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Maternal Awareness and Accessibility of eHealth Technologies for Child Healthcare in Rural Nasarawa State, Nigeria: A Community-Based Assessment

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Abstract

Maternal and child mortality remain critically high in rural Nigeria, with Nasarawa State recording maternal mortality ratios between 814 and 1,047 per 100,000 live births. Digital health (eHealth) technologies, particularly mobile health (mHealth) interventions, have been promoted to bridge access gaps. However, the success of these technologies depends on two interrelated factors: maternal awareness and accessibility. This study assessed the types of eHealth technologies used, the level of awareness among rural mothers, and the level of accessibility, including multidimensional barriers. A descriptive cross-sectional mixed-methods design was conducted in four rural Local Government Areas of Nasarawa State (Awe, Nasarawa Eggon, Kokona, Doma). Using multistage sampling, 394 women of reproductive age (15–49 years) completed a structured questionnaire (response rate 95%). Facility checklists documented available technologies, and 25 key informant interviews were conducted with health workers and community leaders. Quantitative data were analysed using descriptive statistics and one-sample t-tests ($p<0.05$). Qualitative data underwent thematic analysis. Voice/audio messages (63.9%) and SMS reminders (57.4%) were the most frequently used technologies; video-based education (19.1%) and USSD services (19.9%) had very low uptake. Mothers demonstrated statistically significant awareness of eHealth technologies (mean=18.65, t=2.36, p=0.018), with 65.9% having

received health messages or calls. However, overall accessibility was not statistically significant (mean=21.57, t=1.86, p=0.064). Key accessibility barriers included low literacy (39.1% with no formal education; mean reading SMS=2.85/4), inability to use mobile apps (mean=2.72), unaffordability of smartphones/data, unreliable electricity and network coverage, and socio-cultural factors (need for husband's permission, mean=3.63; privacy concerns, mean=3.51). Qualitative findings confirmed these barriers, with 18 of 25 key informants citing gender restrictions and infrastructure deficits. Rural mothers in Nasarawa State are significantly aware of eHealth technologies but face multidimensional accessibility barriers that prevent effective use. The awareness-accessibility gap undermines the potential of digital health interventions. Policy and practice must prioritize voice-based, literacy-adapted solutions, invest in rural infrastructure, provide data subsidies, and engage communities to address socio-cultural constraints. Without these measures, eHealth will continue to benefit the digitally privileged, widening existing health inequities.

Keywords: eHealth, maternal health, awareness, accessibility, mHealth, digital divide, rural Nigeria, Nasarawa State

Introduction

Maternal and child mortality remains one of the most pressing public health challenges globally, with sub-Saharan Africa bearing a disproportionate burden of the crisis. As of 2023, the global maternal mortality ratio (MMR) stood at approximately 223 deaths per 100,000 live births; however, this aggregate figure conceals profound inequities. Women in low-income countries face an MMR of around 346 per 100,000 live births, compared to just 10 per 100,000 in high-income countries (World Health Organization [WHO], 2023a). Sub-Saharan Africa alone accounts for nearly 70% of global maternal deaths—approximately 182,000 annually—with an MMR estimated between 442 and 545 per 100,000 live births (UNICEF, 2023; WHO, 2023b). Within this region, Nigeria presents an especially dire situation. Approximately 75,000 women die annually from pregnancy-related causes in Nigeria, representing nearly one-third of the global total, with the country's MMR ranging from 814 to 1,047 per 100,000 live births depending on the geographic region (The Guardian, 2025; WHO, 2023b). Critically, these deaths are largely preventable, with leading causes including postpartum hemorrhage, hypertensive disorders, sepsis, unsafe abortion, and obstructed labor (WHO, 2023b).

The rural-urban disparity in maternal and child health outcomes is particularly stark. In sub-Saharan Africa, the maternal mortality ratio among rural women (640 per 100,000 live births) far exceeds that of their urban counterparts (447 per 100,000 live births) (Bekyieriya et al., 2023). In Nigeria, access

to healthcare services in rural areas remains significantly more limited than in urban centers, a gap exacerbated by inadequate healthcare facilities, shortages of skilled health professionals, poor road networks, and low health literacy (Bolarinwa et al., 2021; Ibe & Obembe, 2022). These structural and socio-economic barriers frequently result in delays in seeking, reaching, and receiving appropriate care, contributing to unsatisfactory pregnancy outcomes and preventable maternal and neonatal deaths. Persistent health imbalances between urban and rural populations underscore the urgent need for context-specific, equity-focused health system reforms (WHO, 2023).

In response to these challenges, digital health technologies have emerged as promising tools to enhance access to maternal and child healthcare, particularly in low-resource settings. Mobile health (mHealth) interventions—including short message service (SMS) reminders, voice calls, teleconsultation platforms, and mobile applications—have demonstrated positive effects on antenatal care (ANC) attendance, skilled birth delivery rates, immunization coverage, and health-seeking behaviors (Ameen et al., 2023; WHO, 2022; Khatun et al., 2023). These technologies are especially valuable in overcoming geographic and infrastructural barriers that disproportionately affect rural and marginalized populations. Mobile phone ownership, in particular, has been strongly associated with greater utilization of maternal health services. A recent cross-sectional analysis of Demographic and Health Survey (DHS) data across 28 low- and middle-income countries (LMICs) revealed that women who owned mobile phones were significantly more likely to attend four or more ANC visits, deliver in health facilities, and attend postnatal care compared to those without phones (Adanikin et al., 2023).

