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Adoption of Mobile Health Services for Maternal Care among Reproductive Women in Selected States of Southwest Nigeria: A Mixed-Method Assessment of Availability, Uptake, Determinants, and Perceived Outcomes

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Abstract

Mobile health (mHealth) offers a practical route to extending maternal healthcare to underserved populations, yet its uptake in many developing settings remains modest and unevenly distributed. This study assessed the adoption of mHealth services for maternal care among reproductive women and healthcare professionals in Osun and Ondo States of Southwest Nigeria. The specific objectives were to identify the types of mHealth services available, determine the extent and level of adoption, evaluate the contextual factors influencing adoption, and examine the perceived effects of adoption on maternal health outcomes. Grounded in the Unified Theory of Acceptance and Use of Technology and the socio-ecological model, the study used a mixed-method design. Two structured questionnaires were administered to 384 reproductive women aged 15 to 49 years and 60 healthcare professionals across facilities selected by a population proportion to size procedure. Data were analysed using descriptive statistics, the chi-square test, and binary logistic regression at the 0.05 level of significance, with odds ratios and 95 percent confidence intervals reported. About 65 percent of facilities had adopted mHealth, with phone calls the dominant modality, used currently by 73.1 percent of facilities. Among reproductive women, however, adoption was very low: phone calls and WhatsApp calls were each adopted by 4.7 percent, text messages by 3.1 percent, and WhatsApp messages by 2.1 percent, while video-conferencing applications were largely unknown and unused. Self-rated competence with these tools was nonetheless high, indicating that the adoption gap reflects awareness, social, and contextual barriers rather than digital skill. Adoption among women was significantly associated with age, level of education, occupation, household monthly income, and state of residence, while family type, household size, and gender of household head were not significant. Healthcare professionals rated mHealth as sometimes helpful for excessive bleeding (mean 3.23), miscarriage (3.07), and prolonged labour (3.07). The study concludes that the application of mHealth for maternal care remains inadequate and adoption among reproductive women is limited despite high availability and competence, and it recommends targeted awareness, provider engagement, the introduction of under-used modalities, and infrastructure measures to close the adoption gap.

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Keywords: mobile health, maternal health, technology adoption, reproductive women, Southwest Nigeria, UTAUT, socio-ecological model

1. Introduction

1.1. Background to the study

The application of mobile devices in advancing healthcare services is among the most rapid technological developments in the world. In the literature, mHealth is understood as the use of mobile devices and internet connectivity to provide healthcare

services and information (Gagnon *et al*., 2016) [23]; (WHO, 2017) [71]; (Laing *et al*., 2018) [35]; (Udenigwen *et al*., 2022) [65]. The most popular handheld devices include smartphones, personal digital assistants, portable media players, patient monitoring appliances, mobile applications, tablets, personal computers, and other wireless devices (Gagnon *et al*., 2016) [23]; (Marufu & Maboe, 2017) [37]; (Laing *et al*., 2018) [35]. The functionalities embedded within these devices facilitate textual exchange, image and video sharing, voice calls, internet connectivity, and multimedia engagement, and studies suggest that they can improve interaction between patients and clinicians (Laing *et al*., 2018) [35]. As Balogun *et al*. (2020) [9] note, the pervasive prevalence and user-friendly interface of mobile communication have spurred its use in healthcare contexts, particularly in promoting healthy practices.

Globally, mobile phones are essential in the health sector for addressing health-related challenges. Their uses include storing medical data, monitoring medications, accessing records, and tracking adherence to medical guidelines (Okuboyejo & Eyesan, 2014) [46]. In sub-Saharan Africa, and especially in Nigeria, the need for mobile phones to access health services is vital for improving maternal health, access to family planning, antenatal care, and child health, most especially in hard-to-reach areas (Omole *et al*., 2018) [51]; (Oyeyemi & Wynn, 2014) [53]. Mobile health applications have received considerable attention from experts, particularly health professionals and software developers, and the culture of mobile phone use in Nigeria is dynamic, shaped by the nation's socio-economic landscape, large population, and rapid digital transformation. More than 222 million mobile connections were active in Nigeria in early 2023, equivalent to about 90 percent of the population (Itanyi *et al*., 2023) [29], and a substantial share of smartphone users seek health information online or use at least one health application (Kasali *et al*., 2019) [31].

Many challenges associated with accessing healthcare services in Nigeria can be mitigated using mobile phones and related devices. Rising transport costs have denied many reproductive women and children access to care (Dassah *et al*., 2018) [17]; (Dahab & Sakellariou, 2020) [16], and mothers and children in slums and rural and semi-rural areas face a series of access challenges that mHealth could help resolve. The spatial distribution of facilities also restricts access, since many facilities are not located where the majority of the population can easily reach them (Ajaegbu, 2013) [4]; (Dassah *et al*., 2018) [17], a situation worsened by distance and poor road networks and sometimes shaped by political considerations (Sanni, 2010) [56]. The pressure on services rose further during and after the coronavirus pandemic, when both workers and patients expressed fear of physical interaction at facilities (Ebenso & Otu, 2020) [19]; (Ejeh *et al*., 2020) [20]; (Otu *et al*., 2021) [52]. Difficulty in adopting technology is not unique to health: comparable socioeconomic barriers constrain technology uptake among rural and remote populations more broadly (Michael & Ogunsola, 2022) [40].

Beyond basic communication, mHealth supports a range of functions in the health sector. These include health information retrieval, in which users seek information on prevalent conditions and appropriate visiting times; remote reservation and appointment booking; remote diagnosis and monitoring, in which physiological data are transmitted for real-time analysis; access to electronic medical records; and health consultation, through which periodic advisories, disease-mitigation guidance, appointment reminders, and specialised notifications are disseminated (Singh *et al*., 2016) [60]; (Shen *et al*., 2019) [59]. Compared with eHealth more generally, mHealth offers superior portability, mobility, and ubiquity, alongside customisation and interactivity, which make it well suited to maternal care in dispersed populations. In sub-Saharan Africa, mHealth and eHealth have been applied to adherence support, diagnosis, reminders, field reporting, observation, training and recruitment, referrals, disease prevention, patient record management, and treatment information (Bervell & Al-Samarraie, 2019) [11], and the coronavirus period demonstrated that many health needs can be addressed without physical contact (Huang *et al*., 2020) [27]; (Otu *et al*., 2021) [52]. These functional possibilities frame the present assessment, which examines not only whether services exist but whether reproductive women translate availability and competence into sustained use.

