Feasibility and Acceptability of Smartphone Interventions for Maternal and Child Health in Slum Settings in Kampala, Uganda

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Abstract

The use of mobile phones for health interventions has become increasingly popular in low-income settings, particularly in sub-Saharan Africa. This study aimed to investigate the acceptability of a smartphone intervention to provide maternal and child health messages for women living in slum settings in Uganda. The study utilized a mixed-methods design, comprising a survey and interviews. A total of 200 women participated in the survey, and 23 women participated in the interview sessions. The results indicated a high level of acceptability of the smartphone intervention, with the majority of women expressing their willingness to receive maternal and child health messages via their mobile phones. The women reported that the messages were informative, relevant, and useful for their daily lives. They also appreciated the privacy and convenience of receiving messages on their phones. However, some women expressed concern about the cost of receiving the messages and the need for support to access and use the technology. The study findings suggest that mobile phone interventions for maternal and child health promotion are acceptable to women living in slum settings in Uganda. The findings also highlight the need for equitable access to mobile phones and support for technology use in these settings.
Keywords: Acceptability, Low-income Settings, Maternal and Child Health, mHealth, Mobile Phones, Slum Settings.

Introduction

Recent developments in mobile health (mHealth) technologies have significantly transformed healthcare approaches, particularly in the developing world. These advancements are especially pivotal in maternal health care, a sector where they hold substantial promise as evidenced by various studies [1]. In the underserved urban slums of Uganda, mHealth technologies emerge as a vital solution to the prevalent healthcare accessibility issues.

The influence of mobile technology on maternal health in East Africa has undergone extensive examination. These studies, relevant to the Ugandan scenario, delve into regional specificities and the potential advantages of such technologies [2]. The rise in mHealth innovations in East Africa, aimed at reducing healthcare disparities, reflects similar trends in Uganda, where smartphone-based solutions have demonstrated efficacy in improving maternal health outcomes [3].

Research focusing on the application of mHealth in resource-poor environments highlights improvements in antenatal care. These findings are notably pertinent to projects within Ugandan slums [4]. A comprehensive analysis of mHealth

applications in maternal health across Sub-knowledge for understanding regional impacts, particularly in Ugandan slums [5].

Systematic reviews have underscored the positive effects of mHealth interventions on maternal health, reinforcing the potential of smartphone-based solutions in the unique context of Ugandan slums [6]. The effectiveness of mHealth strategies for maternal and child health in developing nations supports the hypothesis that smartphone interventions in slums in Uganda could lead to substantial health improvements [7].

In-depth examinations of mobile app usage in maternal healthcare across Sub-Saharan Africa provide insightful context for interventions in Ugandan slum areas [8]. In Uganda, maternal and child health outcomes continue to face significant challenges, particularly in slum settings where access to quality healthcare is constrained [9]. Recognizing the transformative impact of mobile phones, these interventions are seen as a way to enhance health outcomes in low-income settings, including slums [10]. They offer increased access to crucial health information, thereby contributing to better health outcomes. Understanding the acceptability and feasibility of these interventions is key to developing effective and sustainable strategies in Ugandan slums [11].

The employment of participatory design in crafting mHealth interventions has proven to increase their acceptability and effectiveness. A Ugandan study indicated that involving the target demographic in designing a maternal and child health mobile intervention led to heightened user satisfaction and engagement [12]. Additionally, training healthcare workers and community health workers has been effective in enhancing maternal and child health outcomes. A study in Uganda showed that training community health workers in these areas led to better knowledge, practices, and increased utilization of antenatal care and

Saharan Africa offers crucial contextual skilled delivery services [13]. Moreover, behaviour change communication strategies have positively impacted maternal and child health outcomes. A Ugandan intervention demonstrated that such strategies led to improved knowledge and practices [14].

Furthermore, mobile health clinics have proven effective in providing healthcare services to underserved populations. A study in Uganda revealed that mobile clinics increased access to healthcare services and improved health outcomes for women and children [15]. Public-private partnerships have also been effective in expanding the reach and sustainability of healthcare interventions, as demonstrated by a Ugandan study that showed increased access to healthcare services and improved health outcomes through such partnerships [16].

These findings highlight the efficacy of various strategies in enhancing the acceptability and effectiveness of mobile phone interventions in maternal and child health for women in slum areas. However, it is important to recognize that contextual factors like access to mobile phones and literacy levels can influence the implementation and success of these interventions. Hence, tailoring these strategies to the specific needs and circumstances of the target population is crucial.