However, the successful deployment of digital health solutions in rural contexts faces persistent and multifaceted challenges. Recent studies classify these impediments into normative and economic factors (UNICEF, 2021; Musoke et al., 2022). Normative constraints arise from deep-rooted cultural norms, traditional beliefs, and gender dynamics that often limit women's autonomy in healthcare decision-making. Economic hurdles include inadequate mobile network infrastructure, the cost of mobile devices, and affordability of data or airtime, which disproportionately affect low-income populations. Furthermore, a fundamental digital divide persists: women in LMICs are less likely to own mobile phones, control their usage, or access internet-enabled services compared to men (GSMA, 2023; ITU, 2022). Literacy remains another critical barrier. As of 2020, only 59% of adult women in sub-Saharan Africa were literate, and low literacy levels are strongly associated with poorer maternal health outcomes and exclusion from text-based digital health interventions (UNESCO, 2023; The World Bank, 2021).

Nasarawa State, located in the North-Central geopolitical zone of Nigeria, exemplifies these challenges. The state has a diverse ethnic composition and a predominantly agrarian population, with the majority of residents living in rural areas characterized by limited access to essential healthcare services. According to the 2006 National Population and Housing Census, Nasarawa State had a population of 1,869,377, projected to exceed 3.1 million by

2025, with a significant proportion residing in rural communities. The state's maternal and child mortality indicators remain persistently high, healthcare service utilization in rural areas is low, and digital health interventions have only recently begun to emerge under constrained infrastructural conditions. Selected rural Local Government Areas (LGAs)—including Awe, Nasarawa Eggon, Kokona, and Doma—reflect a cross-section of the socio-economic, cultural, and infrastructural dynamics affecting technology use in maternal and child healthcare delivery.

Despite the proliferation of eHealth initiatives globally, a critical gap persists in the empirical literature: few studies have systematically assessed the interrelated dimensions of awareness and accessibility of digital health technologies among mothers in rural Nigerian communities. Awareness—understood as the cognitive precursor to technology adoption—does not automatically translate into equitable access or utilization. Accessibility encompasses not only the physical availability of devices and network coverage but also affordability, digital literacy, language compatibility, and socio-cultural permission structures. The disconnect between technology presence and meaningful access is particularly pronounced among low-literate, low-income, and socially marginalized women. Moreover, most existing studies have focused on the feasibility and acceptability of mHealth interventions without rigorously evaluating the contextual barriers that determine whether rural mothers can effectively use these tools for maternal and child health.

Therefore, this study seeks to bridge this gap by conducting a community-based assessment of maternal awareness and accessibility of eHealth technologies for child healthcare in rural Nasarawa State, Nigeria. Specifically, the study aims to: (1) identify the types of digital technologies currently used to deliver maternal and child healthcare services in the study area; (2) assess the level of awareness of these technologies among mothers in rural communities; and (3) determine the level of accessibility of these technologies among the same population. By providing empirical evidence on the prevailing levels of awareness and the multifaceted barriers to accessibility, this study will generate actionable insights for policymakers, healthcare managers, and development partners. The findings are expected to inform targeted interventions that move beyond technology deployment toward genuine, equitable digital health inclusion, ultimately contributing to improved maternal and child health outcomes in rural Nasarawa State and similar resource-limited settings across Nigeria and sub-Saharan Africa.

STATEMENT OF THE PROBLEM

Maternal and child mortality remains unacceptably high in rural Nigeria, despite global advances in healthcare delivery. Sub-Saharan Africa accounts for nearly 70% of global maternal deaths, with Nigeria alone contributing about one-third of those fatalities—approximately 75,000 women annually (WHO, 2023a; The Guardian, 2025). In Nasarawa State, maternal mortality ratios range between 814 and 1,047 per 100,000 live births, with rural communities bearing the heaviest burden (WHO, 2023b). These deaths are largely

preventable through timely antenatal care (ANC), skilled birth attendance, and emergency obstetric services. However, rural women face persistent structural barriers: inadequate healthcare facilities, shortages of skilled health professionals, poor road networks, and low health literacy (Bolarinwa et al., 2021; Ibe & Obembe, 2022). Digital health technologies—particularly mobile health (mHealth) interventions such as SMS reminders, voice messages, and teleconsultation platforms—have been widely promoted as cost-effective solutions to bridge these gaps. Evidence from low- and middle-income countries shows that mHealth can increase ANC attendance, facility-based deliveries, and immunization coverage (Ameen et al., 2023; Khatun et al., 2023).

However, two critical and interrelated problems undermine the potential of eHealth in rural Nasarawa State: **low awareness** and **limited accessibility** of digital health technologies among the very women who need them most.

First, **awareness**—the cognitive precursor to technology adoption—remains poorly understood and inadequately measured in rural Nigerian settings. Preliminary evidence from the study area indicates that although some mothers have heard of SMS reminders or mobile health apps, awareness of telemedicine and mobile health applications is significantly lower. In the broader Nigerian context, awareness of digital health services is often confined to educated, urban populations, leaving rural women uninformed. For instance, a 2022 study in rural Oyo State found that healthcare professionals were highly engaged with digital tools, but residents—especially mothers—had limited knowledge of available eHealth services (Okeke et al., 2024). Without adequate awareness, even the most well-designed digital interventions cannot be utilized. Yet, no systematic community-based assessment of maternal awareness of eHealth technologies has been conducted in Nasarawa State.

Second, **accessibility**—the ability to actually use digital health tools—is severely constrained by multiple, overlapping barriers. While mobile phone ownership in Nigeria is relatively high (86% of women), ownership does not translate into effective access (GSMA, 2021). Low literacy levels are a major impediment: 39.1% of mothers in the study population have no formal education, and only 59% of adult women in sub-Saharan Africa are literate (UNESCO, 2023). Many rural women cannot read SMS messages or navigate mobile applications. Affordability remains another barrier—data and airtime costs are prohibitive for low-income households. Infrastructure deficits, including unreliable electricity and poor network coverage, further limit accessibility. Additionally, socio-cultural norms often require women to seek permission from husbands or family members before using digital tools, and privacy concerns about shared devices deter usage (Udenigwe, 2023). These access barriers disproportionately exclude the most vulnerable women: those who are poor, uneducated, and living in remote hamlets.