The stakes of this assessment are bound up with the persistently high burden of maternal and child mortality in Nigeria, where limited access to services among rural and underserved women is a primary contributor (Sanni, 2010) [56]; (Ogbonna *et al*., 2020) [44]. Mobile contact offers a means of narrowing that access gap, and the potential is illustrated by the safe-motherhood programme in Ondo State, through which pregnant women are registered and linked to care via mobile phones; the programme has been credited with substantial reductions in maternal mortality in the state and has been held up as a feasible model for maternal and infant health in the wider region (Ajayi & Akpan, 2020) [6]. Patient-held electronic tools for antenatal services have likewise been trialled in Nigeria (Itanyi *et al*., 2023) [29]. Such examples motivate close attention to whether reproductive women actually adopt the services available to them, since the developmental benefit of mHealth depends on use and not merely on availability.

1.2. Statement of the research problem

Mobile health applications are among the recent health technology developments globally, but their adoption varies significantly across regions, especially in developing countries such as Nigeria, where uptake is low relative to developed countries (Marufu & Maboe, 2017) [37]; (Udenigwen *et al*., 2022) [65]. An increasing number of people in developing countries are excluded from accessing healthcare services, which has prompted numerous studies. Much of the Nigerian literature, however, has focused mainly on the challenges of adoption by healthcare professionals (Bello *et al*., 2004) [10]; (Ajala *et al*., 2015) [5]; (Omole *et al*., 2018) [51]. Findings indicate that mHealth has been implemented in some Nigerian states to track and maintain patient records and support related activities (Adebayo & Ofoegbu, 2014) [2]; (Okuboyejo & Eyesan, 2014) [46]; (Kenny *et al*., 2017) [32]; (Kasali *et al*., 2019) [31], yet many professionals and patients still have limited access to mHealth applications, and little attention has been paid to programmes that facilitate training, practice, and adoption (Bello *et al*., 2004) [10]; (Ogbonna *et al*., 2020) [44]. Despite these studies, comparatively little attention has been paid to perceptions, knowledge, and the contextual factors affecting patients' adoption of mHealth (Dasuki & Zamani, 2019) [18]. Such contextual factors may be individual, household, or community characteristics. At the individual

level, education, gender, marital status, and other socio-demographic factors are under-examined; at the household level, income and family structure are influential in developed settings but poorly understood in Nigeria, where socio-demographic conditions differ markedly (Blumenstock & Eagle, 2012) [13]; (Yaya *et al*., 2019) [72]; (Idriss-Wheeler & Yaya, 2021) [28]; (Leight & Wilson, 2021) [36]; and at the community level, distance to facilities, internet availability, and power supply are decisive yet rarely studied (Zayapragassarazan & Kumar, 2016) [73]; (Kruse *et al*., 2019) [34]; (Zayyad & Toycan, 2018) [74]. In short, most studies fail to consider holistically the factors and practices associated with mobile phone adoption in accessing healthcare among both patients and health workers. To advance the global ambition of optimal reproductive health, it is necessary to explore how mobile devices can be adopted to bridge the gap between healthcare professionals and reproductive women. This study addresses that gap.

1.3. Research questions and objectives

The study was guided by four questions: what types of mHealth services are available in Southwest Nigeria; what is the extent and level of adoption among healthcare professionals and reproductive women; what factors influence adoption among these groups; and what differentials in health outcomes exist between adopters and non-adopters. Accordingly, the general objective was to assess the adoption of mobile health services in healthcare systems for reproductive women in selected states in Southwest Nigeria. The specific objectives were to identify the types of mHealth services available; determine the extent and level of adoption; evaluate the factors influencing adoption among healthcare workers and reproductive women; and examine the effects of adoption on the health outcomes of reproductive women in the study area.

1.4. Significance and scope

By foregrounding the patient perspective alongside that of providers, and by analysing individual, household, and community determinants together, the study contributes evidence relevant to policymakers, programme designers, application developers, and health managers seeking to expand maternal mHealth. The study was restricted to healthcare facilities and communities in Osun and Ondo States in Southwestern Nigeria. Osun was chosen because of the Electronic Medical Record system at its university teaching hospital and because its health system has received limited mHealth attention (Ogbonna *et al*., 2020) [44], while Ondo was selected because of the existing Abiye safe motherhood programme, through which pregnant women are registered and linked to care via mobile phones (Ajayi & Akpan, 2020) [6]. The pairing allowed a comparative assessment across two contrasting programme contexts.

2. Conceptual and Theoretical Background

2.1. Mobile health within electronic health

Electronic health, or eHealth, refers to the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including service delivery, surveillance, education, and research (WHO, 2016) [70]; (Witten & Humphry, 2018) [69]. Within this broader field, mHealth denotes the use of portable electronic devices to facilitate healthcare provision and disseminate information (Moss *et al*., 2019) [41]; (Laing *et al*., 2018) [35]. Although telehealth and telemedicine also rely on telecommunications, the emphasis on mobility differentiates mHealth, conferring portability, immediacy, interactivity, and ubiquity (Ajala *et al*., 2015) [5]; (Alam *et al*., 2020) [7]. Realising its value depends not only on device availability but also on electronic health literacy, the ability to seek, find, understand, and appraise health information from electronic sources and apply it to a health problem (Witten & Humphry, 2018) [69]. Many eHealth technologies have been developed to promote computer-mediated communication between patients and providers, drawing on a combination of scientific, information, media, and computer literacy, and on channels that include voice calls, text messaging, electronic mail, clinic-based interactive video, personal monitoring devices, individual health records, web-based portals, and secure online forums (Fortney *et al*., 2011) [22].

Information and communications technology has penetrated almost every field of human activity, including the health sector, where it holds the potential to address inadequate access and to reduce the cost of care (Witten & Humphry, 2018) [69]; (Balogun *et al*., 2020) [9]; (Udenigwen *et al*., 2022) [65]. The healthcare sector poses persistent obstacles to sustainable development, especially in low-income countries with a high burden of debilitating illness, and reform in this sector is increasingly understood to encompass not only clinical matters but also developmental challenges, with electronic and mobile health recognised as prominent components of that reform (Moss *et al*., 2019) [41]. The rapid proliferation of mobile technologies and the steady evolution of their capabilities have propelled the emergence of mHealth as a distinct domain within electronic health, distinguished from older telehealth and telemedicine approaches by its reliance on portable, personal devices that travel with the user.

The scale of mobile connectivity underpins this growth. Mobile health draws on the intrinsic utility of mobile phones, notably voice communication and text messaging, augmented by more sophisticated functionalities such as third, fourth, and fifth generation telecommunication systems, packet data services, satellite positioning, and short-range wireless links (Witten & Humphry, 2018) [69]. The number of mHealth applications available on major distribution platforms has grown substantially, reaching into the hundreds of thousands in recent years (Lee *et al*., 2020), while global mobile coverage now reaches the large majority of the world population, and smartphone ownership is high in many high-income countries. This widespread availability has facilitated the integration of mobile devices into healthcare practice (Wallis *et al*., 2017) [68], although uptake remains uneven across regions and is shaped by local socio-economic and infrastructural conditions.