The application of smartphones in promoting maternal and child health messages in Ugandan slums has been a focal point of recent research. A randomized controlled trial in a Kampala slum found that short message service (SMS) reminders significantly increased pregnant women's attendance at antenatal care clinics. The study, involving 352 women, concluded that SMS reminders could be a cost-effective method to enhance maternal health outcomes in slum areas [10].

Another study in a peri-urban area of Kampala City in Uganda showed the effectiveness of mobile phone-delivered health

education messages in increasing women's knowledge and altering behavior. The study with 208 women revealed that those receiving these messages had higher knowledge levels and were more likely to exclusively breastfeed compared to those who didn't receive the messages [10].

Additionally, a study in Kampala's slums in Uganda found a mobile phone-based referral system effective in improving access to emergency obstetric care. The study, involving 125 health workers, concluded that such systems could enhance maternal health outcomes in resource-limited settings [11].

The use of smartphones to promote maternal and child health messages in slums in Uganda has demonstrated significant potential in improving antenatal care attendance, enhancing education, and facilitating access to emergency care [11]. This underscores the potential of mobile phone-based interventions in enhancing maternal health outcomes in such settings.

Given the ongoing challenges in maternal and child health outcomes in slums in Uganda , there is an urgent need for innovative strategies. The limited access to quality healthcare services in these areas necessitates exploring effective interventions. While mobile phone interventions have shown promise in improving health outcomes in low-income settings, understanding their impact within the unique context of slum communities remains crucial. Therefore, this study aims to investigate the effectiveness of mobile phone interventions in enhancing maternal and child health outcomes specifically in Ugandan slum settings. This research will provide invaluable insights to address the significant health disparities faced by women and children in these marginalized communities.

The general objective of this study was to assess the acceptability of a smartphone intervention for improving maternal and child health access in a slum setting in Uganda.

The specific Objectives of the study were to

1. Determine the level of smartphone ownership and usage among women of reproductive age in the slum setting.
2. To assess the feasibility and acceptability of implementing smartphone intervention for maternal and child health access in the slum setting.

The novelty of this study lay in the specific context of the slum setting and the use of smartphone intervention. While previous studies have investigated the acceptability of various interventions for maternal and child health in other settings, this study is the first to focus specifically on the slum setting and the use of smartphones in Uganda.

Research Methodology

Selection of Study Area

The study was conducted in five slums of Kawala, Kiswa, Kisenyi, Kanyanya and Namuwongo in Kampala the capital city of Uganda, where access to maternal and child health services is often limited. These were selected based on their high population density, poor living conditions, and lack of basic amenities such as clean water and sanitation facilities. The study participants were women of reproductive age who resided in these slums.

Sample Size Determination

The target population consisted of women of childbearing age (15 – 49 years) residing in the slum settlements in the five slums in Kampala, the capital of Uganda. Nurses and midwives in health centres in the slum settlements responsible for monitoring and reporting on the frequency of visits by the women were also included. The study population included pregnant women in any stage of pregnancy, mothers within the postpartum period (6 – 8 weeks after delivery), and mothers with infants aged 2 months to 1 year residing in slum settlements in Kampala

city. These categories were chosen as they represent high-risk groups for pregnancy-related morbidity and mortality and allow for the evaluation of the intervention's impact on vulnerable populations. The study involved 200 participants out of which 23 women participated in the interview sessions and the others filled in questionnaires. convenience sampling was used whereby the participants were enrolled as they attended the health facilities, were used. Purposive sampling was used to identify nurses and midwives from health facilities in the slums based on their availability and willingness to participate. It is noteworthy that the study was conducted across five health centres, comprising two Health Centers (HC) III and three Health Centers (HC) IV, to ensure comprehensive data collection and representation.

Data Collection

The study used a mixed-methods approach to collect data. To ensure data control, reliability, and validity, rigorous tests of the data instruments were conducted on the survey questionnaire and the interview guide. These measures enabled the researcher to collect the required data effectively and maintain the quality of the study.

Qualitative data were collected through in-depth interviews with the study participants. The interview guide was meticulously designed to explore the acceptability of a smartphone intervention for improving maternal and child health access. The guide also delved into the perceived benefits and barriers to the use of smartphones for health purposes. Importantly, the interview guide underwent rigorous reliability and validity checks to ensure that it effectively captured the intended information accurately.