The consequence of low awareness and poor accessibility is a digital health paradox: eHealth interventions are being deployed, but they largely reach women who already have some education, income, and digital literacy—not the underserved rural mothers for whom they are intended. This paradox widens existing health inequities rather than reducing them. In

Nasarawa State, no empirical study has holistically assessed both awareness and accessibility levels among rural mothers, nor have the specific barriers been documented in a way that can inform targeted policy and programmatic action.

Therefore, this study is urgently needed to: (1) identify the types of digital technologies currently used for maternal and child healthcare in rural Nasarawa State; (2) assess the level of awareness of these technologies among mothers; and (3) determine the level of accessibility of these technologies, including the infrastructural, economic, literacy, and socio-cultural barriers. By answering these questions, the study will provide evidence-based recommendations to bridge the awareness-accessibility gap, ensuring that digital health technologies fulfill their promise of improving maternal and child health outcomes for all rural women, not just the digitally privileged.

General aim

The general aim of this study was to assess the maternal awareness and accessibility of eHealth technologies for child healthcare in rural Nasarawa state, Nigeria; a community-based assessment.

Specific objectives

The specific objectives are:

1. To Assess the level of awareness of these technologies among mothers in rural communities.
2. To Determine the level of accessibility of these technologies among mothers in rural communities.

Research questions

1. To what extent are mothers in rural communities aware of these healthcare technologies?
2. How accessible are maternal and child healthcare technologies to mothers in rural areas of Nasarawa State?

Hypothesis

H1 Mothers in rural communities of Nasarawa State are not significantly aware of available digital healthcare technologies for maternal and child care.

H2: Maternal and child healthcare technologies are not significantly accessible to mothers in rural areas of Nasarawa State.

Conceptual Framework of Awareness and Accessibility in eHealth

Understanding the role of digital health in maternal and child healthcare requires clear definitions of two interrelated concepts: awareness and accessibility. Awareness refers to the cognitive state of knowing about the existence, features, and potential benefits of digital health technologies. In the context of maternal health, awareness encompasses knowledge of specific

tools such as short message service (SMS) reminders, mobile health (mHealth) applications, telemedicine platforms, interactive voice response (IVR) systems, and electronic health records. The Technology Acceptance Model (TAM) posits that awareness is a necessary precursor to perceived usefulness and perceived ease of use, which in turn influence behavioral intention and actual technology adoption (Davis, 1989; Venkatesh & Davis, 2022). Without adequate awareness, even the most sophisticated digital interventions remain unused.

Accessibility, on the other hand, is a multidimensional construct. The World Health Organization (WHO) defines accessibility in digital health as the extent to which individuals can obtain, afford, and effectively use digital health services without undue barriers (WHO, 2021). Accessibility comprises several domains: physical accessibility (availability of mobile devices, network coverage, electricity), economic accessibility (affordability of devices, data, airtime), cognitive accessibility (literacy, digital literacy, language compatibility), and social accessibility (freedom from gender-based restrictions, cultural permission, privacy protection). In rural low-resource settings, these dimensions intersect to create cumulative disadvantage for marginalized women (Udenigwe, 2023; GSMA, 2023).

Types of Digital Technologies Used in Maternal and Child Healthcare

Digital health technologies for maternal and child health have proliferated globally, with the most common being mobile-based interventions. A systematic review by Gilano et al. (2024) of 32 articles published in Africa between 2015 and 2023 found that mobile phones remain the dominant channel, particularly through SMS text messaging and voice calls. In Nigeria, the "Hello Mama" program, a voice-based mHealth service, has been widely adopted and described by users as "doctors at a distance" because it bridges gaps between pregnant women and medical experts in remote locations (Chaka et al., 2020). Similarly, Knope et al. (2024) demonstrated that mHealth interventions delivered via voice messages and SMS significantly increased antenatal care (ANC) attendance, facility-based deliveries, and childhood immunization timeliness across low- and middle-income countries (LMICs).

Other technologies include telemedicine (remote consultations via phone or video), electronic health records (EHRs) for tracking maternal and child data, and interactive voice response (IVR) systems that do not require literacy. However, adoption rates vary considerably. A facility-based assessment in rural Nigeria revealed that while voice messages and SMS reminders were used by over 60% of respondents, video-based health education and USSD code-based services had utilization rates below 20%, primarily due to equipment shortages, electricity constraints, and lack of training (Ebenso et al., 2021; Garcia et al., 2020).

Level of Awareness of eHealth Technologies Among Rural Mothers

Empirical evidence on maternal awareness of digital health technologies in rural sub-Saharan Africa reveals a mixed picture. On one hand, several studies report relatively high awareness of basic mobile phone-based health services. In a cross-sectional study conducted in northern Malaysia, Rahman et al. (2024) found that 97.5% of respondents considered mHealth

applications beneficial, yet only 13.6% actually used them—highlighting that awareness does not automatically translate into use. In Nigeria, Chaka et al. (2020) reported that awareness of mHealth services was 89% among educated respondents, but significantly lower among women with no formal education. This finding is critical because in rural Nasarawa State, 39.1% of mothers have no formal education (dissertation data).

In sub-Saharan Africa, a 2022 study in rural Oyo State, Nigeria, found that while healthcare professionals demonstrated high awareness of digital tools, rural mothers had limited knowledge of telemedicine and mobile health applications (Okeke et al., 2024). Similarly, a study by Obasola and Mabawonku (2017) documented that women in rural Nigeria were more likely to be aware of radio-based health messages than SMS-based interventions, reflecting the influence of literacy and medium accessibility. The dissertation's own findings (Table 4.2) showed that while mothers agreed on overall awareness (grand mean 3.11), awareness of telemedicine (mean 2.60) and personal use of mobile health apps (mean 2.81) was lower. These results underscore the need for targeted awareness campaigns that go beyond general messaging to include specific digital tools.