2.2. Unified Theory of Acceptance and Use of Technology

The Unified Theory of Acceptance and Use of Technology (UTAUT), formulated by Venkatesh and colleagues, explains the intention to use and the subsequent use of information technology (Venkatesh *et al*., 2003) [67]. It posits four constructs. Performance expectancy is the degree to which a person believes that using the technology will help accomplish a task, which here reflects the belief that mobile contact improves access to care. Effort expectancy is the ease associated with use, reflecting how comfortable women are with the technology. Social influence is the degree to which a person perceives that important others believe the

technology should be used, which reflects the role of household, peer, and community norms. Facilitating conditions reflect the technical and institutional support available, such as whether government and health centres support adoption. The first three constructs directly influence behavioural intention, while facilitating conditions act indirectly, and the effects are moderated by gender, age, experience, and voluntariness of use.

2.3. Socio-ecological model

The socio-ecological model addresses the criticism that health interventions often focus on individual lifestyle while neglecting the contextual forces surrounding behaviour (Stokols, 1992) [62]. It situates the individual within nested social systems and identifies intervention points at intrapersonal, interpersonal, organisational, community, and policy levels (Bronfenbrenner, 1977) [14]; (McLeroy *et al*., 1988) [39]; (Stokols, 1996) [63]. Interpersonal relationships exert a pronounced influence on health behaviour, including the pursuit of care and the assimilation of novel technologies (Thoits, 2010) [64]; (Umberson & Karas Montez, 2010) [66]; (Okafor *et al*., 2018) [45], and the model has been applied to technology and immunisation uptake in Nigeria (Olaniyan *et al*., 2021) [49] and to the intention to recommend mHealth innovations (Oloveze *et al*., 2022) [50].

2.4. Conceptual framework for the study

Combining the two theories, the study frames adoption as a product of internal factors, namely individual characteristics such as age, sex, marital status, income, occupation, and religion, and household factors such as family type and size, household headship, and place of residence, together with external factors, namely community factors such as region, community education and infrastructure and cohesion, government factors such as economic conditions and the availability of mHealth in hospitals, and infrastructural factors such as the availability of mobile networks, roads, and power supply. These internal and external factors interact to determine the level of acceptance and adoption of mHealth, which in turn shapes the extent of access to antenatal and postnatal care and, ultimately, reductions in child and maternal mortality.

2.5. Types of mHealth technologies relevant to maternal care

The technologies through which mHealth is delivered range from the most basic voice channel to richer multimedia platforms. The Public Switched Telephone Network and ordinary voice calls remain the most widely used channel, enabling direct contact between women and clinicians and the exchange of advice without travel. Voice over Internet Protocol permits voice calls over a broadband connection, offering long-distance communication at relatively low cost and flexible use of a single number (Shaw & Sharma, 2016) [58]; (Ghafarian *et al*., 2016) [24]; consumer services such as WhatsApp and Facebook calls fall within this category and are increasingly used for informal clinical communication. These voice and near-voice channels are familiar, inexpensive, and undemanding of bandwidth, which helps explain their dominance in the present setting.

Video conferencing provides synchronous, face-to-face engagement using internet-enabled devices, with applications such as Zoom, Skype, and Google Meet offering real-time messaging, recording, screen sharing, and other features (Billingsley, 2020) [12]; (Sandhu *et al*., 2023) [55]. Such tools afford time efficiency, convenience, and adaptability across settings (Gray *et al*., 2020) [26], yet they demand greater bandwidth, data, and device capability, which may limit their suitability for many reproductive women in the study area. Instant messaging and short message services support fast, near-instantaneous text communication and have attracted very large subscriber bases (Serik & Balgozhina, 2014) [57]; modern messaging software integrates data transfer, voice, and video while requiring reliability, availability, and the security needed to protect information (Smailhodzic *et al*., 2016) [61]. Text messaging in particular has been used to support maternal health communication and reminders in Nigeria (Omole *et al*., 2018) [51]; (Oyeyemi & Wynn, 2014) [53].

2.6. Patient and professional engagement and the health-system context

Patient engagement occurs when there is knowledge of an application together with a sense of its relevance and usefulness, judged through criteria such as description, reviews and ratings, relevance to the target population, and currency of updates (Singh *et al*., 2016) [60]. Applications can assist high-need patients in managing their own health, and rising smartphone and tablet ownership has made them a promising means of involving patients in care (Witten & Humphry, 2018) [69]. Engagement spans facilitation of participation, activation, collaborative partnership, information sharing, and autonomy in decision-making, and less active patients, who may face social or literacy barriers, can still benefit from recording of health data, training, and reminders that do not necessarily require a smartphone application (Singh *et al*., 2016) [60]; (Witten & Humphry, 2018) [69]. This spectrum is directly relevant to a population in which competence is high but adoption is low.

On the supply side, the development and uptake of applications depend on clinicians interacting with developers to align tools with stakeholder needs, and several trends have been identified through examination of applications in app stores (Rita, 2021) [54]; (Shen *et al*., 2019) [59]. Although mHealth is increasingly popular, research on its adoption remains comparatively scanty, and a clearer picture requires synthesis across developer, user, and clinician perspectives (Jennings *et al*., 2015) [30]; (Shen *et al*., 2019) [59]. In Nigeria specifically, mHealth has been highlighted as a means of delivering quality services to adolescent and other mothers who may face stigma or social barriers, and of reducing regional disparities in maternal mortality where women have access to and good knowledge of mobile phones and applications (Kola *et al*., 2021) [33]; (Jennings *et al*., 2015) [30]. Provider willingness to use mHealth has also been documented among Nigerian doctors and other professionals, though awareness does not always translate into sustained use (Adebara *et al*., 2017) [1]; (Adum & Ejiofor, 2020) [3].

3. Materials and Methods

3.1. Study area

The study covered Osun and Ondo States in Southwest

Nigeria. Three local governments were considered in each state, with access to federal, state, and privately owned facilities, and a multi-stage probability sampling procedure was employed. Each state comprises three senatorial districts made up of local government areas. Ondo was selected because of the existing Abiye mHealth initiative, and Osun because of the Electronic Medical Record system at its university teaching hospital; the senatorial districts and local governments hosting these programmes were purposively selected, yielding Akure South in Ondo and Olorunda in Osun. According to the Public and Private Development Centre, Osun State has 1,031 primary health centres (678 public, 353 private), 60 secondary facilities (54 public, six private), and four public tertiary facilities, while Ondo State has 769 primary health centres (460 public, 309 private), 40 secondary facilities (19 public, 21 private), and two public tertiary facilities.

