Healthcare and Medical Research - Vol. 12, No. 01
Publication Date: February 25, 2025
DOI:10.14738/bjhr.1201.18109.
Ogweno, S., Harrison, R., Bonface, O., & Murithi, B. (2025). mHealth Interventions for Health Promotion in Sub-Saharan Africa: Assessing Impact on Health Literacy and Comparative Analysis of Online Communication Channels. British Journal of Healthcare and Medical Research, Vol - 12(01). 28-48.

SERVICES FOR SCIENCE AND EDUCATION

mHealth Interventions for Health Promotion in Sub-Saharan Africa: Assessing Impact on Health Literacy and Comparative Analysis of Online Communication Channels

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ABSTRACT

Introduction: Considering the increased incidence of noncommunicable diseases (NCDs) and the need for novel approaches to health promotion, this study investigates the feasibility of cross-country mHealth interventions in Sub-Saharan Africa. The study, which focuses on using digital platforms for health communication, intends to investigate the feasibility and effectiveness of cross-country mhealth interventions aimed at disseminating health promotion materials in Sub-Saharan Africa across various platforms. The study is based on the NCDs 365 project, a year-long health promotion initiative in five nations aimed at promoting NCD literacy. Methodology: The study utilized a multi-stage sample technique, including an intentional selection of five nations (Cameroon, Kenya, Nigeria, Uganda, and Zimbabwe) with active local partner organizations conducting the initiative. The following stage was convenience sampling of members of these organizations who participated in the NCD365 project activities. Data gathering included the distribution of questionnaires via local partners, followed by thorough analysis using descriptive techniques and comparison tests such as ANOVA and the Kruskal-Wallis test. The extensive methodology ensured a broad and representative sample, which increased the findings' validity and generalizability. Results: The findings demonstrated the potential of mHealth interventions to close health literacy gaps and promote positive health behaviors throughout Sub-Saharan Africa. According to an analysis of online communication platform usage, WhatsApp was the most popular (58.6%), followed by X (20.8%) and Facebook (6.8%). The study also found significant trends in platform preference across all five countries. Furthermore, gender-specific study indicated comparable literacy rates, with males slightly outperforming females. The Kruskal-Wallis test found no

significant difference in the efficacy of various online communication channels for health promotion, confirming the viability of cross-country mHealth programs. Conclusions: This study highlights the significant potential of cross-country mHealth interventions for health promotion in Sub-Saharan Africa. The study's strong methodology, agreement with current research, and gender-specific analysis add to its dependability and credibility. The findings of this analysis provide significant recommendations to policymakers seeking to optimize platform-specific policies and stimulate cross-country collaborations in health promotion. Finally, these findings expand the discussion on health literacy promotion and establish the groundwork for evidence-based recommendations that might drive effective health communication initiatives in the region and beyond.

Keywords: Noncommunicable diseases (NCDs), mHealth interventions, Health promotion, Sub-Saharan Africa, Health literacy, Cross-country collaborations.

CHAPTER 1: INTRODUCTION

This study assessed a mHealth strategy aiming at increasing health literacy for noncommunicable illnesses in five Sub-Saharan countries. The mhealth intervention was the Stowelink Foundation's WHO-recognized NCDs 365 initiative (1). The study utilized a qualitative method, collecting data from participants in Kenya, Uganda, Nigeria, Cameroon, and Zimbabwe by questionnaire.

Health Promotion and Health Literacy in Sub-Saharan Africa

Health promotion is defined as the act of giving people more control over their health and its factors in order to enhance their health (2). It is a crucial component of public health and aims to enhance population, community, and individual health. Promoting health can be accomplished in a variety of ways. Educating people about healthy lifestyles and the value of preserving their health is one strategy that can be used, along with education and awareness initiatives (3). Enacting laws and regulations that uphold the structural determinants of health and environments is another strategy for promoting health.

Laws that forbid smoking in public areas or mandate that eateries display nutritional information on their menus, for instance, can encourage the adoption of healthy habits (4,5). However, there are a number of obstacles that health promotion in sub-Saharan Africa must overcome in order to be effective. Among the primary obstacles are scarce resources and a deficient healthcare system in comparison to nations with more developed economies (6). The lack of funding and human resources in many Sub-Saharan African nations might make it challenging to put health promotion initiatives into action. This can be particularly difficult for programs that demand hefty time and financial commitments.

Health literacy is described as an individual's ability to receive, process, and comprehend essential health information and services required to make their own, appropriate health decisions (7). It's an important part of health promotion. It is based on the premise that establishing adequate levels of health literacy will result in enhanced self-care practices and the use of health care services to maintain good primary and secondary health. The relevance of health literacy is emphasized in global programs such as universal health coverage (UHC) (8) and the Sustainable Development Goals.

URL: http://dx.doi.org/10.14738/bjhr.1201.18109.

Health literacy is a key concern in Sub-Saharan Africa, as many people struggle to understand and use health information and services (9). Some of the major problems include language barriers, inadequate infrastructure such as a lack of roads, transportation, and communication systems, limited knowledge, particularly when health information is delivered in a technical or scientific language, and even cultural barriers (10). With these challenges in health promotion and health literacy, there is a need for a better solution that solves some of the infrastructural issues and provides an opportunity for health promotion and health literacy to be amplified across the board. In here lies the potential of e-health and mhealth technologies.

eHealth and mHealth Technologies

eHealth refers to the use of various technologies such as websites, applications, telemedicine, and electronic health records, to improve the efficiency, efficacy, and accessibility of health care (11). It is critical for health professionals, patients, and the public because it has the potential to greatly enhance health care by increasing access to information, improving communication and self-management, and offering educational resources.