Quantitative data were gathered through a survey questionnaire administered to the study participants. The questionnaire assessed critical factors, including the level of smartphone ownership and patterns of smartphone usage among the participants. Similar to the interview guide, the survey questionnaire was subjected to rigorous reliability and validity assessments to maintain the data's integrity.

Statistical Analysis

The qualitative data were analyzed thematically using a deductive approach. The data were transcribed, coded, and organized into categories based on the research objectives and themes that emerged from the data using NVIVO 12. The data were then synthesized to identify patterns and trends related to the acceptability of the smartphone intervention for improving maternal and child health access in a slum setting in Uganda.

Additionally, it is important to note that the collected data from the focus discussion groups were originally conducted in Luganda, which is a local language widely spoken in the slum settlements. To ensure a comprehensive analysis and understanding, these interactions were later translated into English. This translation allowed the participants to express themselves effectively. Recordings of the interactions were made and later listened to to generate key issues and themes raised.

The quantitative data were analyzed using descriptive statistics to determine the level of smartphone ownership and usage among the study participants using Statistical Package for Social Sciences (SPSS) version 26. Descriptive and inferential statistics, such as chi-square tests, were also employed to explore the associations between smartphone ownership and usage and other variables such as age, education level, and income.

Triangulation of the quantitative and qualitative findings was conducted in line with the assertion by [17], as it allows for a deeper examination of certain aspects for comparison and provides more information that might not have been clear by one method of data analysis.

Results and Discussion

Demographic Data for the Study Participants

Survey Results: Participant Characteristics

Figure 1 below shows the age distribution of study participants, providing insights into the age profile of the women involved in the study.
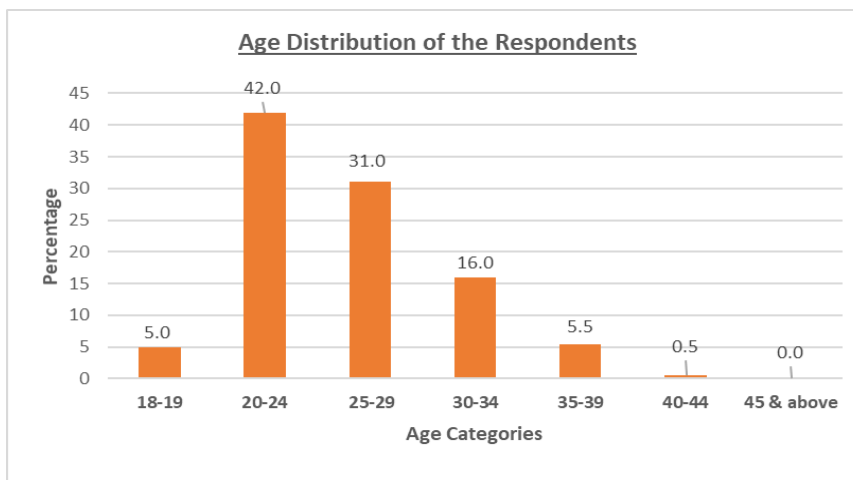

Figure 1. Age Distribution of Study Participants

Table 1 below presents demographic data of the study participants, detailing various aspects like education level, occupation, and marital status.

Table 1. Demographic Data for the Study Participants

SN.	Covariate Category	Covariate Detail	Percentage (%)	Frequency
1.	Highest Level of Education	1. No formal	0.5	1
		2. Primary Education	11.5	23
		3. Secondary Education	74.0	148
		4. Vocational/Trade school	0.0	0
		5. Bachelor's Degree	5.0	10
		6. Master's degree	0.0	0
		7. Doctorate	0.0	0
		8. Others	9.0	18
		Total	**100.0**	**200**
2.	Primary Occupation	1. Home Maker/ Domestic unpaid worker	51.5	103
		2. Self-employed (small-scale business)	25.0	50
		3. Employed in the formal sector (Govt/private)	10.0	20
		4. Employed in the informal sector (Causal/daily wage labour)	7.0	14
		5. Student	2.5	5
		6. Unemployed	2.0	4
		7. Others	2.0	4
		Total	**100.0**	**200**
3.	Marital Status	1. Single	0.0	0
		2. Married	25.5	51
		3. Widowed	0.0	0
		4. Divorced	0.5	1
		5. Separated	3.0	6
		6. In a relationship	44.5	89
		7. Cohabiting	26.5	53
		Total	**100.0**	**200**
4.	Period Spent at Place of Residence	1. Less than 1 year	38.0	76
		2. 1-2 years	24.0	48