Infrastructure Barriers

The most frequently cited accessibility obstacle in rural LMICs is unreliable infrastructure. Poor electricity supply and inconsistent mobile network coverage directly limit the functionality of digital health tools. In a study across three Nigerian states (Ondo, Kano, and the Federal Capital Territory), Ebenso et al. (2021) found that frontline health workers reported difficulty accessing both video training and data digitization applications due to lack of mains electricity and poor internet connectivity. Participants described having to use personal Wi-Fi or wait for colleagues to transmit data. Adeyemi et al. (2021) and Chukwu et al. (2023) reinforced these findings, showing that inconsistent electricity and network problems significantly hinder the scalability and sustainability of digital health programs in rural Nigeria. The dissertation's key informant interviews (KII) similarly identified electricity and network coverage as the most pervasive challenges, with 18 out of 25 respondents citing them as primary barriers.

Literacy and Digital Skills

Low literacy remains a profound barrier to accessibility, particularly for text-based interventions. Globally, women account for over two-thirds of the world's illiterate population, and sub-Saharan Africa has the lowest adult female literacy rate (59%) (UNESCO, 2023; The World Bank, 2021). In rural Nigeria, where 39.1% of mothers have no formal education, reading SMS messages or navigating mobile applications is often impossible. Udenigwe (2023) conducted a comprehensive review of inclusion criteria in digital maternal health programs across sub-Saharan Africa and found that literacy was frequently an implicit or explicit requirement for participation, thereby excluding the most vulnerable women. The dissertation's quantitative data (Table 4.3) revealed that mean scores for reading SMS

messages (2.85), using mobile apps for health information (2.72), and booking clinic appointments via phone (2.84) were all below the threshold for agreement, indicating significant literacy-related accessibility gaps.

Economic and Affordability Barriers

Even when mobile phones are available, the cost of airtime and data presents a substantial barrier. In a study in semi-urban Bangladesh, Chang et al. (2024) found that although over 90% of households had mobile phones, only 7.2% of adults used them for health-related information, with cost and confidence in technology cited as primary reasons. Similarly, Fischer et al. (2019) demonstrated that socioeconomic status significantly influences the ability to purchase mobile devices and data, thereby affecting mHealth adoption. In the dissertation's findings, affordability of personal smartphones suitable for health apps had a mean score of 3.21 (indicating agreement with the barrier), and many KII respondents mentioned that mothers could not afford data or airtime for regular health communication.

Socio-Cultural and Gender Barriers

Socio-cultural factors exert a powerful influence on accessibility, particularly in patriarchal rural settings. The need for spousal or family permission before using digital health tools is a recurring theme. Bekyieriya et al. (2023) found that pregnant women in some sub-Saharan African cultures prefer to deliver at home to demonstrate faithfulness to their husbands, reflecting how gender norms shape healthcare decisions. In digital health, women often lack independent control over mobile devices. GSMA (2023) reports that the mobile gender gap in sub-Saharan Africa ranges from 4% in Nigeria to 27% in Mozambique, with women less likely to own phones or govern their usage. The dissertation's data (Table 4.5) confirmed that respondents agreed with the need for husband's permission (mean 3.63) and the presence of cultural/religious beliefs discouraging women's phone use for health (mean 3.18). Privacy concerns, especially when phones are shared, also deter usage. Van Pelt et al. (2023) and Patel et al. (2021) documented that women in rural Burkina Faso, Uganda, and Ghana feared that health messages could reveal secrets or expose private conditions like HIV status, leading to social pressure to opt out.

Intersectional Vulnerabilities

An intersectional perspective reveals that women with multiple marginalized identities—low literacy, poverty, rural residence, disability, and membership in minority ethnic or linguistic groups—face compounded accessibility barriers. Udenigwe (2023) argues that digital health programs often fail to account for these intersections, resulting in systematic exclusion. For example, women who are both illiterate and non-speakers of the dominant language (e.g., Hausa in Nasarawa State) cannot access text-based or voice-based interventions in a language they understand. Women with disabilities, though under-researched in sub-Saharan Africa's digital maternal health literature, face additional physical and attitudinal barriers (Eide &

Neille, 2022; Olaniran et al., 2021). The dissertation did not specifically assess disability but noted that 34.7% of respondents could not read SMS without help, and 19.1% could not afford basic airtime, indicating substantial intersectional disadvantage.

Theoretical Framework: Technology Acceptance Model (TAM)

This study is anchored in the Technology Acceptance Model (TAM), originally proposed by Davis (1989). TAM posits that two primary cognitive beliefs—perceived usefulness (the degree to which a person believes that using a technology will enhance their performance) and perceived ease of use (the degree to which a person believes that using a technology will be free of effort)—determine behavioral intention and actual technology use. External factors, such as system design, training, and user characteristics, influence these beliefs. TAM has been extensively applied in digital health research. For instance, Ebenso et al. (2021) found that perceived usefulness (e.g., saving lives of women and infants) and perceived ease of use (e.g., intuitive video content) were central drivers of technology acceptance among frontline health workers in Nigeria. Similarly, Zin et al. (2023) extended TAM to examine digital healthcare adoption among older adults, confirming that perceived ease of use significantly affects perceived usefulness and adoption intention.

In the context of maternal awareness and accessibility, TAM provides a useful lens: awareness serves as a precursor to perceived usefulness (if a woman does not know a technology exists, she cannot judge its utility), while accessibility directly impacts perceived ease of use (if a woman cannot afford data, cannot read SMS, or lacks network coverage, the technology is by definition not easy to use). Thus, low awareness and poor accessibility fundamentally undermine the TAM pathway, explaining why many digital health interventions fail to achieve uptake in rural settings.

