Enhancing Uptake of Maternal Health Services Using an Electronic Community Health Information System in Muhoroni Sub-County of Kisumu County, Kenya

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Abstract

Background: Maternal health, encompassing pregnancy, childbirth, and the postpartum, is a key indicator of public health but remains a challenge in low- and middle-income countries due to limited skilled care, poor nutrition, and low service uptake. Maternal health services can reach many women, yet limited studies exist on the impact of digitisation on maternal health outcomes. This study assessed the utilisation of an electronic community health information system (eCHIS) in enhancing the adoption of maternal health services in Muhoroni Sub-County, Kisumu County, Kenya.

Methodology: This study utilised a cross-sectional descriptive design, using a structured questionnaire to collect quantitative data from 398 lactating mothers with children younger than six months. Participants were selected by simple random sampling from a sampling frame drawn from eCHIS data across villages in Muhoroni Sub-County. Analysis was performed using SPSS, with linear regression applied to examine variable relationships.

Results: eCHIS use showed a positive, significant relationship with maternal health service adoption ($p = 0.001$). The R^2 of 0.656 indicated eCHIS explained 65.6% of the variation, with the remaining 34.4% variance linked to confounders such as cultural beliefs, spousal support, accessibility, and power outages. The Smart Health App, used by Community Health Promoters (CHPs), improved service access and utilisation by 18.4%.

Conclusion: The findings highlighted eCHIS as a transformative tool in improving maternal health outcomes, particularly in marginalised areas. The adoption of eCHIS by CHPs represents a critical step in Kenya's efforts to reduce maternal complications and advance maternal health equity.

Recommendation: The study recommended that the Department of Health strengthen monitoring of eCHIS to improve maternal health service delivery, implement educational programs to raise community awareness and informed decision-making, and enhance health facility services to encourage care-seeking and meet the rising demand created by eCHIS.

***Keywords**: Electronic Community Health Information System, eCHIS, CHPs, Maternal Health*

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Introduction

Maternal and child health remains a significant global concern, particularly in low- and middle-income countries (LMICs) where health systems are often underdeveloped, and access to quality healthcare services is limited. The World Health Organisation (WHO) has recognised the potential of digital health technologies to bridge these gaps and improve healthcare delivery. These are tools and systems that use digital platforms, software, and

electronic devices to improve health care delivery, access, management, and outcomes. Over the years, digital health has evolved, encompassing various components such as telemedicine, mobile health (mHealth), and electronic health records to enhance service delivery at all levels of healthcare. In 2005, the World Health Assembly, through resolution WHA58.28 on eHealth, urged Member States to integrate information and communication technology (ICT) infrastructure into healthcare, ensuring fair, cost-effective, and inclusive access to digital health solutions[1]. As a result of the COVID-19 outbreak, using a telemedicine platform, the Vietnamese Division of Health reduced the time of direct patient contact that Community Health Workers (CHWs) had and thus decreased their risk of infection.

Regionally across Sub-Saharan Africa, the Mobile Training and Support (MOTS) pilot, which was conducted in the Bo region of Sierra Leone, was established to ascertain whether the adopted interactive voice response (IVR) technology strategy would be well received by CHWs and other significant stakeholders, as well as whether knowledge would be renewed or learned by CHWs utilising MOTS. The data gained shows that the CHWs, their supervisors, and other MoHS managerial echelons who took part in the trial had an exceptionally favourable assessment of MOTS.[2]

Several studies have been done to examine how digital tools influence maternal health service delivery. Due to underdeveloped health systems, limited access to, and underutilization of healthcare services, rates of maternal, neonatal, and pediatric mortality are more rampant in low-income nations than in high-income ones. Even though the health indices of mothers, newborns, and under-5s have significantly improved recently, more rapid development is needed for target achievement, especially Sustainable Development Goal 3 (SDG)[3]. Africa's high maternal and infant mortality rates result from unresponsive health systems that keep disparities alive through inefficient and unsustainable interventions. To ensure the long-haul viability of eHealth initiatives and meet enduring development objectives, locally led investment is crucial.[3] The effects of mHealth on low-income countries' mothers' health include an impact on CHW responsibilities, pregnant women's tolerance, and care delivery while examining the implementation challenges in these contexts and the viability of integrating these techniques. There is, however, little evidence to support the idea that mHealth could improve maternal health outcomes. The results showed increased community members' trust, satisfaction, awareness of safer health behaviours, and use of healthcare facilities. Still, research on how mHealth affects specific health outcomes has yet to be done.[4]

Even while digital health technologies are starting to be widely utilised within the health systems, there is no conclusive evidence to support the argument that their widespread usage strengthens national health systems or makes healthcare more affordable or accessible.[5] Furthermore, more investigation is needed to pinpoint the specific impact of mobile health technology on clinical outcomes and develop implementation best practice frameworks.[4]

Nationally, Kenya still has high maternal and child health indicators, and extensive systems are needed to meet the third SDG goal by 2030. According to the Kenyan Ministry of Health, [5] community health services were crucial in ensuring that everyone in Kenya had access to health care. The current community health strategy (2020–2025) calls for increasing households' capacity to demand services from all providers and becoming increasingly aware of their legal entitlements to equitable and high-quality healthcare. To strengthen the healthcare system even more, the national government worked with partners and stakeholders to create

the National Community Health Digitisation Strategy. This initiative was led by Community Health Promoters (CHPs), who provide direct services to individual households, and aimed to digitise the health information system at the lowest level of healthcare service delivery.