		3. 3-5 years	15.5	31
		4. 6-10 years	11.0	22
		5. More than 10 years	11.5	23
		Total	**100.0**	**200**
5.	Status of Pregnancy	1. Yes	90.5	181
		2. No	9.5	19
		Total	**100.0**	**200**
6.	Ownership of Mobile Phones	1. Yes	99.5	199
		2. No	0.5	1
		Total	**100.0**	**200**

Source: Primary data, 2023

Figure 2 below shows the number of children that the study participants indicated to have had.

Table 2 details the place of delivery of previous children of the participants, offering insights into childbirth practices among the study group.
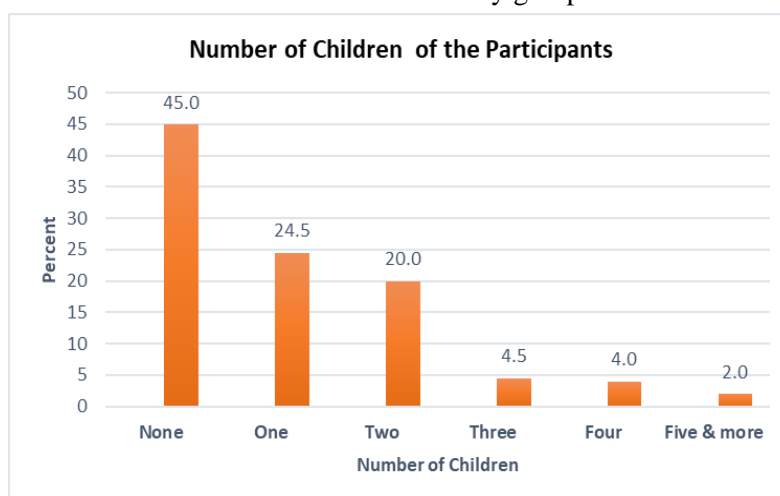
Figure 2. Number of Children of the Participants

Place of Delivery of the Previous Child

Table 2. Place of Delivery of the Previous Child

SN.	Place of Delivery	Number of Children (n=200)			
		One Child (%)	Two Children (%)	Three Children (%)	Four Children (%)
1.	Health Facility	52.5	30.0	11.0	6.0
2.	Home	2.5	0.5	0.0	0.0
3.	Others	0.0	0.0	0.0	0.0
4.	NA	45.0	69.5	89.0	94.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3 provides an overview of the study participants' comfort levels with using mobile applications.
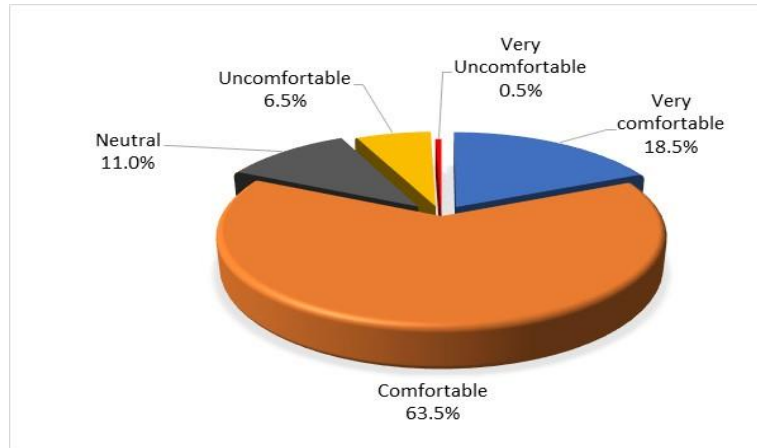
Comfort Level with Using Mobile Apps