Summary of Literature Gaps

The literature reviewed reveals several critical gaps. First, while numerous studies have assessed the effectiveness of mHealth interventions on maternal health outcomes, very few have systematically measured awareness levels among rural mothers as a distinct construct. Second, accessibility is often narrowly defined (e.g., mobile phone ownership) without capturing the multidimensional barriers of literacy, affordability, social permission, and infrastructure. Third, few studies have been conducted in North-Central Nigeria, particularly Nasarawa State, which has unique socio-demographic and infrastructural characteristics. Fourth, there is a lack of community-based assessments that simultaneously evaluate both awareness and accessibility using mixed methods. This study aims to fill these gaps by providing empirical evidence on the types of eHealth technologies in use, the level of maternal awareness, and the specific accessibility barriers in rural Nasarawa State, thereby informing targeted interventions to bridge the digital divide.

METHODOLOGY

This study was conducted in Nasarawa State, North-Central Nigeria, specifically in four purposively selected rural Local Government Areas—Awe, Nasarawa Eggon, Kokona, and Doma—chosen based on rurality, maternal health burden, and limited healthcare infrastructure. A descriptive cross-sectional mixed-methods design was adopted, combining quantitative and qualitative approaches to assess awareness and accessibility of eHealth technologies among women of reproductive age (15–49 years), including pregnant and nursing mothers residing in rural communities. Using Cochran's formula at a 95% confidence level and 5% margin of error, a minimum sample size of 384 was obtained and increased by 10% to 422 to account for non-response; however, 394 valid questionnaires were analysed after data cleaning, representing a 95% response rate. A multistage sampling technique was employed involving purposive selection of LGAs and PHCs, random selection of wards, systematic random sampling of eligible mothers attending antenatal, postnatal, and immunization clinics, and purposive selection of 25 key informants comprising community health workers, ward development committee members, and community leaders. Data were collected using a structured 40-item questionnaire, a facility checklist documenting available digital health technologies and infrastructure, and a semi-structured Key Informant Interview (KII) guide. The questionnaire was translated and administered face-to-face in English, Hausa, Eggon, alago, Mada, Gwandara languages by trained research assistants. Validity was established through expert review by public health and nursing specialists, while reliability testing during a pilot study conducted in Kaduna State produced a Cronbach's alpha coefficient of 0.952, indicating high internal consistency. Data collection was conducted over six weeks between February and March 2025. Quantitative data were analysed using IBM SPSS Statistics with descriptive statistics and one-sample t-tests at a significance level of $p < 0.05$, while qualitative data were transcribed verbatim and analysed thematically. Findings from both components were triangulated to enhance validity and provide a comprehensive understanding of awareness and accessibility challenges related to eHealth technologies. Ethical approval was obtained from the Nasarawa State Ministry of Health Research Ethics Committee, informed consent was secured from all participants, and confidentiality and anonymity were strictly maintained throughout the study.

RESULTS

The Table 1 above showed the sex distribution of the respondents. The socio-demographic profile of the respondents shows that the majority are young to middle-aged adults, with 65 respondents (16.5%) aged 15–24 years, 194 respondents (49.2%) aged 25–34 years, 127 respondents (32.2%) aged 35–44 years, and only 8 respondents (2.0%) aged 45 years and above. This indicates that most participants are in their prime reproductive years, which is significant for maternal and child health service utilization. Regarding educational level, 154 respondents (39.1%) had no formal education, 73 respondents (18.5%) had primary education, 124 respondents (31.5%) had secondary education, and 43 respondents (10.9%) had tertiary

education, suggesting that low literacy levels may affect understanding and use of health information and digital health technologies.

In terms of occupation, most respondents are either farmers (170 respondents, 43.1%) or engaged in small skill-based businesses (171 respondents, 43.4%), while 27 respondents (6.9%) are civil servants, 15 respondents (3.8%) run medium or large businesses, and 11 respondents (2.8%) work in private sector businesses. This reflects a rural population largely dependent on agriculture and small-scale enterprises. The number of children among respondents shows that 171 respondents (43.4%) have 0–2 children, 175 respondents (44.4%) have 3–5 children, and 48 respondents (12.2%) have 6–10 children, indicating that most families are small to medium-sized and emphasizing the ongoing need for maternal and child health services.

Regarding marital status, 135 respondents (34.3%) are married, 101 respondents (25.6%) are single, 90 respondents (22.8%) are divorced, and 68 respondents (17.3%) are widowed. This suggests that while married adults are the main users of maternal and child health services, single, divorced, and widowed individuals also form a significant portion of the population and may require tailored interventions. The findings imply that maternal and child healthcare programs in these communities should be accessible, culturally appropriate, and adapted to low literacy levels, while also considering the economic realities and family structures of the rural population.t

Descriptive statistics

Research question one: To assess the level of awareness of these technologies among mothers in rural communities in Nasarawa.

Table 1: response on the level of awareness of these technologies among mothers in rural communities in Nasarawa

S/No	level of awareness of these technologies among mothers in rural communities	Mean	SD	Decision
1	I am aware that digital technologies such as SMS reminder and mobile health apps are used in healthcare.	3.36	1.288	Agreed
2	Health workers in my area educate women about digital health tools	3.28	1.301	Agreed
3	I have received health-related messages or calls from health providers.	3.12	1.258	Agreed
4	I have heard about telemedicine (consulting health workers by phone or video).	2.6	1.271	Disagreed
5	I believe digital technologies are useful for maternal and child healthcare.	3.48	1.157	Agreed
6	I have personally used or seen others use mobile phones for pregnancy tracking or health education	2.81	1.277	Disagreed
	Grand Mean	**3.11**	**1.26**	**Agreed**

Source: Field work, 2025

Table 1 shows the Responses on level of awareness of these technologies among mothers in rural communities in Nasarawa, Nigeria. It is found that the grand mean of 3.6 and SD (1.15) is greater than the cut-off points of 3, implying that the respondents generally agreed with the items assessing their level of awareness of these technologies among mothers in rural communities in Nasarawa. Item-by-item analysis indicates that they agreed with all the items implying that the respondents generally did not agree with the items No 4 and 6 with corresponding mean of 2.60 and 2.81. The conclusion is that majority of the respondent's level of awareness of these technologies among mothers in rural communities in Nasarawa.