Maternal health indicators in Kisumu County remain a significant concern. According to the Kenya Health Policy (2014–2030), maternal mortality in Kisumu stands at 497 per 100,000 live births—higher than the national average of 362 per 100,000 live births, and significantly above the national target of 147 per 100,000 live births. [6] Antenatal care (ANC) is a critical intervention to monitor the progress of pregnancy and mitigate the potential risks of morbidity and mortality for both the mother and the child throughout the stages of pregnancy, delivery, and the postpartum period, yet only 63% of women in Kisumu County receive the recommended four or more ANC visits.

The situation is even more critical in Muhoroni Sub-County, where only 52.7% of women report receiving four or more ANC visits [6]. Such statistics reflect the urgent need to improve maternal health service uptake at the community level. In response, the Ministry of Health implemented a digital health technology at the lowest level of healthcare service delivery through the pilot of an electronic community health information system in Kisumu County, equipping CHPs with mobile applications to streamline data collection, improve service tracking, and enable early identification of maternal health risks.

A mobile phone with an intelligent health application was given to the CHPs to replace the health departments' paper-based reporting system. The inclusion of a decision-support feature improved the system's functionality by enabling the determination of risky situations and excellent management of community referrals via the release of automatic triggers that come with tasks for the CHWs to complete. [4] As opposed to the paper-based method, which was prone to transcription errors, laborious, and time-consuming in data reporting, this digital health system generated real-time data electronically in a more efficient manner, and with improved data quality measures. The information produced at this level was essential for planning, making decisions, and tracking the development of UHC.

This study was therefore conducted to assess the impact of the electronic community health information system on maternal health service uptake in Muhoroni Sub-County. It specifically examined how the use of eCHIS influences uptake of ANC services, skilled birth attendance, and postnatal care. By generating local-level evidence on digital health's feasibility, effectiveness, and scalability, the study aimed to inform broader national strategies for eCHIS expansion, contributing to Kenya's progress toward Universal Health Coverage and Sustainable Development Goal 3 (SDG 3).

Methodology

Study design and site

The study employed a cross-sectional design. The study was conducted in Muhoroni Sub-County, Kisumu County, in Kenya. Muhoroni Sub-County was purposively selected as it was the first region to pilot an electronic community health information system and had low ANC coverage compared to other sub-counties in Kisumu County, Kenya.

Study population

The study included lactating mothers with children younger than six months, residing in the study area, whose pregnancies were registered by Community Health Promoters (CHPs) during the implementation of the electronic Community Health Information System (eCHIS) between July and December 2023. Inclusion required that participants be residents of the study area during the eCHIS implementation period (2022–2023), have children younger than six months, and provide informed consent. Mothers who were critically ill

at the time of data collection and did not consent to participate were excluded.

Sample size and sampling technique

The sample size calculation was performed using Yamane's formula, as stated below:

$$n = [(N)] / [(1 + N (e)^2)]$$

Where n was the sample size, N the population size (Population estimated for women of reproductive age in Muhoroni Sub-County was 75,000 at the time of data collection.[6]), and e as the level of precision. With a 95% confidence level and p = 0.5, the appropriate sample size was 398 participants.

A sampling frame was developed by identifying lactating mothers with children under six months whose pregnancies had been registered by Community Health Promoters (CHPs) using the electronic Community Health Information System (eCHIS) between July and December 2023. A simple random sampling technique was then employed to select the participants. Using Excel's RAND () function, random numbers were assigned to each individual in the sampling frame, duplicates were removed, and the first 398 unique entries from the sorted list were selected.

Data collection tools

Data was collected using a structured questionnaire. To establish validity, a pilot study involving 10% of the target population (n=40) was conducted in Nyando Sub-County, a site with similar characteristics to the study area and where eCHIS was implemented with Muhoroni Sub-County. This site was not part of the main study. Feedback from this pre-test was used to refine and improve the instrument. Additionally, the questionnaire was reviewed and validated by the university supervisor to ensure it accurately captured the study's objectives and content. For reliability, the instrument's internal consistency was tested using Cronbach's Alpha, yielding a reliability coefficient (α= 0.89), which indicated good/acceptable internal consistency and suitability for the main study. The data collection tool was carefully designed to maintain consistency, and research assistants were trained on standardised procedures for administering the questionnaire. The lead investigator supervised the entire data collection process to minimise errors and ensure consistent application of the methods across all respondents.