Figure 3. Comfortability Level with Using Mobile Apps

From Figure 1 above, it is indicated that majority of the respondents fall within the age bracket of 20-24 years constituting 42.0% implying that they are young mothers that need assistance during this period of pregnancy and the early stages of childbirth to reduce on complications. In terms of the education levels, the majority of the respondents 74.0% had attained secondary education which indicated that they are able to read these health messages on their phones but also were able to understand the questions in the survey questionnaire as well as the interview guide and the focus discussion checklist to give valid responses for this study. The major form of occupation among respondents was home make which constituted 51.5%; 44.5% of the respondents were in a relationship implying that they are bound to get pregnant therefore the smartphone intervention would be a valuable mechanism to access healthcare services and information. Also, these results suggest a community with limited higher education and formal employment opportunities. This context is important for understanding the health needs and access to healthcare information of the population. 38% of the respondents had stayed in these slums for less than 1 year indicating that the number of people increase which is bound to increase the pregnancy levels and childbirth. 24.5% of the respondents had only one child and 52.5% of the respondents had produced their 1st child in health centres, while 30% of the respondents had produced child number 2 in health centres, 11.0% in health centres for child number 3 and 6.0% had produced child number 4 in health centres. In regard to ownership of smartphones, 99.5% of the respondents owned smartphones, 90.5% of the respondents were pregnant hence the app being so essential for information accessibility while 82.1% of the respondents were comfortable using smartphones implying that more efforts to train these women who own smartphones on how to use them is important.

Quantitative Results from Survey

Percentage of Smartphone Owners and Use their Phones to Access Health Information

This bar chart, titled "Smartphone Use," visually represents a study on smartphone ownership and its use for accessing health information among participants. The vertical axis shows percentages, while the horizontal axis has three categories: "No" (participants who don't use their smartphone for health

information), "Yes" (those who do), and "Total" (overall smartphone ownership).
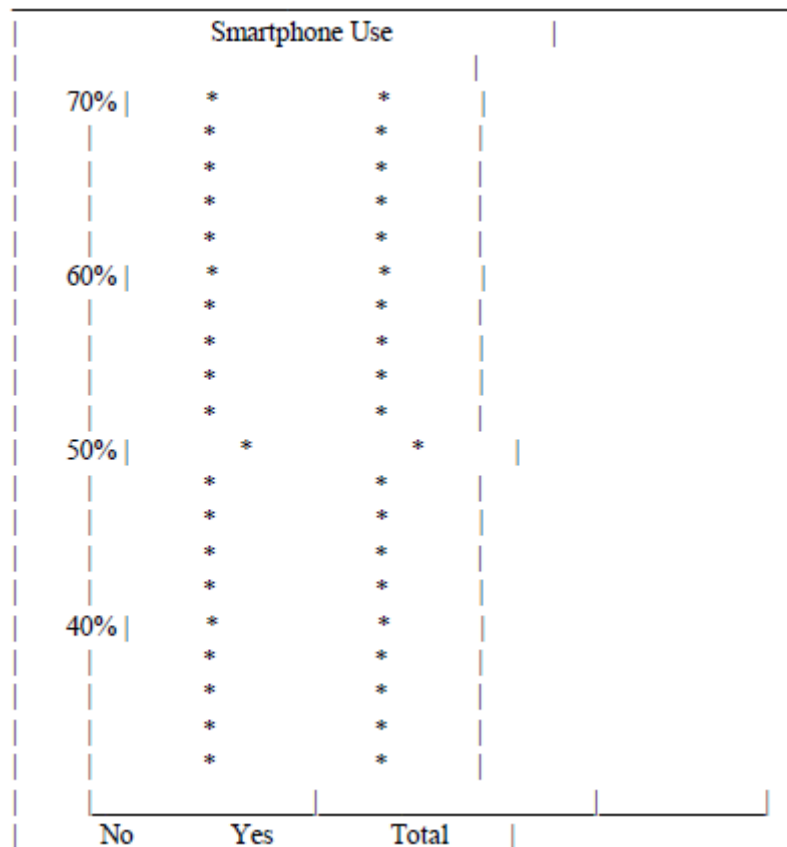

Figure 4. The Frequency and Percentage of Participants Who Owned a Smartphone and Used it for Accessing Health Information

Figure 4 shows the percentage of participants who owned a smartphone and used it for accessing health information. The "No" and "Yes" bars represent the percentage of participants who did not use their smartphone for health information and those who did, respectively. The "Total" bar shows the total percentage of participants who owned a smartphone. 70.0% of participants owned a smartphone, and 50.0% of all participants used it for accessing health information.

Percentage of Women in the Study Reported Facing Barriers to Accessing Maternal and Child Health Services

Table 3 below shows the Percentage of Women Facing Barriers to Accessing Maternal and Child Health Services. 5 women (2.5% of the respondents) report finding it somewhat difficult to access these services, 76 women (38%) find it somewhat easy, and 119 women (59.5%) report finding it very easy to access these services.