Mobile health, often known as mHealth, is a subset of ehealth that describes the practice of providing healthcare services and information using portable electronic devices such as smartphones or wearable technologies. mHealth is primarily concerned with leveraging mobile technology to improve healthcare delivery and management, often in locations with low resources. MHealth is also closely related to health literacy. Intended users must have sufficient abilities to obtain and correctly interpret the information, which, if necessary, leads to acceptable health care behaviors now and/or in the future. Evaluations of a wide range of mHealth applications have found persuasive evidence that mHealth technologies can be utilized to improve health literacy by offering accessible, easy-to-understand health information and services, as well as by promoting chronic disease self-management (12).

Research Context

The Stowelink Foundation implemented the WHO-recognized NCDs 365 project (1), which began in five Sub-Saharan African countries. The project, which collaborated with civil society organizations, involved daily distribution of 366 posters and text messages about various NCDs via various channels, including social media platforms and websites. The information presented focused mostly on noncommunicable diseases (NCDs), such as diabetes, cardiovascular disease, and cancer. These diseases account for 74% of global mortality and disability (13) with 80% occurring in Sub-Saharan Africa (14). This is attributable in part to the high prevalence of risk factors for NCDs and the limited ability to prevent, diagnose, and treat NCDs (15). To minimize the burden of noncommunicable diseases in Sub-Saharan Africa, various obstacles must be addressed. These include raising knowledge and understanding of NCDs, improving access to preventive, diagnosis, and treatment services, and addressing the underlying social, economic, and environmental causes of NCDs. The increasing usage of mobile devices in the region opens up the potential of mHealth, providing chances to improve healthcare access, promote healthy habits, and improve surveillance, all of which contribute to NCD prevention and management (16).

Problem Statement:

Given these challenges, improving health literacy is critical, particularly in Sub-Saharan Africa. Limited health literacy impairs people's capacity to successfully obtain and use health

information and services, contributing to inequities in health outcomes. Addressing this issue is crucial for improving health outcomes in areas such as noncommunicable illnesses and meeting the health-related SDGs.

Aim and Objectives

The purpose of this study was to assess the impact of a mHealth intervention (The NCDs 365 Project) on improving health literacy levels, with a particular emphasis on chronic conditions. The objectives included:

1. To explore the association between exposure to mHealth interventions designed for health promotion and the health literacy levels of individuals in Sub-Saharan Africa.
2. To assess and compare the impact of various online communication channels, including social media platforms and websites, in delivering mHealth interventions to promote health in Sub-Saharan Africa.

CHAPTER 2: LITERATURE REVIEW.

mHealth and Health Literacy from Global to Local Perspectives

The World Health Organization defines mHealth as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices" (17). Health literacy, on the other hand, refers to "the achievement of a level of knowledge, personal skills, and confidence to take action to improve personal and community health by changing personal lifestyles and living conditions" (18). Understanding how health literacy is one of the primary communication hurdles to the efficient use of mHealth allows us to see the link between the two. To be effective, mHealth applications must send messages that are tailored to the intended audience members' specific health communication needs, orientations, and capabilities (19). Studies have revealed how the capacity to grasp taking medications effectively, a poor overall health state, and greater mortality are all consistently connected with disparities in health literacy level (20, 21). Rectifying this can be performed by introducing mHealth interventions, which have been shown to improve health literacy and, as a result, everything associated to it (22).

In the recent past, mHealth has emerged as a potent tool for global health communication, demonstrating its ability to improve healthcare delivery, increase access to information and services, and reduce costs in both developed and developing countries (23, 24). MHealth has shown great promise in tackling health challenges in low- and middle-income countries, such as Sub-Saharan Africa, where traditional healthcare facilities may be limited (23). Although there are gaps in the deployment and use of mHealth in Sub-Saharan Africa, such as limited internet connectivity and a lack of health literacy (25), the region's healthcare challenges are like those in other developing countries, implying that solutions that work in one area can be applied in another.

Table 2.1 demonstrates how mHealth has been deployed in other low-income nations, with usually positive results. It should also be emphasized that the broad use of mobile technology in Sub-Saharan Africa creates opportunity to use mHealth solutions to improve healthcare delivery, illness management, and health promotion.

URL: http://dx.doi.org/10.14738/bjhr.1201.18109.

Table 2.1: Studies showing the use of mHealth in low- and middle-income countries