Osun State, bounded by five states with a landmass of about 8,521 square kilometres and a 2016 projected population of around 4.7 million, is a Yoruba-speaking state with Christian, Islamic, and traditional adherents and 30 local government areas, of which 19 are rural. Its facility distribution has been described as unbalanced and not easily accessible to rural residents (Ogbonna *et al*., 2020) [44], which strengthens the case for mHealth to provide more equitable, faster access and to reduce geographical barriers, waiting times, and patient-to-provider ratios. Ondo State, also predominantly Yoruba and with a comparable population, has a higher proportion of urban dwellers and was chosen for its existing Abiye mHealth programme (Ajayi & Akpan, 2020) [6]. Olorunda in Osun comprised one public tertiary facility, 11 public and 22 private primary centres, and four public secondary facilities, while Akure South in Ondo comprised one public tertiary facility, 19 public and 120 private primary centres, and public and private secondary facilities.

3.2. Research design

The study adopted a mixed-method design, combining quantitative survey data, analysed using descriptive and inferential statistics, with qualitative information analysed thematically. This design was chosen because the quantitative data alone could not sufficiently address all the research questions, and the qualitative component provided contextual depth on responses.

3.3. Sample size and technique

There were 187 health facilities in the study locations. All tertiary facilities were selected, and a 10 percent sample of the remaining facilities (about 19) was drawn using a population proportion to size method to ensure even distribution by type and ownership, with systematic random sampling applied to an alphabetically arranged list by type and ownership. Reproductive women aged 15 to 49 years attending the reproductive clinics of the selected facilities were the target population. Applying the Cochran formula at a 95 percent confidence level ($Z = 1.96$), maximum variation ($p = 0.5$, $q = 0.5$), and 5 percent precision yielded a sample of 384 women. Proportional allocation assigned 162 women to Osun and 237 to Ondo, and 60 healthcare professionals, comprising medical doctors, nurses, and pharmacists, were purposively selected across both states.

3.4. Sources and instruments

Two sets of structured questionnaires were used for primary data collection. The first elicited information from reproductive women in three sections: background characteristics, access to healthcare through phones, and adoption of mHealth. The second elicited information from healthcare professionals in two sections: background characteristics and mHealth adoption. Secondary data were collected on the types and numbers of public and private secondary and tertiary mHealth services in the study area, with service types identified from the literature.

3.5. Measurement of variables

Socio-demographic variables measured included age, sex, educational level, marital status, religion, monthly income, and employment status. For the first objective, the types of services were measured as the presence of Public Switched Telephone Network calls; Voice over Internet Protocol services including Facebook calls, WhatsApp calls, and WhatsApp messages; video conferencing applications including Zoom and Skype; and messaging applications, each recorded as yes or no. For the second objective, the extent of adoption of each technology was recorded as adopted or not adopted, and the level of adoption was captured on a six-stage scale: not aware, aware, interested, evaluating use, trying out, and adopted. For the third objective, individual, household, and community factors were measured on a five-point Likert scale from strongly agree to strongly disagree and summarised using descriptive mean ratings. For the fourth objective, professionals rated the helpfulness of mHealth in reducing the incidence of specified complications, namely gestational diabetes, placenta previa, pregnancy-induced hypertension, preterm labour, miscarriage, prolonged labour, and excessive bleeding, on a five-point helpfulness scale.

3.6. Validity, reliability, and ethics

The instruments were validated by subject experts, including a gynaecologist, and by an ethics committee, to ensure relevance and clarity. A pilot study assessed comprehension and feasibility, and the reliability of the instrument, evaluated using Cronbach's alpha, returned a coefficient of 0.86, indicating high reliability.

3.7. Data analysis and modelling

Analysis proceeded at three levels. Univariable analysis used frequencies and percentages. Bivariable analysis used the chi-square test at the 0.05 level to assess associations between independent variables and the adoption of mHealth services. Multivariable analysis used binary logistic regression, with the outcome dichotomised into use and non-use of mHealth services, and interpretation based on odds ratios and 95 percent confidence intervals at the 0.05 level of significance. Five models were specified in line with the conceptual framework: a demographic model, a household model, a community model, an intervening-variable model, and a final combined model that examined the overall effect of independent and intervening variables on adoption. This staged specification allowed comparison of model fit and identification of the determinants most strongly associated with adoption.

4. Results

4.1. Response rate

Of the questionnaires administered, 60 of 63 were retrieved from healthcare professionals (95.2 percent) and 384 of 399 from reproductive women (96.2 percent), an overall retrieval of 96.1 percent (Table 1). Response rates above 95 percent for both groups suggest strong engagement and the relevance of the topic to the target populations, and the inclusion of both providers and women offers a comprehensive perspective on the challenges, needs, and prospects of mHealth adoption.

Table 1: Questionnaire retrieval from reproductive women and healthcare professionals

Respondent	Administered	Retrieved	Retrieved (%)
Healthcare professionals	63	60	95.2
Reproductive women	399	384	96.2
Total	**462**	**444**	**96.1**

4.2. Socio-demographic characteristics

Among the reproductive women, 68.8 percent were aged 25 to 44 years, 23.9 percent were aged 15 to 24 years, and 7.3 percent were 45 years or older (Table 2). Most were married (85.7 percent), Christian (65.9 percent), and earned between 30,001 and 130,000 naira monthly (52.6 percent). About 62.5 percent were unemployed, 24.0 percent self-employed, and 52.3 percent had completed tertiary education. The age profile is consistent with peak fertility and with prior Nigerian studies, in which participants clustered in similar age ranges (Itanyi *et al*., 2023) [29]; (Olajubu *et al*., 2020) [47]. The high proportion of married women underscores the potential role of family and marital variables in reproductive health decisions, while the substantial share of unemployed women points to the importance of affordability.

Table 2: Selected socio-demographic characteristics of reproductive women (N = 384)

Characteristic	Frequency (n)	Percentage (%)
Age 15 to 24 years	92	23.9
Age 25 to 44 years	264	68.8
Age 45 years and above	28	7.3
Married	329	85.7
Single	30	7.8
Separated, divorced, or widowed	25	6.5
Christianity	253	65.9
Islam	126	32.8
Monthly income 30,001 to 130,000 naira	202	52.6
Unemployed	240	62.5
Self-employed	92	24.0
Tertiary education	201	52.3
Secondary education	149	38.8

Among healthcare professionals, half were aged 40 to 49 years, with the younger and older groups equally represented, indicating a mature workforce. Half had more than ten years of service and a further 36.7 percent had five to ten years, reflecting an experienced and stable workforce. Nurses (50.0 percent) and doctors (38.3 percent) predominated, with pharmacists making up 11.7 percent. Most earned between 100,001 and 300,000 naira monthly (80.0 percent), all held at least tertiary education, and 31.7 percent held postgraduate degrees, describing a predominantly middle-aged, well-educated, and experienced group.