Data analysis

Data analysis involved both data entry and statistical evaluation using Microsoft Excel and SPSS version 25**.** After cleaning and verifying the data, descriptive statistics such as frequencies, means, and standard deviations were used to summarise the respondents' characteristics and key variables. Relationships between independent variables (socio-demographic and health system factors) and the dependent variable (adoption of maternal health services) were tested using linear regression analysis to determine the strength and significance of associations.

Ethical considerations

Ethical approval was received from Mount Kenya University Ethical Review Committee (MKU/ERC/2419**).** To ensure confidentiality, all participants' personal information was anonymised and securely stored. Participants were also informed of their rights to voluntary participation and freedom to withdraw at any time without penalty.

Results

Response rate

Out of a total sample size of 398, there were 392 responses, resulting in a response rate of 98.4%.

Demographic characteristics

The age distribution showed that the majority of respondents were between 20-24 years (27.8%), followed by 25-29 years (26.0%). Only 0.3% were above 45 years. In terms of education, the findings indicated that 47.0% of respondents had attained primary education, with

27.6% not completing it, making it the largest category. Similarly, 43.2% had secondary education, with 23.0% failing to complete their studies. Only 8.7% of respondents had reached tertiary education**,** with 1.8% dropping out. Notably, 1.0% of respondents had no formal education. Regarding marital status, 80.9% were married, 14.8% were single, and the rest were either cohabiting, separated, divorced, or widowed.

Table 2 shows the influence of selected socio-demographic factors on the adoption of maternal health services in Muhoroni Sub-County. The level of education had the highest mean score (M = 3.73, SD = 1.320) and was ranked first, with a statistically significant p-value of 0.010. Age distribution followed with a mean score of 2.99 (SD = 1.345) and was also statistically significant (p = 0.003).

Table 1

Demographic Characteristics of Participants

Variables		Frequency	Percentage (%)
Age Distribution	15-19	50	12.8
	20-24	109	27.8
	25-29	102	26.0
	30-34	76	19.4
	35-39	36	9.2
	40-44	18	4.6
	Above 45	1	0.3
Education Level	No formal school	4	1.0
	Primary education-complete	76	19.4
	Primary education-incomplete	108	27.6
	Secondary education-complete	79	20.2
	Secondary education-incomplete	90	23.0
	Tertiary education-complete	27	6.9
	Tertiary education-incomplete	8	1.8
Marital Status	Single	58	14.8
	Cohabiting	2	0.5
	Married	317	80.9
	Separated	4	1.0
	Divorced	3	0.8
	Widowed	8	2.0
	Total	392	100

Table 2

The influence of selected socio-demographic factors on the adoption of maternal health services in Muhoroni Sub-County

No	Item	Mean	Std. Deviation	Rank	*P-value*
1	Age distribution	2.99	1.345	2	.0030
2	Level of education	3.73	1.320	1	.0100
3	Marital status	2.79	0.882	3	.1100

Table 3

Model Summary of Regression Analysis

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	.810[a]	0.656	0.442	3.84282

Marital status had a mean score of 2.79 (SD = 0.882), but the association was not statistically significant (p = 0.110). The use of smartphones by Community Health Promoters (CHPs) showed a significant positive effect on maternal health service uptake (Mean = 1.14, SD = 0.544, p = 0.001). Respondents reported that digital tools improved affordability, accessibility, and engagement with health service.

The regression model showed a strong correlation between independent variables (health system and socio-demographic factors) and the dependent variable (adoption of maternal health services), with an R-value of 0.810. The R-squared value was 0.656, indicating that 65.6% of the variation in the adoption of maternal health services could be explained by the model. Table 3.

The unstandardized coefficient for the intervening variable (use of smartphones) was 0.184 (p = 0.001), indicating that for each unit increase in the use of digital health tools, maternal health service adoption increased by 18.4%. Table 4.