Study Author	Type of Study	Place	Initiative	Results
Ali & Prins 2020(27)	RCT	Sudan	SMS to remind patients of TB to adhere to treatment versus those who	Patients in the intervention group exhibited a reduced default rate of 6.8% as opposed to the control group's rate of 10.8% (P-value 0.563; Odds Ratio: 1.673, 95% Confidence Interval: 0.521-5.374). Additionally, the intervention group displayed an elevated cure rate of 78.4%, surpassing the control group's rate of 59.5% (P-value 0.020; Odds Ratio: 2.472, 95% CI: 1.133 – 5.434).
Murthy et al., 2019(27)	Pseudo RCT	India	Voice messaging to pregnant women from start of pregnancy till child was 1 year of age, to improve infant care practices and improve mother's knowledge	Feeding practices were improved at 6 months (OR 1.4, 95% CI 1.08–1.82, p = 0.009) as well as immunization status (OR 1.531 95% CI: 1.141–2.055 p=0.005)
Jahan et al., 2020 (28)	RCT	Bangladesh	SMS messages and health educating on lifestyle for patients of hypertension	The control group had higher adherence rates (9%) for salt intake (P=.04) and physical activity (P<.03), with minimal variations in other behaviors. In both groups, keeping a salt consumption of less than 6 g/day resulted in considerable improvement over time (P<.001). In light of these findings, it is possible that the SMS service may have been more relevant and timelier.
Ben-Zeev et al., 2021(29)	RCT	Nepal	Smartphone app that promotes daily exercise for psychiatric patients	Participants rated CORE as highly usable and acceptable. The intent-to-treat analyses revealed significant treatment-time interactions for the BDI-II. (F1,313=13.38; P<.001), GAD-7 (F1,313=5.87; P=.01), RAS (F1,313=23.42; P<.001), RSES (F1,313=19.28; P<.001), and SDS (F1,313=10.73; P=.001). Patients also reported finding the app to be remarkably usable and acceptable.

Application of mHealth for the Management of NCDs in Low to Middle Income Countries

In terms of specific mobile phone functions that can be used for health care, there are numerous options. These options include but are not limited to, game apps (which gamify how healthcare is delivered) (30), short messaging services (SMS) that facilitate the provision of healthcare

information and alerts (31) and social platforms such as X, Facebook or Instagram among others, which can facilitate diseases awareness campaigns (32).

One promising mobile phone feature for delivering health information is SMS, a low-cost text messaging service that enables real-time data transmission. SMS can serve various purposes, such as reminding users to take prescribed medications or vaccinations (33, 34), sending automated updates on blood test results (35), disseminating public awareness messages about emerging diseases (36), providing information on available healthcare services, or even delivering direct guidance from a user's physician or clinic (37).

Regarding the challenges faced in mHealth to manage health conditions such as NCDs, various research, listed below, have identified critical areas that must be addressed. A qualitative study looking into the potential usability and acceptability of SMS text messaging for managing NCDs in rural Zimbabwe discovered that CHWs and healthcare professionals had utilized mobile devices to offer health services, such as sending notifications for clinical appointments (38). Another study that investigated the acceptability of an SMS-based intervention among persons living with HIV in rural Uganda discovered that the SMS message language, phone attributes, and expertise with similar technologies all had an impact on ease of use (39). This does not imply that mobile technology is too hard to employ for health-related tasks, but rather that it is critical to identify and overcome hurdles while maximizing opportunities.

Overall, overcoming accessibility, cost, language hurdles, and targeted messaging will be critical to the success of mHealth initiatives aimed at promoting health literacy and, ultimately, lowering the burden of NCDs in Sub-Saharan Africa.

mHealth and the Influence of Policymakers

Legislative action is critical to the development of mHealth, and policymakers' opinion and perspectives can impact it. WHO urges the continuous development and implementation of mHealth therapies as part of its Global Action Plan for the Control and Prevention of Noncommunicable Diseases. Despite this, the bulk of mHealth efforts are still in the pilot stage and are rarely expanded to entire countries, as is the situation in Sub-Saharan Africa (40).

A scoping review revealed that policymakers are concerned about the cost implications and effectiveness of implementing mHealth interventions (42). Out of eleven studies reviewed, only two addressed cost implications; however, the review highlighted the importance of stakeholders' willingness to share costs, which is crucial for ensuring long-term sustainability.

Research Gaps on mHealth Interventions in NCDs Health Promotion in Africa

After reviewing the current literature, the following are some study gaps on mHealth interventions in noncommunicable disease (NCD) health promotion activities in Africa:

1. There is little data to support the effectiveness of mHealth treatments in enhancing health literacy for NCD prevention and control in Africa (25, 43). More study is needed to determine the impact of mHealth interventions on health promotion and literacy, as well as to identify the most effective interventions for various demographics and circumstances.
2. The existing body of research in Sub-Saharan Africa is mostly focused on the use of SMS as a key channel for mHealth treatments, leaving other possible channels unexplored.

URL: http://dx.doi.org/10.14738/bjhr.1201.18109.

There is a scarcity of comprehensive study comparing the efficacy of various platforms, such as WhatsApp, X, and other eHealth technologies, in fostering health literacy across the region. Further evidence is required to investigate this (43).

3. Cross-country mHealth initiatives for health promotion in Sub-Saharan Africa remain underexplored, with limited evidence regarding their feasibility and effectiveness. Comparative studies examining the implementation and impact of these interventions in different countries could offer valuable insights into their potential to address health literacy disparities in the region (45).

To close these research gaps, it is critical to invest in research that will inform the development and implementation of effective, sustainable, and ethical mHealth treatments.

CHAPTER 3: METHODOLOGY

Study Setting

The study was undertaken in five African countries: Cameroon, Kenya, Nigeria, Uganda and Zimbabwe.

Inclusion and Exclusion Criteria

Inclusion Criteria:

1. Any member of a partner organization involved in implementing the project throughout the entire calendar year of 2020.
2. Any individual from a participating organization who was 18 years or older.
3. Engaged with the online resources at least once.
4. Possessed basic English comprehension to complete the online survey.
5. Agreed to participate in the evaluation by providing written informed consent.

Exclusion Criteria:

The following participants were excluded.