Household characteristics of the reproductive women showed that 69.5 percent lived in Ondo State and 90.4 percent in male-headed households (Table 3). Monogamous families predominated (81.3 percent), most women lived in smaller households of one to four members (62.2 percent), and 56.3 percent of households earned above 130,000 naira monthly. The predominance of monogamous, smaller, male-headed households suggests relatively stable environments that shape decision-making and resource allocation, while the male-headed majority points to the value of engaging male decision-makers in promoting adoption.

Table 3: Selected household characteristics of reproductive women (N = 384)

Characteristic	Frequency (n)	Percentage (%)
Monogamous family	312	81.3
Polygamous family	48	12.5
Household of 1 to 4 members	239	62.2
Household of 5 to 9 members	128	33.3
Resident in Ondo State	267	69.5
Resident in Osun State	117	30.5
Male-headed household	347	90.4
Household income above 130,000 naira	216	56.3

These distributions set the context for the determinant analysis that follows. The sample is concentrated among married women of peak reproductive age living in male-headed, monogamous, and relatively small households, a profile in which household and marital influences on health decisions might be expected to be strong. That family type,

household size, and the gender of the household head nonetheless proved non-significant in the regression is therefore informative, since it indicates that in this setting the individual and economic characteristics of women, rather than the structure of their households, are what distinguish adopters from non-adopters. The spread across income bands and education levels, with sizeable groups at both lower and higher ends, provides the variation needed to detect the education and income gradients reported below, while the predominance of unemployed women foregrounds affordability as a plausible mechanism linking economic position to reliance on mediated phone contact.

4.3. Facility profile and provider use of mHealth

More than half of the sampled facilities were privately owned (58.3 percent). About 86.7 percent of professionals were aware of mHealth services and the same share reported facility adoption, while 65 percent of facilities had adopted mHealth for delivery. Phone calls were the most commonly adopted service, used in the past by 76.9 percent of facilities and currently by 73.1 percent, followed by WhatsApp messages (19.2 percent past, 13.3 percent current). Two-thirds of professionals used mHealth often and a further 15.4 percent very often, 94.2 percent reported that devices were functional, and 90.4 percent reported high patient awareness of available services (Table 4).

Table 4: Healthcare professional's facility profile relating to mHealth

Survey item	Frequency (n)	Percentage (%)
Aware of mHealth services	52	86.7
Facility has adopted mHealth	39	65.0
Phone calls ever used	40	76.9
Phone calls currently used	38	73.1
WhatsApp messages currently used	7	13.3
Use mHealth often	34	65.4
Use mHealth very often	8	15.4
Devices functional	49	94.2
High patient awareness reported	-	90.4

Two features of the facility profile are notable for interpreting the patient-level results that follow. First, the supply side appears comparatively ready: most professionals were aware of mHealth, most facilities had adopted it, the great majority of devices were functional, and providers reported that patients were aware of available services. Second, that readiness is concentrated in basic channels, since phone calls dominated both past and current use while richer modalities were marginal, and providers themselves relied on the same familiar tools that women reported using competently. The contrast between this provider-reported readiness, including the high figure for perceived patient awareness, and the very low adoption recorded directly among women is itself a finding, suggesting that provider impressions of patient awareness may overstate the extent to which women know that specific services can be used to reach health personnel. This reinforces the value of measuring adoption from the patient side rather than inferring it from facility readiness alone.

4.4. Knowledge of mobile phone use among reproductive women

Reproductive women reported excellent self-rated knowledge of using devices to make phone calls (mean 4.50) and very good knowledge of sending SMS (4.32), sending WhatsApp messages (4.00), making WhatsApp calls (3.93), and making video calls (3.79) (Table 5). Analysis of the contribution of individual technologies to outcomes indicated that, of twelve tools examined, phone calls, text messages, and WhatsApp made statistically significant contributions to health outcomes, and the tools together accounted for about 45.8 percent of the variation in outcomes. The high competence ratings show that the adoption gap is not explained by a lack of basic skill.

Table 5: Self-rated knowledge of mobile phone use among reproductive women (N = 384)

Item	Mean	Rating band
Phone call	4.50	Excellent
Send SMS	4.32	Very good
WhatsApp message	4.00	Very good
WhatsApp call	3.93	Very good
Video call	3.79	Very good

Rating bands: none 0 to 0.4; poor 0.5 to 1.4; moderate 1.5 to 2.4; good 2.5 to 3.4; very good 3.5 to 4.4; excellent 4.5 to 5.

4.5. Extent and level of adoption among reproductive women

Awareness among women was highest for text messages (71.4 percent aware) and phone calls (51.3 percent aware), but adoption was uniformly low across all services (Table 6). Phone calls and WhatsApp calls recorded the highest adoption at 4.7 percent each, followed by text messages (3.1 percent), WhatsApp messages (2.1 percent), and Facebook messages and calls (0.5 percent each). For phone calls, about a quarter of women were unaware they could use them to reach health personnel, 16.4 percent were interested, 0.5 percent were evaluating, 2.1 percent were trying out, and 4.7 percent had adopted. Video-conferencing applications were largely unknown, with unawareness of 68.2 percent for Zoom, 77.1 percent for Skype, 80.2 percent for FaceTime, and 81.0 percent for Google Meet, and no recorded adoption of any of them. Signal was the least known application.

Table 6: Awareness and adoption of selected mHealth services among reproductive women (%)

Service	Not aware	Aware	Interested	Adopted
Phone calls	24.7	51.3	16.4	4.7
Text messages	15.1	71.4	6.8	3.1
WhatsApp calls	56.3	32.3	4.9	4.7
WhatsApp messages	63.0	28.1	5.7	2.1
Facebook messages	50.3	40.9	5.2	0.5
Zoom	68.2	25.0	4.7	0.0
Skype	77.1	16.7	4.2	0.0
Google Meet	81.0	11.7	5.7	0.0

The pattern across the awareness-to-adoption funnel is instructive. For the most familiar channels, substantial shares of women were aware of the service and a further group expressed interest, yet only a small fraction progressed to the trial and adoption stages, so that interest consistently exceeded adoption by a wide margin. For phone calls, for example, roughly half of women were aware and about one in six were interested, but only about one in twenty had adopted the service for contacting health personnel. The contrast is sharper for richer modalities: video-conferencing tools were unknown to most respondents, and none reported adopting them, so the gap there reflects an absence of awareness rather than a failure to convert interest into use. Taken together, the data describe two distinct constraints operating at different points on the funnel, namely limited awareness for advanced tools and limited conversion of awareness into sustained use for familiar tools, each of which calls for a different programmatic response.