Table 3. Women facing barriers in accessing maternal and child health services

	Respondent(n=200)
Somewhat difficult to access	5 (2.5%)
Somewhat easy to access	76(38.0%)
Very easy to access	119(59.5%)

The data from the Table 3 indicates that a small fraction (2.5%) of the women in the study report difficulties in accessing maternal and child health services, while a significant majority (97.5%) find it relatively easy to access these services. This suggests a

promising potential for leveraging smartphone technology as a tool to bridge healthcare access gaps. If supplemented with targeted capacity-building initiatives, such as training in the use of health-related mobile applications or information services, the widespread ease of access to these services could be further enhanced. This approach could be particularly effective in empowering those who currently face barriers, thereby contributing to improved health outcomes in the community.

Percentage of Women Reported that they Would be Willing to Receive Maternal and Child Health Messages via their Smartphones.

Table 4 summarizes the responses of 200 women regarding their willingness to receive health-related messages on their smartphones. The responses are categorized into four groups: 'Never', 'Rarely', 'Sometimes', and 'Often'.

Table 4. Women Willing to Receive Maternal and Child Health Messages via Their Smartphones

Response	Number of Respondents	Percentage
1. Never	26	13.0%
2. Rarely	0	0.0%
3. Sometimes	173	86.5%
4. Often	1	0.5%
Total	**200**	**100.0%**

According to the table, a significant majority (86.5%) of the participants, combining 'Sometimes' and 'Often' categories, are open to receiving these messages, demonstrating a high level of receptiveness to mobile health communication. In contrast, 13.0% of the participants, represented by the 'Never' category, are not inclined to use their smartphones for this purpose. This table provides crucial insights into the acceptance of mobile health interventions among women in the study.

Interview Results

The chart in Figure 5 below shows the results of two Likert scale questions on the acceptability and feasibility of a smartphone intervention, with the acceptability results on top and the feasibility results on the bottom. The bars represent the percentage of participants who answered, "strongly agree," "agree," "neutral," "disagree," and "strongly disagree" to the questions. The majority of participants responded positively to both questions, with the highest percentage of responses falling under the "strongly agree" and "agree" categories.
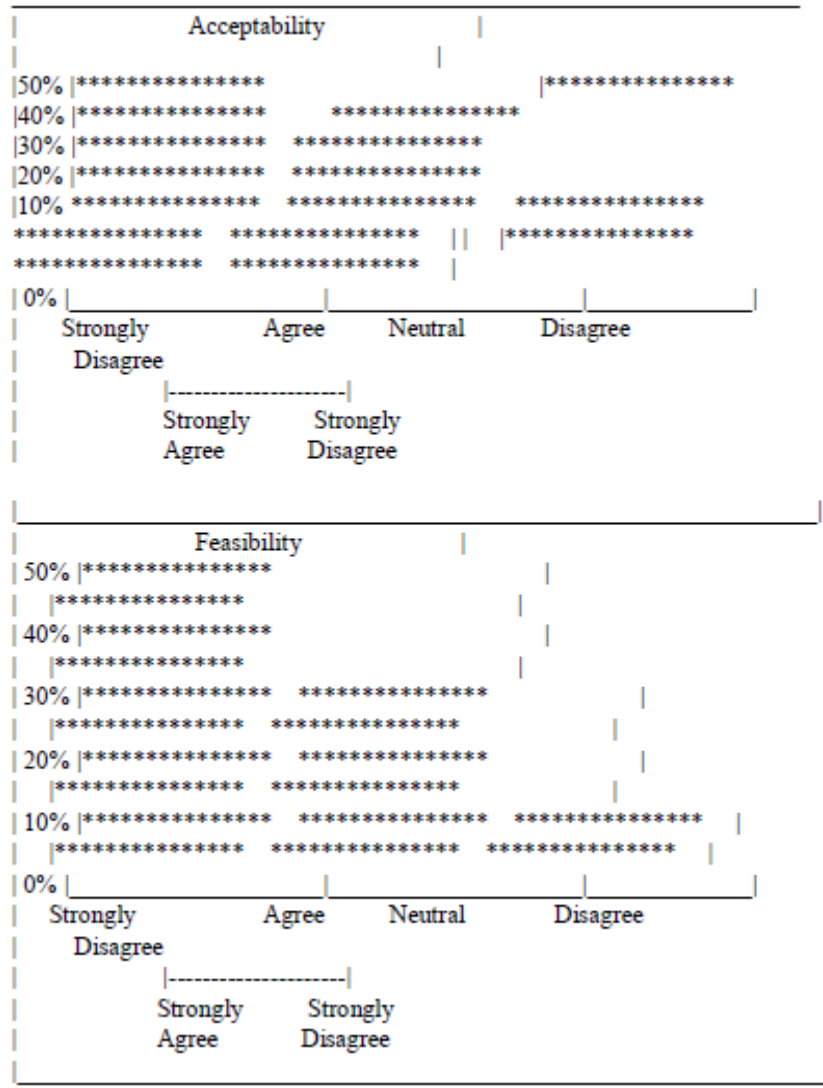
Figure 5. Results of the Likert Scale Questions on the Acceptability and Feasibility of the Smartphone Intervention