1. Any member from a partner organization that did not implement the project for the entire calendar year of 2020.
2. Unable to read, write, or respond in English.
3. Did not take part in the NCDs 365 project.
4. Individuals under the age of 18.
5. Non-residents or those living outside the chosen countries.
6. Individuals who are either unwilling or unable to provide informed consent.

Sampling

A multi-stage sampling process was applied to select participants from the eight countries involved in the NCDs 365 project, which reached a total of 5,186 participants. In the first stage, purposive sampling was used to select five countries—Cameroon, Kenya, Nigeria, Zimbabwe, and Uganda—based on the presence of active local partner organizations leading project implementation on the ground. These partner organizations, primarily Community-Based Organizations (CBOs) or Civil Society Organizations (CSOs), had consistently executed the NCDs 365 project from January 1st to December 31st, 2020, ensuring uniformity across the selected countries.

In the second stage, participants were selected using a convenience sampling technique. A total of 400 individuals (80 from each country) actively engaged in the NCDs 365 project were chosen from the membership of partner organizations in the five selected countries. Convenience sampling was appropriate as these individuals were already affiliated with the organizations involved in the project. The organizations participating at this stage included the Food and Genes Initiative in Nigeria, Stowelink Foundation in Kenya, Berna Acargo Foundation in Uganda, RADA CSO in Cameroon, and Health Access Initiative CBO in Zimbabwe.

Data Collection Management and Storage

Data collection was carried out using an online Google form, which was disseminated to participants via the local partner organizations overseeing project implementation. The Stowelink Foundation managed and monitored the form, ensuring that all data was centrally gathered and securely stored on a unified platform. This method streamlined the data collection process, ensuring efficiency and safeguarding the integrity of the data, as illustrated below:

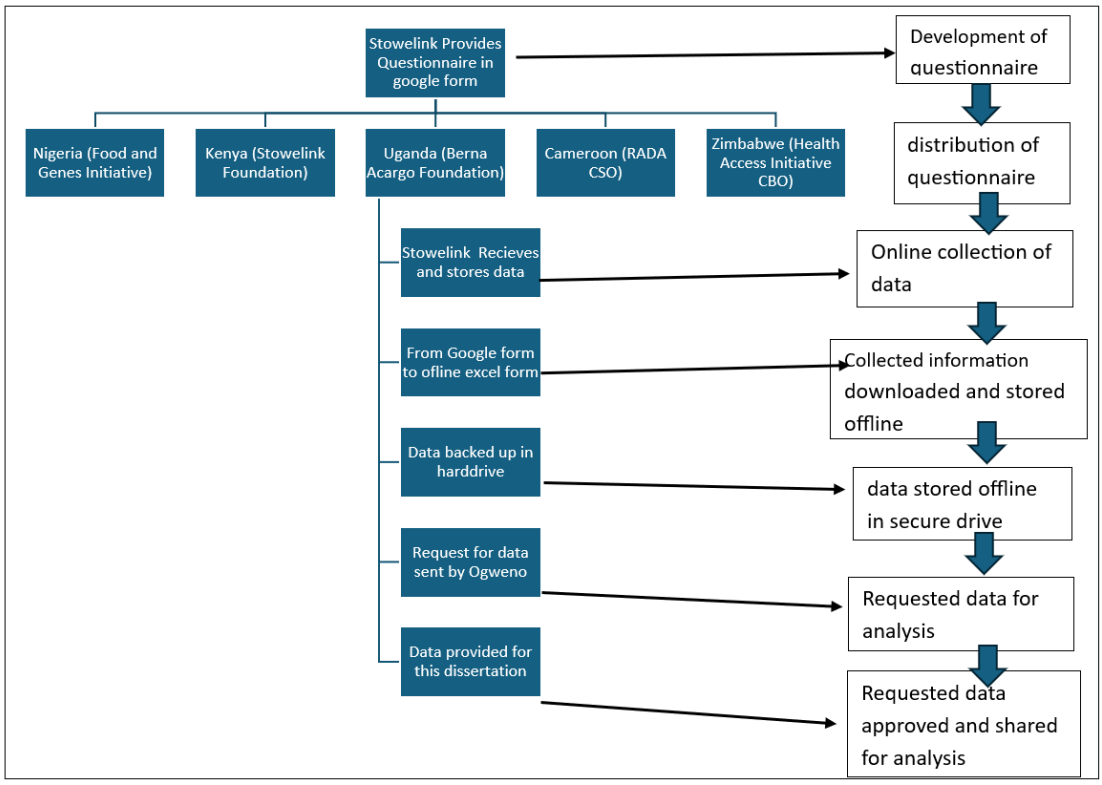

Figure 3.1: Framework for data collection

Data Analysis

A summary score was calculated to assess overall literacy and knowledge, based on responses from part 2 of the questionnaire. Each question offered both factually correct and incorrect response options. Correct responses were assigned a score of one point, while incorrect responses were scored zero. For Likert scale or multiple-choice questions, where multiple correct answers existed (e.g., three correct responses), each correct answer was weighted equally, at 0.33 points out of a total possible score of 1. The correct responses were summed for each question to produce a total score. The maximum achievable score was 27 points, representing 100%, while the minimum score was zero.

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Descriptive statistics, including measures such as mean, median, and standard deviation, were used to summarize the dataset, while inferential statistics, particularly ANOVA, were applied for further analysis. A significance threshold of $p < 0.05$ and a 95% confidence interval were used to assess the statistical relevance of the results. The literacy scores were also evaluated in relation to several control variables, such as project exposure, country of the participants, engagement with social media platforms, and educational background. This method enabled the exploration of potential correlations and differences in literacy levels across various factors, offering a detailed insight into the study outcomes.