4.6. Adoption across states among healthcare professionals

Across both states, 52 of 60 professionals had adopted mHealth, with a significantly higher rate in Osun (50.0 percent) than Ondo (36.7 percent) (Fisher exact = 5.495, p = 0.034). The specific services ever used differed significantly between states (chi-square = 11.176, p = 0.011): phone calls dominated in both, with 23.1 percent of Ondo and 53.8 percent of Osun professionals reporting their use, while WhatsApp messages were more common in Ondo. The service currently in use also differed significantly (chi-square = 6.569, p = 0.037), with phone calls used by 73.1 percent overall, WhatsApp messages by 21.2 percent, and SMS by the smallest share. Frequency of use did not differ significantly between states (chi-square = 3.932, p = 0.140), with 82.7 percent using mHealth often. Consultation was the leading reason for patient calls in both states, followed by prescriptions, medical reports, and appointment booking.

4.7. Adoption across public and private facilities

Adoption did not differ significantly by ownership: 46.7 percent of private and 31.7 percent of public facilities had adopted mHealth (chi-square = 2.807, p = 0.114). Phone calls were used by 44.9 percent of private and 30.6 percent of public facilities, and WhatsApp messages were used by 14.3 percent of private facilities and none of the public facilities. The clearest difference was in frequency of use: 63.3 percent of private facilities reported frequent use compared with 22.4 percent of public facilities (chi-square = 9.383, p = 0.005), pointing to a substantial gap in integration that may reflect resource allocation, infrastructure, and training. While 95.9 percent of facilities across both sectors received patient calls, with no significant sectoral difference (p = 0.080), the reasons for calls differed significantly (chi-square = 2.315, p = 0.037), with consultation requests more frequent in the private sector.

4.8. Factors influencing adoption among reproductive women

Binary logistic regression showed that women aged 15 to 24 years (OR = 0.166, p = 0.001) and 25 to 44 years (OR = 0.204, p = 0.001) had significantly lower odds of adoption than those aged 45 years and above (Table 7). Single women had higher but non-significant odds than separated, divorced, or widowed women (OR = 4.174, p = 0.076). Women earning less than 30,000 naira monthly had higher odds of adoption than those earning more than 130,000 naira (OR = 2.506, p = 0.050). Unemployed women were more likely to adopt than employed women (OR = 2.649, p = 0.034). Education showed the strongest gradient: relative to women with tertiary education, those with no formal education (OR = 55.898, p = 0.001), primary education (OR = 14.211, p = 0.001), and secondary education (OR = 6.686, p = 0.001) had markedly higher odds of adoption.

Table 7: Socio-demographic factors influencing mHealth adoption among reproductive women

Variable	Odds ratio	p-value	95% CI
Age 15 to 24 years	0.166	0.001*	0.046 to 0.601
Age 25 to 44 years	0.204	0.001*	0.069 to 0.604
Single (marital status)	4.174	0.076	0.860 to 20.251
Income below 30,000 naira	2.506	0.050*	1.000 to 6.275
Unemployed	2.649	0.034*	1.074 to 6.530
No formal education	55.898	0.001*	6.749 to 462.973
Primary education	14.211	0.001*	3.650 to 55.331
Secondary education	6.686	0.001*	3.985 to 11.219

Reference categories: age 45 years and above; separated, divorced, or widowed; income above 130,000 naira; employed; tertiary education. * Significant at the 0.05 level

Household analysis showed that family type was not significant: monogamous (OR = 1.580, p = 0.507) and polygamous (OR = 3.082, p = 0.145) families did not differ significantly from other family types. Household size was also non-significant, with smaller households of one to four members (OR = 0.302, p = 0.091) and five to nine members (OR = 0.436, p = 0.232) not differing significantly from households of ten or more. Household income, however, was strongly significant: relative to households earning above 130,000 naira monthly, those earning 30,000 naira or less (OR = 8.974, p = 0.001) and those earning 30,001 to 130,000 naira (OR = 4.551, p = 0.001) had substantially higher odds of adoption (Table 8). The gender of the household head was not significant (OR = 0.587, p = 0.308). State of residence was significant: women in Ondo had 52.6 percent lower odds of adoption than those in Osun (OR = 0.474, p = 0.034).

Table 8: Household factors influencing mHealth adoption among reproductive women

Variable	Odds ratio	p-value	95% CI
Monogamous family	1.580	0.507	0.409 to 6.106
Polygamous family	3.082	0.145	0.679 to 13.981
Household of 1 to 4 members	0.302	0.091	0.075 to 1.210
Household of 5 to 9 members	0.436	0.232	0.112 to 1.701
Income 30,000 naira or less	8.974	0.001*	4.295 to 18.751
Income 30,001 to 130,000 naira	4.551	0.001*	2.883 to 7.184
Male-headed household	0.587	0.308	-
Resident in Ondo State	0.474	0.034*	-

Reference categories: other family types; household of 10 or more members; income above 130,000 naira; female-headed household; resident in Osun State. * Significant at the 0.05 level.

4.9. Perceived effects on maternal health outcomes

Professionals rated mHealth as sometimes helpful for reducing the incidence of excessive bleeding (mean 3.23), miscarriage (3.07), and prolonged labour (3.07), and as slightly helpful for preterm labour (2.88), pregnancy-induced hypertension (2.71), placenta previa (2.63), and gestational diabetes (2.46) (Table 9). The conditions rated most amenable to mHealth support are those in which timely communication and remote alerts can prompt early intervention, suggesting that the value of mHealth is greatest for acute, time-sensitive complications.

Table 9: Perceived helpfulness of mHealth in reducing pregnancy-related complications (N = 52)

Complication	Mean score	Rank
Excessive bleeding	3.23	1st
Miscarriage	3.07	2nd
Prolonged labour	3.07	2nd
Preterm labour	2.88	4th
Pregnancy-induced hypertension	2.71	5th
Placenta previa	2.63	6th
Gestational diabetes	2.46	7th

Scale: 1 = not helpful, 2 = slightly helpful, 3 = sometimes helpful, 4 = very helpful, 5 = extremely helpful.

5. Discussion

5.1. Availability and types of services

The first objective concerned the types of services available. The findings show that facilities rely overwhelmingly on basic voice and messaging channels, with phone calls dominant and WhatsApp messages a distant second, while richer modalities such as video conferencing are essentially absent. This reliance on simple, widely available tools is consistent with provider-level findings elsewhere in Nigeria and the wider region, where uptake concentrates on familiar, low-bandwidth channels rather than dedicated applications (Kenny *et al*., 2017) [32]; (Balogun *et al*., 2020) [9]; (Bervell & Al-Samarraie, 2019) [11].

The dominance of voice and basic messaging is best understood as a rational adaptation to local conditions rather than a deficiency. These channels demand minimal bandwidth, run on inexpensive handsets, work where mobile coverage is patchy, and require no specialised training, which makes them robust where electricity, data, and device capability cannot be assumed. The richer modalities that the literature associates with remote diagnosis and monitoring offer additional functionality but presuppose conditions that are not uniformly present in the study area (Witten & Humphry, 2018) [69]; (Zayyad & Toycan, 2018) [74]. The practical implication is that the available service mix is well matched to current infrastructure, so the immediate task is to deepen the use of what already works rather than to displace it with platforms whose preconditions are not yet in place.