Ooverall, the study indicated that a smartphone intervention is acceptable and feasible for improving maternal and child health access among women living in slum settings in Uganda. The study suggested that women in slum settings have a high level of mobile phone penetration, use their phones to access health information, and are interested in receiving maternal and child health messages via their smartphones. Additionally, the study suggested that healthcare providers are supportive of the intervention and that it could be implemented in a technically and logistically feasible way.

Discussion

Maternal and child health outcomes remain a significant public health challenge in low-income countries, particularly in slum settings where access to healthcare services is limited [18]. Addressing this challenge requires innovative approaches that leverage the potential of new technologies such as smartphones. The study investigated the acceptability of a smartphone intervention to improve maternal and child health access among slum-dwelling women in Uganda specifically Kamwokya slums and provided important insights into the potential of such an intervention in improving health outcomes.

Overall, the study found that the use of a smartphone intervention to improve maternal and child health access was highly acceptable and feasible among slum-dwelling women in Uganda. These findings are consistent with previous studies that have highlighted the potential of mHealth interventions to improve maternal and child health outcomes in low-resource settings [10].

The study also revealed some interesting insights into the specific features and content that are most valued by slum-dwelling women in the context of maternal and child health. For example, women in the study emphasized the importance of receiving personalized health messages that are relevant to their specific stage of pregnancy or the age of their child. This finding is consistent with previous studies that have highlighted the importance of tailoring mHealth interventions to the specific needs and preferences of target populations [10].

Another key finding of the study was the importance of social support networks in promoting the uptake and sustained use of the smartphone intervention. Women in the study reported that they often shared the health messages and information they received with other women in their communities, and that this process helped to reinforce their own learning and motivation to engage with the intervention. This finding is consistent with previous studies that have highlighted the importance of social support and peer networks in promoting health behavior change [19; 20].

The study had several limitations that should be noted. First, the study was conducted in a single slum setting in Uganda and may not be generalizable to other contexts or populations. Second, the sample size was relatively small, which may have limited the ability of the researcher to detect more nuanced differences in the acceptability and feasibility of the smartphone intervention among different subgroups of women. Finally, the study did not collect data on the actual health outcomes of women and children who used the smartphone intervention, which limits the researcher's ability to assess the impact of the intervention on maternal and child health outcomes.

The study offers important insights into the potential of mHealth interventions to enhance maternal and child health access among slum-dwelling women in Uganda; findings indicate that customizing mHealth interventions to meet the specific needs and preferences of the target populations is essential for effectiveness. Leveraging social support networks is highlighted as a key factor that enhances the impact of these interventions. The study suggests that such tailored mHealth interventions hold promise in promoting behavior change and ultimately improving health outcomes, especially in resource-limited settings.

The study recommends that future studies should build upon the findings of this research to further enhance our understanding of the potential of mHealth interventions, it is imperative that these future studies rigorously evaluate the impact of mHealth interventions on health outcomes, particularly in low-resource settings, to establish robust evidence. The study highlights the importance of addressing privacy concerns as a critical aspect of mHealth interventions. Future initiatives should prioritize robust privacy measures. To maximize the effectiveness of mHealth interventions, it is recommended to tailor messages to individual needs and preferences, ensuring that interventions are highly relevant and engaging for the target population.

Conflict of Interest

commercial, or not-for-profit sectors. The authors have no financial relationships that could be broadly relevant to the work.

Acknowledgements

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