Hypothesis Testing

In this study, two hypotheses were evaluated.

Hypothesis 1:

To assess whether a significant relationship exists between exposure to mHealth interventions focused on health promotion and individuals' health literacy levels in Sub-Saharan Africa, an analysis of variance (ANOVA) was performed. This analysis explored the association between mHealth intervention exposure and health literacy levels across the region.

Hypothesis 2:

To examine whether a significant difference exists in the effectiveness of various online communication channels, including social media platforms and websites, for mHealth interventions promoting health in Sub-Saharan Africa, a comparative ANOVA analysis was conducted. This test evaluated the relative efficacy of different online platforms in delivering mHealth interventions for health promotion.

Ethical Considerations

Ethical considerations were paramount in this research, and multiple safeguards were put in place to ensure participant protection and confidentiality, adhering to the Helsinki Declaration guidelines (46). Informed consent was obtained from all participants prior to their involvement. To further protect privacy, the questionnaire was designed to exclude the collection of personally identifiable information, such as names, emails, ID numbers, or phone numbers. Additionally, formal written permission was secured from the Stowelink Foundation, the primary data custodian, granting access to utilize the secondary data for this study.

CHAPTER 4: RESULTS

Demographic Characteristics of Respondents

Out of the 400 respondents, 336 provided complete responses, yielding a response rate of 84%. Table 4.1 presents the demographic characteristics of the respondents. The age distribution reveals that the majority fell within the 18-24 age group (46.1%), followed by those aged 25-34 years (37.8%), with a mean age of 27.4 and a standard deviation of 0.903. Participants were drawn from five countries, with Kenya (21.1%) and Uganda (20.8%) having the highest representation. Regarding education levels, most respondents (61.6%) held an undergraduate degree, followed by postgraduates (22.9%) and secondary school graduates (15.2%). WhatsApp emerged as the most frequently used communication platform (58.6%), followed by X (20.8%) and Facebook (6.8%). The participants' demographic details are comprehensively outlined in Table 4.1.

Table 4.1: Demographic information of the study participants

Variable	N= 336	%
Age bracket		
18-24	159	46.1%
25-34	127	37.8%
35-44	25	7.4%
45-54	25	7.4%
Mean	27.4	
Standard deviation	0.903	
Gender		
Female	179	53.3%
Male	156	46.4%
Prefer not to say	1	0.3%
Country		
Cameroon	63	18.8%
Kenya	71	21.1%
Nigeria	69	20.5%
Uganda	70	20.8%
Zimbabwe	63	18.8%
Education Level (highest)		
Postgraduate	77	22.9%
Undergraduate	207	61.6%
Secondary school	51	15.2%
Primary school	1	0.3%
Residence		
Rural setting	21	6.3%
Semi- urban setting	114	33.9%
Urban setting	201	59.8%
Communication platform		
WhatsApp	197	58.6%
X	70	20.8%
Facebook	23	6.8%
Instagram	20	5.9%
Websites	18	5.4%
LinkedIn	8	2.4%

Relationship between Exposure to mHealth Interventions and Health Literacy Levels

Analysis of Health Literacy:

The survey findings indicated diverse levels of knowledge and comprehension among participants concerning non-communicable diseases (NCDs) and their associated risk factors (see Table 4.2). Questions aimed at gauging general awareness of NCDs, such as Q7 ("What statement best describes a non-communicable disease?") and Q9 ("non-communicable diseases are the leading causes of death worldwide"), yielded relatively high rates of correct responses, at 93.8% and 83.6%, respectively.

In contrast, when participants were asked to identify specific diseases linked to risk factors like smoking, tobacco chewing, and alcohol consumption, the accuracy of responses was noticeably lower. For example, Q14a ("If yes, can you select all the diseases that could be caused by

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smoking?") and Q14b ("If smoking causes cancer, which cancers are caused by smoking?") received correct response rates of only 48.2% and 40.2%, respectively. This data is detailed in Table 4.2 below.

Table 4.2: Health Literacy Assessment scores (General knowledge and risk factors)

Question	General Knowledge and Risk Factors Assessment Questions	% Score of the Correct Responses
Q7	Which statement most accurately defines a non-communicable disease?	93.8
Q8	Which of the following is not classified as a non-communicable disease?	69.0
Q9	Non-communicable diseases are the primary cause of death worldwide.	83.6
Q10	Select all the correct options. The risk factors for non-communicable diseases include:	52.9
Q11	Choose the accurate statement: Individuals with non-communicable diseases…	90.5
Q14	Does smoking tobacco impact your health?	97.6
Q14A	If yes, please select all the diseases that can result from this habit.*	48.2
Q14B	If smoking is linked to cancer, which types of cancer can it cause? *	40.2
Q15	Can chewing tobacco impact your health?	87.8
15 A.	If tobacco chewing affects your health, can you identify the diseases that may result from this habit?	31.1
Q15B	If chewing tobacco leads to cancer, please select all the types of cancer that could be caused by it.	37.9
Q16	Can drinking alcohol have any impact on your health?	97.0
Q16A	If so, can you list the diseases that may result from consuming alcohol? *	36.0

Questions related to preventive measures and the connection between NCDs, and other health conditions yielded varied levels of correct answers. For example, Q20 ("How much do you know about diabetes?") had a high percentage of correct responses (99.4%). In contrast, Q21A ("Tick all the lung diseases you are aware of") received a much lower response rate of 38%. This is shown in Table 4.3 below.