Research Question Two: To determine the level of accessibility of these technologies among mothers in rural communities in the Rural Areas of Nasarawa.

Table 2: The level of accessibility of these technologies among mothers in rural communities in the Rural Areas

S/No	level of accessibility of these technologies among mothers in rural communities in the Rural Areas of	Mean	SD	Decision
1	I own a mobile phone that I can use for Health-related purposes	3	1.265	Agreed
2	There is reliable network coverage in my community.	3.53	1.105	Agreed
3	I can afford to buy airtime or mobile data to receive or send health message	3.13	1.226	Agreed
4	I know how to read SMS messages related to health	2.85	1.237	Disagreed
5	I can use a mobile app to get pregnancy or child health information	2.72	1.303	Disagreed
6	I have used a mobile phone to book or confirm a clinic appointment	2.84	1.334	Disagreed
7	I can easily contact a health worker through phone or text when I need advice.	3.5	1.175	Agreed
	Grand Mean	**3.09**	**1.25**	**Agreed**

Source: Field work, 2025

Empirical data presented in Table 2 shows the responses on the level of accessibility of these technologies among mothers in rural communities in the Rural Areas of Nasarawa. It is shown that the grand mean of 3.09 and SD (1.25) is less than the cut-off points of 3, implying that the respondents generally did not agree with the items No 4, 5 and 6 with corresponding mean of 2.85, 2.72, and 2.84. The conclusion is that majority of the respondents agreed with the level of accessibility of these technologies among mothers in rural communities in the Rural Areas of Nasarawa.

Inferential Hypothesis

Hypothesis One: Mothers in rural communities of Nasarawa State are not significantly aware of available digital healthcare technologies for maternal and child care.

In testing the first null hypothesis, the variable of interest is available digital healthcare technologies for maternal and child care. among Mothers in rural communities of Nasarawa State will not be significantly high measured by 6 items. The respondents' scores on the scale were summed-up. For the level of aware of available digital healthcare technologies for maternal and child care of Mothers in rural communities be considered significantly high among the respondents, the scores made on the whole scale should be significantly higher/greater than 18 (which is the midpoint between strongly agree and strongly disagree). This implies 3 X 6, the number of items measuring the construct. This null hypothesis was tested with a one-sample t-test) otherwise called population t-test). The results are presented in Table 3.

Table 3 Population t-test analysis of whether Mothers in rural communities of Nasarawa State are not significantly aware of available digital healthcare technologies for maternal and child care.

Variable	Sample Mean	Sample SD	Ref. Mean	T	Sig	Remark
Mothers in rural communities aware of available digital healthcare technologies for maternal and child care.	18.65	5.45	18	2.36	< .018	Sig..

Source: Field work, 2025

A look at the results indicated a statistically significant Mothers in rural communities of Nasarawa State are aware of available digital healthcare technologies for maternal and child care. (M=18.65, SD=5.45), t (393) = 2.36, P <.018. The magnitude of difference in the mean (mean difference = .65), 95% CL: .10 to 1.19) was large (eta squared = 0.64). With these results the first null hypothesis is hereby not supported and hence rejected for the alternative. This implies that the mothers in rural communities of Nasarawa State were significantly aware of available digital healthcare technologies for maternal and child care.

Hypothesis Two: Maternal and child healthcare technologies are not significantly accessible to mothers in rural areas of Nasarawa State.

In testing the second null hypothesis, the variable of interest is the Maternal and child healthcare technologies are not significantly accessible to mothers measured by 10 items. The respondents' scores on the scale were summed-up. For the Maternal and child healthcare technologies are not significantly accessible to mothers, the scores made on the whole scale should be significantly higher/greater than 21 (which is the midpoint between strongly agree and strongly disagree). This implies 3 X 7, the number of items measuring the construct. This

null hypothesis was tested with a one-sample t-test) otherwise called population t-test). The results are presented in Table 4.

Table 4: Population t-test analysis of between Maternal and child healthcare technologies accessible to mothers in rural areas of Nasarawa State.

Variable	Sample Mean	Sample SD	Ref. Mean	T	Sig	Remark
Maternal and child healthcare technologies accessible to mothers in rural areas	21.57	6.03	21	1.86	< .064	NS

Source: Field work, 2025

A critical look at the results indicated a statistically significant high Maternal and child healthcare technology accessible to mothers in rural areas (M=21.57, SD=6.03), *t* (393) = 1.86, P =.064. The magnitude of difference in the mean (mean difference =0.57), 95% CL: -.0321 to 1.16) was very small (eta squared = 0.02). With these results the second null hypothesis is hereby not supported and hence rejected for the alternative. This implies that the Maternal and child healthcare technologies were not significantly accessible to mothers in rural areas of Nasarawa State.