Discussion

The findings of this study revealed critical insights into the role of electronic Community Health Information Systems (eCHIS) in enhancing the uptake of maternal health services in Muhoroni Sub-County. The results demonstrated that both socio-demographic and health system factors significantly influenced the adoption of maternal health services when supported by digital health tools like eCHIS. These findings are consistent with previous studies, which found that mHealth interventions improved maternal and neonatal outcomes through better tracking and follow-up[8], and contributed to improved decision-making and service utilisation in maternal health in low-resource settings.[9]

Education emerged as the most significant socio-demographic determinant of maternal health service utilisation. This aligns with findings that indicate education plays a pivotal role in health-seeking behaviour, especially regarding maternal and child health [10]. Educated women are more likely to recognise pregnancy danger signs, seek antenatal care (ANC) services, and adhere to healthcare provider recommendations. Furthermore, women with secondary or tertiary education in Ethiopia were significantly more likely to initiate early ANC visits compared to uneducated women[10]. Age also showed a statistically significant influence, with women in the 20–29 age group accounting for the majority of service utilisation. This finding concurs with previous studies, which have shown that maternal age is a significant indicator affecting both antenatal and postnatal health-seeking behaviours and is also associated with adverse pregnancy outcomes such as maternal and perinatal mortality [11]. Conversely, teenage and older mothers underutilise maternal health services, reflecting persistent gaps in targeting vulnerable age groups. Marital status did not show a statistically significant effect in this study, which diverges from previous findings, which reported that married women are more likely to utilise maternal health services[12].

Table 4
Coefficient Results

Model		Unstandardized Coefficients		Std. Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.218	.234		-5.282	.000
	Intervening factor	.184	0.037	.185	4.116	.000
Predictors (constant), intervening factor.						
a. Dependent Variable: Adoption of Maternal Health Services.						

However, this variation may be due to the increased role of CHPs and eCHIS in bridging information gaps across marital status categories in Muhoroni Sub-County. This suggests that digital platforms may help mitigate traditional disparities associated with marital status.

The number of ANC visits completed and the timing of first ANC contact were significantly influenced by the frequency of Community Health Promoter (CHP) visits facilitated through eCHIS. This finding supports previous evidence from Tanzania, where CHW-led household visits using mobile applications improved facility-based deliveries and ANC adherence[13]. Similarly, another study highlighted that digital scheduling and referrals increased early ANC initiation and service continuity in rural Ethiopia[14]. Availability of medical products, particularly anti-malarial drugs, also influenced service utilisation. These findings align with the study, which showed that timely administration of malaria prophylaxis during pregnancy reduced complications and improved ANC follow-through[15]. Additionally, knowledge acquisition through CHPs or health facilities was significantly associated with increased maternal health service use, echoing findings that emphasised the role of trusted interpersonal sources in health education[16].

The integration of eCHIS significantly enhanced maternal health service utilisation. The system's ability to track pregnancies, trigger alerts, and guide CHPs in providing timely referrals contributed to improved access and continuity of care. This is in line with global findings that digital health platforms improve real-time data collection and facilitate evidence-based interventions[17, 18]. In Kenya, the eCHIS initiative has been lauded for supporting the Ministry of Health's strategy to digitise community health delivery[19], and this study reinforces its practical impact in a rural Kenyan setting. Overall, this study provided evidence that eCHIS significantly improved maternal health outcomes when reinforced by supportive socio-demographic and health system conditions. However, challenges like knowledge disparities and delayed first ANC contact persist. The findings emphasised the need for continued investment in digital health infrastructure, community-level health education, and targeted support for marginalised groups to optimise maternal health service delivery in line with SDG 3.

Study limitation

The study focused only on Muhoroni Sub-County, Kisumu County, where the electronic community health information system was first piloted, which may limit the generalizability of the findings to other regions in Kenya or beyond.

Conclusion

The study demonstrated a significant positive relationship between the utilisation of the electronic community health information system (eCHIS) and the adoption of maternal health services in Muhoroni Sub-County, Kisumu County. Findings indicated that digital health interventions, particularly the Smart Health App used by CHPs, enhanced access to and utilisation of maternal healthcare when reinforced by supportive socio-demographic and health system conditions. This study contributed to the growing evidence supporting digital solutions in strengthening primary healthcare systems. By addressing system inefficiencies and improving service delivery, eCHIS can play a crucial role in advancing maternal health outcomes and supporting Kenya’s Universal Health Coverage (UHC) goals.

Recommendations

Based on the findings of this study, the following actions were recommended:

1) The study recommended that the Department of Health should enhance monitoring of the electronic community health information

system use to improve maternal health service delivery

2) The study's findings clearly indicate that the County Department of Health should take a leading role in facilitating educational programs that raise critical awareness and understanding of maternal health services.
3) Service delivery in county health facilities should be enhanced to attract more women to seek care, ensuring they utilise available services. This is especially important as the electronic community health information system increases demand for health services from the community to higher levels of care.

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Author contribution

- Conceptualisation: Kennedy Akani
- Methodology: Kennedy Akani, and reviewed by Alexander Mbeke and John Kariuki.
- Data collection: Kennedy Akani
- Data analysis: Kennedy Akani and reviewed by Alexander Mbeke.
- The original draft writing: Kennedy Akani.
- Review and editing: Alexander Mbeke and John Kariuki.
- Supervision: Alexander Mbeke and John Kariuki

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Data availability statement. The data is available from the corresponding author upon reasonable request.

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