Table 4.31: Assessment scores of health literacy (related to specific NCDs and their connections to other conditions)

No.	Questions Regarding Specific NCDS, Their Prevention, and the Connection to Other Health Conditions.	% Score of Right Responses
17	What is your knowledge about high BLOOD PRESSURE?	98.5
17A	If you are aware of high BLOOD PRESSURE, do you think it is important to have your BLOOD PRESSURE monitored?	97.9
17B	If yes, how frequently should BLOOD PRESSURE be checked?	86.6
18	What is your level of knowledge of heart attacks?	97.3
18A	If you know about heart attacks, do you believe they can be prevented?	83.0
19	What is your knowledge about stroke?	95.8

19A	If you are familiar with stroke, do you agree that individuals with high BLOOD PRESSURE are at a higher risk of having a stroke?	86.3
20	What do you know about diabetes?	99.4
20A	If you know about diabetes, what steps can a person take to lower their risk of developing the disease? *	58.5
21	What is your understanding of long-term lung diseases?	87.5
21A	Select all the lung diseases you are aware of	38.0
21B	If you are familiar with long-term lung diseases, what steps can an individual take to reduce the risk of developing these diseases?	96.4
22	What is your level of knowledge about mental health?	96.4
22a	Select all that apply: How many mental health conditions are you aware of?	57.2
22b	If you have knowledge about mental health, what steps can an individual take to reduce the risk of developing mental health issues? *	39.9

The Health Literacy Distribution Curve

The distribution curves reflect the literacy scores of the study participants, which were derived from a thorough evaluation of their knowledge and understanding of non-communicable diseases (NCDs) and related health issues. These curves offer insights into how literacy scores are spread among the participants.

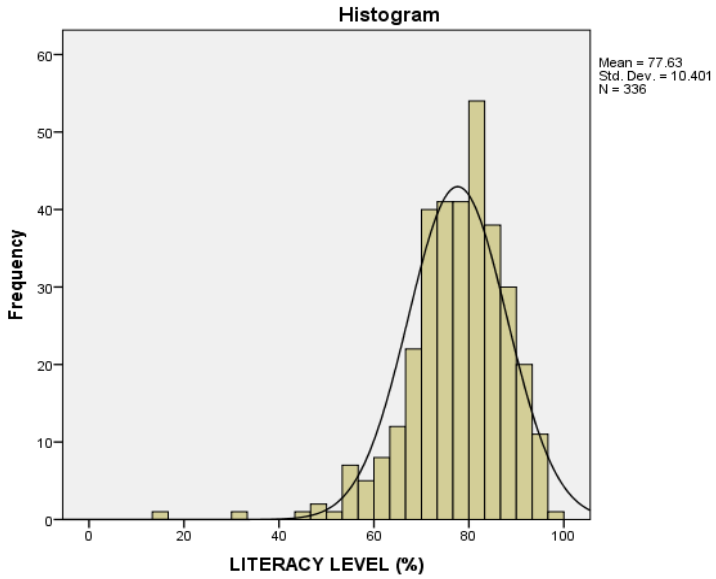

Figure 4.4: Overall Literacy distribution curve

The overall literacy distribution curve is right-skewed, signifying that a greater proportion of individuals achieved higher literacy scores compared to those with lower scores. This rightward skewness suggests a concentration of scores between 70% and 90%. Additionally, the pronounced peak in the distribution indicates a clustering of individuals with higher literacy at this range, accompanied by extended tails on either side. This pattern is depicted in Figure 4.1, which highlights the notable peak on the right side of the curve.

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Literacy Levels on NCDs Knowledge and Education Status

The adjusted literacy rates based on the highest level of education are shown in Table 4.4. The table outlines the percentage of individuals in each education category along with their respective adjusted literacy rates. For individuals with a primary school education, the adjusted literacy rate was 0.23%. Those with secondary education had an adjusted literacy rate of 11.80%. The highest adjusted literacy rate, 47.68%, was seen among individuals with an undergraduate degree. Individuals holding a postgraduate degree also showed a relatively high adjusted literacy rate of 17.86%. In total, the adjusted literacy rate across all education levels was 77.57%.

Table 4.42: Literacy rates adjusted according to the highest level of education.

Highest Education Level	Adjusted Literacy Rate
Primary School	0.23%
Secondary School	11.80%
Undergraduate	47.68%
Postgraduate	17.86%
Total	**77.57%**

Mean Literacy Level Over the Project Lifetime

The data presented in Table 4.5 show the average literacy levels and the participation rates at different stages of the year-long NCDs 365 Project. The standard deviation, ranging from 7.638 to 11.429, reflects the variation around the mean. At the start of the project, 100% of participants were involved, and the average literacy level was 75%. However, as the project progressed, participation dropped, with only 61.6% remaining after three months, at which point the average literacy level had risen to 78%. By the sixth month, just 36.9% of the original participants were still engaged, and the average literacy level increased further to 80%. By the end of the project, only 17.3% of the initial respondents remained, with their average literacy level reaching 82%.