Summary of Key Findings

This study assessed maternal awareness and accessibility of eHealth technologies for child healthcare in rural Nasarawa State, Nigeria. The key findings are: (1) voice/audio messages (63.9%) and SMS reminders (57.4%) are the most frequently used digital technologies, while video-based education (19.1%) and USSD services (19.9%) have very low utilization; (2) mothers demonstrated statistically significant awareness of digital health technologies (mean = 18.65, t = 2.36, p < .018), though awareness of telemedicine (mean = 2.60) and mobile health apps (mean = 2.81) remained low; and (3) overall accessibility was not statistically significant (mean = 21.57, t = 1.86, p = .064), indicating that despite mobile phone ownership (mean = 3.00) and network coverage (mean = 3.53), substantial barriers exist in reading SMS (mean = 2.85), using apps (mean = 2.72), and booking appointments via phone (mean = 2.84).

Types of Digital Technologies Used

The finding that voice/audio messages and SMS reminders dominate mHealth delivery in rural Nasarawa State aligns with the systematic review by Gilano et al. (2024), which identified mobile phones as the most widespread channel for maternal health interventions across Africa. Similarly, Chaka et al. (2020) reported that "Hello Mama" voice-based programs were the most highly rated mHealth service among pregnant women in Nigeria, described as "doctors at a distance." The high utilization of voice messages (63.9%) in this study reflects the adaptation to low literacy levels, as voice-based interventions do not require reading skills.

Conversely, the very low utilization of video-based education (19.1%) and USSD services (19.9%) is consistent with Ebenso et al. (2021), who found that despite the availability of video training modules, frontline health workers faced insurmountable barriers including lack of time, poor electricity supply, and inadequate equipment. The moderate adoption of electronic health records (53.7%) aligns with Garcia et al. (2020), who reported that mHealth systems enhanced standardization and quality of ANC services in Madagascar, though inconsistent implementation remains a challenge across sub-Saharan Africa (Fotso et al., 2023).

Level of Awareness Among Mothers

The statistically significant awareness level ($p < .018$) indicates that rural mothers in Nasarawa State are generally aware of digital health technologies, which is encouraging. This finding is consistent with Chaka et al. (2020), who reported 89% awareness among educated respondents in Nigeria. However, the lower scores for telemedicine (mean = 2.60) and mobile health apps (mean = 2.81) suggest that awareness is largely confined to basic, voice-based tools rather than more advanced platforms. This pattern mirrors findings by Datta, Singh, and Mishra (2023) in India, where only 39.5% of healthcare professionals demonstrated adequate capabilities for telemedicine despite high overall awareness. The disparity likely arises because telemedicine requires smartphone ownership, internet connectivity, and digital literacy—all of which are scarce in rural Nasarawa State. The Technology Acceptance Model (TAM) posits that awareness is a cognitive precursor to perceived usefulness (Davis, 1989). In this study, the relatively high general awareness (e.g., 65.9% received health-related messages) suggests that the foundational knowledge exists, but the gap between awareness and actual use is mediated by accessibility barriers.

Level of Accessibility: Persistent Multidimensional Barriers

The most striking finding is that accessibility was not statistically significant ($p = .064$), meaning that despite mobile phone ownership and network coverage, mothers do not have meaningful access to eHealth technologies. This paradox—high ownership but low effective access—has been documented elsewhere. GSMA (2021) reported that 86% of women in Nigeria own mobile phones, yet Udenigwe (2023) found that literacy, affordability, and social permission are frequently overlooked inclusion criteria that exclude the most vulnerable women.

Literacy barriers: The low mean score for reading SMS messages (2.85) is directly attributable to the fact that 39.1% of respondents had no formal education. UNESCO (2023) reported that only 59% of adult women in sub-Saharan Africa are literate, and women account for over two-thirds of the world's illiterate population. In rural Nigeria, text-based interventions are therefore inherently exclusionary. This finding supports the argument by Obasola and Mabawonku (2017) that radio-based and voice-based health messages are more accessible than SMS in low-literacy settings.

Economic barriers: The mean score for using mobile apps (2.72) and the agreement that respondents cannot afford smartphones suitable for health apps (mean = 3.21) reflect the economic realities of rural agrarian households. Fischer et al. (2019) demonstrated that socioeconomic status significantly influences the ability to purchase mobile devices and data. Chang et al. (2024) found that despite over 90% mobile phone penetration in semi-urban Bangladesh, only 7.2% used them for health information due to cost and confidence barriers. Similarly, in Nasarawa State, the cost of data and airtime is prohibitive for many mothers.

Infrastructure barriers: While 3.53 mean score for reliable network coverage appears positive, key informant interviews revealed that coverage is often intermittent, especially in remote hamlets within Awe and Nasarawa Eggon LGAs. Ebenso et al. (2021) documented similar challenges in three Nigerian states, where poor internet connectivity and lack of mains electricity were the most frequently cited barriers to digital health use.

Socio-cultural barriers: The need for husband's permission (mean = 3.63) and concerns about privacy (mean = 3.51) are consistent with Bekyieriya et al. (2023), who found that pregnant women in some sub-Saharan African cultures face gender-based restrictions on healthcare decision-making. GSMA (2023) reports that the mobile gender gap in Nigeria is 4%, but this figure obscures the reality that many women share devices with husbands or family members, limiting autonomous use. Van Pelt et al. (2023) documented that fears about confidentiality—particularly regarding HIV status or reproductive health—lead some women to discontinue digital health programs. In the current study, 18 of 25 KII respondents mentioned gender-related restrictions or cultural norms that limit women's independent use of technology.

Implications for the Technology Acceptance Model (TAM)

The findings extend TAM in important ways for rural low-resource settings. TAM traditionally emphasizes perceived usefulness and perceived ease of use as determinants of behavioral intention (Davis, 1989). However, this study demonstrates that external factors—particularly literacy, affordability, infrastructure, and socio-cultural norms—can completely override perceived usefulness. Respondents strongly agreed that digital technologies are useful for maternal and child healthcare (mean = 3.48) and that improving technology access would improve health outcomes (mean = 3.93). Yet, this high perceived usefulness did not translate into high accessibility. In other words, even when rural mothers recognize the value of eHealth, they cannot use it if they cannot read, cannot afford data, lack network coverage, or require spousal permission. This suggests that in resource-constrained settings, TAM must be expanded to include enabling conditions (infrastructure, literacy, affordability, social permission) as direct determinants of actual use, not merely as indirect influences on perceived ease of use. This aligns with the Unified Theory of Acceptance and Use of Technology (UTAUT), which incorporates facilitating conditions as a key construct (Venkatesh & Davis, 2022).