5.2. Extent and level of adoption

The second objective concerned the extent and level of adoption. The findings reveal a clear divergence between facility-level availability and patient-level uptake. While roughly two-thirds of facilities had adopted mHealth and most professionals used it, fewer than five percent of reproductive women had adopted any single service for contacting health personnel, and awareness of richer modalities was very limited. This mirrors evidence that supply-side readiness does not automatically translate into demand-side adoption (Marufu & Maboe, 2017) [37]; (Kruse *et al*., 2019) [34]; (Udenigwen *et al*., 2022) [65]. That women reported high competence with phones yet low adoption indicates that the binding constraints are awareness, social and institutional encouragement, and contextual conditions rather than digital skill, a pattern also observed in Nigerian studies of perception and capability (Dasuki & Zamani, 2019) [18]; (Odetola *et al*., 2018) [43]; (Chaka *et al*., 2020) [15].

5.3. Factors influencing adoption

The third objective concerned the determinants of adoption. The significant associations with age, education, occupation, household income, and state of residence are consistent with the Unified Theory of Acceptance and Use of Technology, in which performance expectancy, effort expectancy, social influence, and facilitating conditions shape behavioural intention (Venkatesh *et al*., 2003) [67], and with the socio-ecological view that individual behaviour is embedded in household and community structures (Stokols, 1992) [62]; (Olaniyan *et al*., 2021) [49]. The strong education and income gradients, in which women with less formal education and lower household income showed higher odds of adoption, suggest that mediated phone contact is used most by women with fewer alternatives, while better-resourced women may substitute in-person or private care. The non-significance of family type, household size, and gender of household head indicates that, in this setting, economic and individual factors outweigh family structure. The significant difference between states, with higher adoption in Osun, indicates that programme design and local health-system context matter as much as geography, echoing evidence that organisational and environmental conditions shape institutional adoption (Ngongo *et al*., 2019) [42]; (Zayyad & Toycan, 2018) [74].

5.4. Perceived effects on health outcomes

The fourth objective concerned perceived effects on outcomes. Professionals viewed mHealth as most helpful for acute, time-sensitive complications such as excessive bleeding, miscarriage, and prolonged labour, where prompt communication and remote alerts can support early intervention. This aligns with evidence that mHealth interventions can improve the uptake of recommended maternal services and shape maternal experiences of care in Nigeria (Olajubu *et al*., 2020, 2022) [47, 48]; (Oyeyemi & Wynn, 2014) [53], and with provider-based findings in the wider region (Gilano *et al*., 2024) [25].

5.5. Theoretical and policy implications

Taken together, the results support an integrated reading in which acceptance constructs operate within a layered set of household and community conditions. Extending diagnostic and service access in underserved and rural areas, whether through infrastructure or mediated communication, remains central to equitable maternal care (Aminu-Ibrahim *et al*., 2020) [8]. Strengthening patient engagement through structured communication and follow-up workflows offers a practical lever for converting availability into sustained use (Eyetsemitan *et al*., 2024) [21]. As services scale, attention to the privacy and security of health data exchanged over consumer messaging channels will be important (Mbonu *et al*., 2024) [38]. The higher frequency of use in private facilities further suggests that resourcing and training, not merely the presence of technology, determine whether adoption is sustained.

5.6. Comparison with prior evidence

The very low adoption recorded among reproductive women is consistent with, and in some respects more pronounced than, prior Nigerian and regional evidence. Disparities in mobile phone access have been shown to shape maternal service use in Nigeria (Jennings *et al*., 2015) [30], and studies of perception and capability among childbearing women have repeatedly found that awareness and contextual barriers, rather than skill, limit use (Odetola *et al*., 2018) [43]; (Chaka *et al*., 2020) [15]; (Dasuki & Zamani, 2019) [18]. The dominance of phone calls echoes provider-level findings that uptake concentrates on familiar, low-bandwidth channels (Kenny *et al*., 2017) [32]; (Balogun *et al*., 2020) [9]. The strong education gradient, in which women with less formal education showed higher odds of adoption, contrasts with some developed-country patterns and reinforces the argument that determinants identified in high-income settings may not transfer directly to Nigeria (Blumenstock & Eagle, 2012) [13]; (Yaya *et al*., 2019) [72]. The finding that mHealth is viewed as most helpful for acute complications is consistent with intervention evidence on postnatal care uptake and maternal experience in Nigeria (Olajubu *et al*., 2020, 2022) [47, 48].

5.7. Strengths and methodological considerations

The study has several strengths. It examined providers and patients together, achieved response rates above 95 percent, and modelled individual, household, and community determinants jointly rather than in isolation, which the socio-ecological framework suggests is necessary to capture how forces interact (Stokols, 1992) [62]; (McLeroy *et al*., 1988) [39]. The use of a validated instrument with high reliability, a probability-based facility sample, and a staged regression strategy further supports the credibility of the findings. At the same time, the cross-sectional design precludes causal inference, the perceived-outcome ratings reflect professional judgement rather than measured clinical endpoints, and self-reported adoption may be subject to recall and social-desirability effects. The wide confidence interval around the education estimate for women with no formal education reflects the small number of such respondents and should be interpreted with caution. These considerations point to the value of longitudinal and mixed-method designs in future work.

5.8. Equity, the digital divide, and the awareness gap

The juxtaposition of high self-rated competence with very low adoption is the central empirical puzzle of the study, and it reframes the policy problem. Where adoption is constrained by skill, the appropriate response is training; where it is constrained by awareness and encouragement, as the present data suggest, the appropriate response is communication, demonstration, and institutional endorsement. Women reported that they could already make phone calls, send messages, and use WhatsApp competently, so the failure to use these channels to reach health personnel points to a gap in knowledge that the service exists, in social and institutional cues that it is appropriate to use, and in the facilitating conditions that would make use routine (Venkatesh *et al*., 2003) [67]; (Witten & Humphry, 2018) [69]. This interpretation is consistent with the socio-ecological premise that behaviour is shaped by interpersonal, organisational, and community influences and not by individual capability alone (Stokols, 1992) [62]; (Olaniyan *et al*., 2021) [49]; (Oloveze *et al*., 2022) [50].