Table 4.53: Mean literacy level over time

Duration	Mean Literacy Level	Percentage number of respondents	Std. Deviation
One month	75%	100%	11.429
Three months	78%	61.6 %	9.375
Six months	80%	36.9%	7.638
Twelve months	82%	17.3%	10.578

Hypothesis Testing for the 1st Objective

The hypothesis for Objective 1 posited that there is a significant correlation between exposure to mHealth interventions for health promotion and individuals' health literacy levels in Sub-Saharan Africa. To test this hypothesis, an Analysis of Variance (ANOVA) was performed to explore the relationship between exposure to mHealth interventions and health literacy levels in the region. The results of this analysis are presented in Table 4.6 below.

Table 4.6 4: ANOVA Test on the Association Between Health Literacy and Duration

Test for ANOVA					
Dependent Variable: LITERACY LEVEL (%)					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**

Corrected Model	2452.376[a]	3	817.459	8.033	.000
Intercept	1887428.918	1	1887428.928	18546.350	.000
@24Duration	2452.376	3	817.459	8.033	.000
Error	33787.049	332	101.768		
Total	2061218.889	335			
Corrected Total	36239.424	334			
a. R Squared = .068 (Adjusted R Squared = .059)					

The ANOVA results above show a significant relationship between exposure to mHealth interventions for health promotion (represented by the variable "@24Duration") and health literacy levels in Sub-Saharan Africa. The p-value (Sig.) of 0.000 indicates that this relationship is very unlikely to be due to chance. The R-squared value of 0.068 suggests that exposure to mHealth interventions accounts for about 6.8% of the variance in health literacy levels, underscoring its importance in influencing health literacy outcomes.

The Effectiveness of Various Online Communication Channels for mHealth Initiatives in Promoting Health

The Utilization of Various Online Communication Channels Across Five Countries:

Table 4.7 presents data on the use of various online communication channels for distributing health promotion education and materials through the NCDs 365 project. The findings reveal that WhatsApp was the most popular platform, with 197 users, making up 58.6% of the total participants. X followed with 70 users, representing 20.8%. LinkedIn and websites had the smallest user base, each comprising less than 10% of the total participants.

Table 4.7: Online communication platform use per country

	cumulative	
Channel	**Count**	**%**
WhatsApp Channel	197	58.6
X (formerly X)	70	20 .8
Facebook Platform	23	6.8
Instagram	20	6.0
Websites	18	5.4
LinkedIn	8	2.4
Total	**336**	**100%**

Adjusted Literacy Rates by Platform

Table 4.8 shows that the mean literacy levels across the six platforms vary from 75.36% to 80.84%. The standard deviation, which reflects the variability around the mean, ranges from 7.051 to 15.014. The sample sizes for each platform range from 8 to 197 participants. LinkedIn and websites recorded the highest mean literacy levels, at 81% and 80%, respectively. In general, the mean literacy levels across the platforms show minimal variation, ranging from 75% to 81%.

Table 4.8: Adjusted Literacy Levels by Channel

Channel	(N)	Mean Literacy Level	Adjusted Literacy levels	Std. Deviation
WhatsApp	197	78%	45.12%	11.065
X	70	77%	16.01%	8.973

URL: http://dx.doi.org/10.14738/bjhr.1201.18109.

Facebook	23	75%	5.13%	15.014
Instagram	20	80%	4.76%	7.051
Websites	18	81%	3.86%	7.744
LinkedIn	8	80%	1.90%	13.226

Hypothesis Testing for the 2nd Objective

Objective 2's hypothesis proposed that there is a notable difference in the effectiveness of various online communication channels, including social media platforms and websites, for mHealth interventions aimed at health promotion in Sub-Saharan Africa. To examine this, a Kruskal-Wallis test was conducted. The findings are presented below:

Table 4.5: Kruskal-Wallis test for objective 2

Test Statistics[a,b]	
	@25Platform
Chi-Square	41.582
df	49
Asymp. Sig.	.765
a. Kruskal Wallis Test	
b. Grouping Variable: LITERACY LEVEL (%)	

The results of the Kruskal-Wallis test suggest that there is no significant difference in the effectiveness of various online communication channels, such as social media platforms and websites, for mHealth interventions in promoting health in Sub-Saharan Africa ($x2 = 41.582$, $df = 49$, $p = 0.765$). Given the p-value, the null hypothesis cannot be rejected, indicating that there is not enough evidence to support the notion that different online communication channels for mHealth interventions in Sub-Saharan Africa significantly differ in their effectiveness.

CHAPTER 5: DISCUSSION

Relationship between Exposure to mHealth Interventions and Health Literacy Levels

This study revealed that questions assessing general knowledge about non-communicable diseases (NCDs) received relatively high correct response rates of 93.8% and 83.6%. However, questions addressing the effects of specific risk factors, such as smoking, tobacco chewing, and alcohol consumption, had considerably lower response rates at 48.2% and 40.2%. These results highlight a significant gap in health literacy efforts, particularly in addressing specific risk factors and going beyond basic general knowledge. This observation aligns with findings from a systematic review by (3), which emphasized the importance of detailed health promotion strategies that extend beyond foundational knowledge. To address this gap, it is crucial to adopt innovative health promotion approaches. Digital platforms, for instance, present an opportunity to deliver accessible, stage-specific health information tailored to different levels of health literacy.

An analysis of the health literacy distribution curve indicated a skewed pattern, with a higher concentration of individuals scoring between 70% and 90%. This range represents relatively high health literacy scores compared to average scores reported in other countries. For example, the 2015 WHO STEPwise survey on NCDs in Kenya showed that only 25.9% of the population was aware of NCDs and their associated risk factors (48).