Comparison with Other Rural Nigerian Studies

The findings are broadly consistent with recent research in other rural Nigerian contexts. Okeke et al. (2024) in rural Oyo State found that while healthcare workers were digitally engaged, residents faced barriers linked to formal education and digital confidence. Balogun et al. (2021) documented that the COVID-19 pandemic widened the rural-urban digital divide in maternal healthcare access, as digital health programs often assumed smartphone ownership and internet access. In the current study, the very low utilization of USSD services (19.9%)—a technology specifically designed for basic phones without internet—is surprising and suggests a lack of awareness or implementation rather than a technological gap. This finding indicates that even low-tech solutions require active community sensitization and training.

Several limitations should be acknowledged. First, the cross-sectional design captures awareness and accessibility at a single time point; longitudinal studies are needed to assess changes as infrastructure improves. Second, the study relied on self-reported data, which may be subject to social desirability bias (respondents may overstate awareness or underreport barriers). Third, the study did not specifically assess women with disabilities, who face unique accessibility barriers. Fourth, the generalizability of findings to other rural areas in Nigeria may be limited due to differences in ethnic composition, infrastructure, and digital health initiatives. Finally, the study did not measure actual health outcomes (e.g., ANC attendance, immunization rates) in relation to awareness and accessibility; this remains an important area for future research.

In conclusion, this study reveals a critical disconnect: rural mothers in Nasarawa State are significantly aware of digital health technologies but face multidimensional accessibility barriers—literacy, affordability, infrastructure, and socio-cultural norms—that prevent effective use. The high utilization of voice/audio messages and low utilization of text-based or video-based tools underscore the need for literacy-appropriate interventions. Addressing the awareness-accessibility gap requires not only awareness campaigns but also investments in infrastructure, subsidies for data/airtime, gender-sensitive program design, and community engagement to overcome socio-cultural barriers. Without these measures, eHealth technologies will continue to benefit the digitally privileged while leaving the most vulnerable rural mothers behind.

CONCLUSION

This community-based assessment examined the types, awareness levels, and accessibility of eHealth technologies for maternal and child healthcare in rural Nasarawa State, Nigeria. The study concludes that while digital health technologies are present in these communities, their reach remains fragmented and inequitable. Voice-based messages and SMS reminders are the most commonly used technologies, reflecting a pragmatic adaptation to low literacy and limited infrastructure. However, more advanced tools—such as telemedicine, mobile health applications, and USSD services—have extremely low utilization, primarily due to infrastructural deficits, lack of training, and economic constraints.

Mothers in rural Nasarawa State demonstrate statistically significant awareness of digital health technologies. They recognize the usefulness of these tools for improving maternal and child health outcomes. Yet, this awareness does not translate into equitable access or effective use. The study finds that overall accessibility is not statistically significant, meaning that despite relatively high mobile phone ownership and reported network coverage, women face substantial, multidimensional barriers. These include low literacy (39.1% have no formal education, reflected in difficulty reading SMS messages), economic constraints (inability to afford smartphones, data, or airtime), infrastructural gaps (unreliable electricity and network connectivity), and socio-cultural norms (need for spousal permission and privacy concerns). Collectively, these barriers create a **digital health paradox**: eHealth interventions are being deployed, but they largely benefit women who already have some education, income, and digital literacy—not the most underserved rural mothers.

Theoretically, the findings extend the Technology Acceptance Model (TAM) by demonstrating that in resource-constrained rural settings, perceived usefulness alone is insufficient to drive adoption. Enabling conditions—including literacy, affordability, infrastructure, and social permission—must be addressed as direct determinants of accessibility and actual use. Without such enabling conditions, even high awareness and positive attitudes toward technology will not translate into improved maternal and child health outcomes.

In conclusion, while eHealth holds significant promise for improving maternal and child healthcare in rural Nasarawa State, the current awareness-accessibility gap must be urgently addressed. Interventions must move beyond simply deploying technology to actively removing the barriers that exclude the most vulnerable women.

Recommendations

Based on the findings and conclusions, the following recommendations are made for Nurses, Midwives, community health extension workers.

1. Nurses, midwives, and Community Health Extension Workers (CHEWs) should receive regular practical training on digital health technologies and maternal eHealth applications to enhance their ability to support pregnant women and mothers in utilizing digital healthcare services effectively.
2. Nurses, midwives, and CHEWs should serve as digital health navigators by assisting mothers with low digital literacy to receive, interpret, and respond appropriately to voice messages, SMS reminders, and other digital maternal health information.
3. Frontline healthcare workers should provide continuous health education and counseling on the benefits and proper use of eHealth services during antenatal, delivery, postnatal, and immunization visits.
4. Nurses, midwives, and CHEWs should collaborate with community leaders, women's groups, and local volunteers to increase awareness, trust, and acceptance of digital maternal healthcare interventions within rural communities.

5. Community Health Extension Workers should conduct regular follow-up visits and community outreach programs to support mothers who experience difficulties accessing or using digital health services.
6. Nurses and midwives should encourage the use of local language audio-based maternal health information and advocate for culturally sensitive communication approaches that accommodate women with low literacy levels.
7. Frontline healthcare workers should participate in routine monitoring and reporting of challenges related to digital health accessibility, including poor network coverage, inadequate electricity supply, and low user engagement, to support continuous improvement of maternal eHealth programs.

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