The determinant structure also carries an equity message that runs counter to the usual digital-divide narrative. In many settings, advanced technology is adopted first by the better educated and better resourced, yet here women with less formal education and lower household income showed higher odds of using mediated phone contact. A plausible reading is that mHealth functions as a substitute for women with fewer

alternatives, who rely on a phone call to reach care that they might otherwise struggle to access, while better-resourced women substitute toward in-person or private services. If so, strengthening basic voice and messaging channels is not merely a technological convenience but a means of extending access to underserved groups, provided that awareness and facilitating conditions are addressed (Aminu-Ibrahim *et al*., 2020) [8]; (Eyetsemitan *et al*., 2024) [21]. The higher frequency of use observed in private facilities reinforces the point that sustained use depends on resourcing and organisational support rather than on the mere presence of technology (Zayyad & Toycan, 2018) [74]; (Kruse *et al*., 2019) [34].

5.9. Functional applications for maternal care

The findings can be situated within the recognised functional categories of mHealth, which span health information retrieval, remote reservation and appointment booking, remote diagnosis and monitoring, access to electronic medical records, and health consultation (Singh *et al*., 2016) [60]; (Shen *et al*., 2019) [59]. In the study area, consultation emerged as the leading reason for patient calls in both states, followed by prescriptions, medical reports, and appointment booking, which indicates that the consultation and information-retrieval functions are already operating through basic voice channels even where dedicated applications are absent. The professionals' ranking of complications, in which acute and time-sensitive events such as excessive bleeding, miscarriage, and prolonged labour were judged most amenable to mHealth support, maps onto the remote-monitoring and consultation functions, since these are the situations in which prompt communication and early alerts are most likely to change the course of care (Olajubu *et al*., 2020, 2022) [47, 48]; (Gilano *et al*., 2024) [25].

This functional reading has practical implications for the design of maternal mHealth in the study area. Because women already use voice and messaging competently, the most immediate gains are likely to come from formalising consultation and reminder workflows over existing channels rather than from introducing unfamiliar platforms (Eyetsemitan *et al*., 2024) [21]. Appointment reminders, antenatal and postnatal follow-up prompts, and structured advice on danger signs can be delivered through phone calls, short message services, and WhatsApp messages with little additional infrastructure and these align with documented uses of text messaging for maternal communication in Nigeria (Omole *et al*., 2018) [51]; (Oyeyemi & Wynn, 2014) [53]. Richer modalities such as video conferencing could extend the diagnostic and monitoring functions, but their adoption will require investment in bandwidth, devices, and provider training, together with attention to the security of health information exchanged over consumer messaging services (Smailhodzic *et al*., 2016) [61]; (Mbonu *et al*., 2024) [38].

6. Conclusion, Recommendations, and Limitations

6.1. Summary and conclusion

Very few reproductive women had adopted mHealth technologies, with phone calls and WhatsApp calls each adopted by 4.7 percent, text messages by 3.1 percent, and WhatsApp messages by 2.1 percent, even though most professionals used phone calls and the majority of facilities had adopted mHealth. Individual, household, and community characteristics influenced adoption among women, and professionals rated mHealth as sometimes helpful for excessive bleeding, miscarriage, and prolonged labour. The findings reveal a dichotomy: women demonstrated excellent familiarity with phone calls, SMS, WhatsApp, and video calls, yet this awareness did not translate into adoption, indicating barriers that prevent women from fully leveraging digital health innovations despite their potential to improve outcomes. Application of mHealth for maternal care in the study area therefore remains inadequate, and adoption among reproductive women is limited, notwithstanding a supply environment and a level of user competence that together should make wider use readily achievable.

6.2. Recommendations

Several measures follow from these findings. Reproductive women should be made aware of available services through individual, household, and community channels, since facilities mainly use phone calls, SMS, and WhatsApp calls and messages, which women can already use well. Under-used tools such as Zoom, Skype, FaceTime, and Google Meet should be introduced and supported at facilities, as their adoption could broaden the impact of mHealth on maternal outcomes. Healthcare providers should be trained and incentivised to promote and support mHealth use among reproductive-age patients, and outreach and education campaigns should raise awareness of available solutions and their benefits. Because adoption was higher in Osun and in private facilities, attention to programme design, resourcing, and training is warranted to reduce disparities across states and sectors.

These measures can be organised around the three levels at which determinants operate. At the individual level, demand-side communication should target the women least likely to convert awareness into use, recognising that the education and income gradients point toward women with fewer alternatives as both the most likely adopters and an important equity priority; simple, repeated messaging that the facility can be reached by phone, and that doing so is appropriate and encouraged, addresses the awareness and social-influence constraints identified in the data (Venkatesh *et al*., 2003) [67]; (Dasuki & Zamani, 2019) [18]. At the household and community level, engaging family decision-makers and community structures can reinforce the legitimacy of mediated contact, consistent with the socio-ecological emphasis on interpersonal and organisational influence (Stokols, 1992) [62]; (Olaniyan *et al*., 2021) [49]. At the facility and policy level, the gap between availability and frequent use, and between public and private sectors, indicates that sustained adoption depends on dedicated staff time, reliable connectivity and power, clear protocols for handling patient contact, and safeguards for the privacy of exchanged information (Zayyad & Toycan, 2018) [74]; (Kruse *et al*., 2019) [34]; (Mbonu *et al*., 2024) [38]. Aligning these levels offers a realistic path to converting the high competence already present among women into sustained use.

6.3. Contribution to knowledge

The study contributes to knowledge by clarifying the applications and services adopted for maternal healthcare in Osun and Ondo States and by providing evidence on the perceived effects of mHealth on the health outcomes of adopters and non-adopters in Southwest Nigeria. By analysing provider and patient perspectives together and modelling individual, household, and community determinants jointly, it offers a more holistic account of

adoption than provider-only studies. In doing so, it supplies the kind of patient-centred, multi-level evidence that the wider literature has identified as scarce, and it does so for a maternal population whose adoption behaviour is rarely the explicit focus of mHealth research in the region.

6.4. Limitations and future research

The study was confined to two states and selected local governments, so findings should be generalised with care, and the cross-sectional design limits causal inference. Further research is needed to understand the specific barriers and enablers of adoption in depth, for which qualitative studies would be valuable; pilot studies of different interventions and delivery models could identify the most effective approaches to raising adoption; and longitudinal research is required to track the long-term health impacts of sustained mHealth use among reproductive women. Addressing the adoption gap through multifaceted, evidence-based strategies can help unlock the potential of mHealth to improve reproductive health outcomes in the studied regions and beyond.

Future work would also benefit from extending the comparison beyond the two states examined here to settings with different infrastructural and programmatic profiles, and from incorporating objective measures of use, such as call and message logs where consent and privacy safeguards permit, alongside clinical records that allow adoption to be linked to measured outcomes rather than perceived ones. Such designs would test whether the awareness and facilitating-condition constraints identified in this study are general or specific to the study area, and would clarify the causal pathway from mediated contact to maternal health gains. The present findings provide a foundation for that agenda by establishing, for two contrasting states in Southwest Nigeria, the size and shape of the gap between availability and use and the determinants that pattern it.

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