The study further demonstrated that the duration of exposure to mHealth interventions had a positive influence on mean literacy levels, showing a consistent improvement over time. As illustrated in Table 4.5, the mean literacy level increased from 75% in the first month to 82% at the 12th month. Consistent with the ANOVA results, there was a statistically significant correlation between exposure to mHealth interventions and health literacy levels. The effect size, represented by an R-squared value of 0.068, indicates that approximately 6.8% of the variance in literacy levels can be explained by exposure to these interventions (Table 4.6). This finding is supported by a similar study conducted by (49) in Sweden, which reported that 65% of participants experienced improved health literacy after engaging with health literacy materials over a three-month period. This further reinforces the role of exposure in enhancing health literacy outcomes.

It is important to acknowledge that the field of digital health interventions is multifaceted, with outcomes that can vary significantly. A systematic review of 69 studies evaluating the impact of health information technology on patient outcomes reported mixed findings, highlighting the need for more in-depth exploration and analysis to better understand how digital technology and mHealth interventions influence health literacy and health outcomes (50). Similarly, another systematic review involving 34 studies found that while mHealth applications offer certain benefits, the tools used to evaluate individuals' comprehension of health literacy may not always be well-aligned with the design and delivery of mHealth platforms. These findings emphasize the complex and nuanced nature of mHealth interventions and reinforce the necessity for ongoing research to accurately assess their effects on health literacy and overall health outcomes (51).

In conclusion, this study demonstrated that while participants exhibited strong general awareness of non-communicable diseases (NCDs), there were clear knowledge gaps concerning specific risk factors such as smoking and alcohol consumption. However, given that this project was conducted online, the materials remain readily accessible for users. This digital format allows participants to be easily redirected to relevant information, optimizing both time and resources. Such an approach eliminates the need for repeated interventions, which would otherwise be resource-intensive in traditional, in-person project structures.

Effectiveness of Different Online Communication Channels for mHealth Interventions

The study findings revealed that WhatsApp was the most widely used online communication platform, accounting for 58.6% of participants, followed by X at 20.8% and Facebook at 6.8%. These results align with similar studies conducted at a country-specific level. For example, a 2015 HIV study in South Africa by Lanham et al. demonstrated WhatsApp's effectiveness in delivering HIV/AIDS prevention and care messages to rural populations (52). Likewise, prior research has highlighted X's success in disseminating health information, particularly within African contexts (53). Supporting these findings, Statistica data confirms WhatsApp's dominance in social media usage across countries such as Kenya (97%), Nigeria (94.9%), and its significant adoption in Zimbabwe (89%), Uganda (93%), and Cameroon (85%) (54).

When assessing mean literacy levels across the six communication platforms, slight variations were observed, ranging from 75.36% to 80.84%. Platforms like LinkedIn and websites demonstrated the highest mean literacy levels at 81% and 80%, suggesting that these platforms attract individuals with more advanced literacy skills. Despite these slight variations (ranging

URL: http://dx.doi.org/10.14738/bjhr.1201.18109.

between 75% and 81%), platforms such as WhatsApp and X, which have larger user bases (197 and 70 users, respectively), made more substantial contributions to the overall adjusted literacy rate (45.12% and 16.01%) compared to LinkedIn (3.86%) and websites (1.90%). This trend indicates that platforms requiring higher technical expertise, such as LinkedIn and websites, appeal to a smaller but more literate audience, while more accessible platforms like WhatsApp and X cater to a wider range of users with varying literacy levels. These findings emphasize the importance of tailored approaches to user engagement and highlight WhatsApp's potential as a powerful platform for executing health promotion campaigns via mobile communication (55).

Lastly, results from the Kruskal-Wallis test showed no statistically significant difference in the effectiveness of the various online communication platforms, including social media and websites, for mHealth interventions in promoting health across Sub-Saharan Africa (x^2 = 41.582, df = 49, p = .765).

RECOMMENDATIONS

The findings of this study carry important implications for the design and implementation of mHealth interventions in Sub-Saharan Africa. Firstly, while no single online communication channel needs to be prioritized over others, strategically capitalizing on the widespread use of WhatsApp and X (formerly Twitter) in the region could deliver the best results. Secondly, the study emphasizes the importance of personalization in health communication, with WhatsApp's tailored and interactive nature being a key driver of increased engagement. Health intervention implementers are encouraged to incorporate personalized messaging techniques, such as translating content into local languages, simplifying medical terms, and utilizing implicit, explicit, and adaptive personalization methods to meet the diverse communication preferences of target audiences (56).

Finally, the study highlights the benefits of a multi-platform approach to effectively reach and engage a broader audience. Since platform preferences often depend on accessibility and familiarity, combining platforms like WhatsApp, X, and Facebook can ensure more inclusive coverage and engagement across various demographic groups (52).

CONCLUSION

In summary, this study has provided an in-depth analysis of the feasibility and effectiveness of cross-country mHealth interventions for health promotion within Sub-Saharan Africa. By examining data across six online communication platforms and five countries, the research has demonstrated the capacity of mHealth technology-based initiatives to improve health literacy among diverse populations.

The study's rigorous methodology, alignment with prior research, and attention to gender disparities enhance the reliability of the findings, offering valuable insights for policymakers looking to implement platform-specific strategies and foster cross-country collaboration in health promotion efforts.

Furthermore, these findings establish a solid groundwork for future research aimed at refining and advancing health communication approaches.

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