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Original Research

Digital Technology-Enhanced Remote Health Services: Antenatal Clients' Perception, Acceptance and Readiness at a Nigerian Tertiary Hospital.

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Abstract

Background: Digital technology offers promising solutions for monitoring pregnant women but client's readiness for its adoption in Nigeria remains underexplored. This study assessed antenatal clients' perceptions and readiness for digital health adoption.

Methodology: This cross-sectional survey involved 228 antenatal clients recruited through systematic sampling. Participants completed the 16-item Technology Readiness Index (TRI 2.0) and supplementary perception scales on 5-point response scales. Respondents were categorised as explorers, pioneers, skeptics, paranoids, or laggards based on their TRI scores. The range of Cronbach's alpha for scales was: 0.80–0.92. Data were analysed using SPSS version 29, applying descriptive and generalised linear regression analyses, with statistical significance set at $p \leq 0.05$.

Results: The response rate was 100% and most participants were aged 25–34 (43.9%), married (51.8%), and held tertiary education (38.6%). Ownership of digital devices was smartwatches (6.1%), smartphones (25.9%), and computers (26.3%). Clients prioritised e-prescription (3.09±1.11) and access to personal health information (3.08±1.13) as top benefits of remote services. TRI Scores were overall TRI (3.00±0.31), optimism (3.12), innovativeness (3.22), discomfort (3.12), and insecurity (3.19). Majority (90.4%) were classified as skeptics. Unemployed clients showed lower acceptance of devices for remote maternal monitoring (B = -0.13, 95% CI: -0.24, -0.01, p = 0.033).

Conclusion: Despite the global momentum toward digital maternal health solutions, antenatal clients in Nigeria demonstrate low digital engagement and are predominantly skeptics. Targeted interventions including digital literacy campaigns, improved trust through data privacy protections, and broader infrastructural investments are critical for promoting equitable adoption of remote digital maternal health solutions.

Keywords: Digital Technology; Remote Healthcare; Antenatal Care; Technology Readiness Index; TRI; Teaching Hospital; Nigeria.

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Introduction

The integration of digital technology into maternal healthcare aimed to improve health outcomes, enhance service delivery, and reduce maternal and neonatal mortality, has gained global momentum, [1]. Digital health innovations such as mobile health (mHealth) applications, wearable devices, telemedicine, AI-assisted diagnostics, and electronic health records (EHRs) are transforming antenatal care (ANC) worldwide [2,3]. These innovations facilitate real-time monitoring, early detection of complications, and better communication between pregnant women and healthcare providers [3]. Experiences from low- and middle-income countries like India, Rwanda, and Kenya show the substantial impacts of such interventions on ANC attendance, early risk identification, bridging healthcare gaps and materno-fetal outcomes [4,5].

Despite progress in the reduction of maternal mortality in many regions of the world, it remains high in sub-Saharan Africa and South Asia, which account for over 86% of global maternal deaths [1]. Nigeria's maternal mortality ratio (MMR) of 512 per 100,000 live births which stands as one of the highest globally [6]. Significant contributors to the high MMR are delays in care-seeking, inadequate infrastructure, and poor maternal monitoring [7,8]. The contributors to maternal deaths are mostly diagnosed when clients visit health facilities during scheduled ANC appointments or on emergencies. Although facility-based visits during pregnancy for routine ANC is critical for early diagnosis of high-risk conditions such as pre-eclampsia and anaemia [9], a lot could go wrong between such visits.

The integration of remote technology into ANC offers immense opportunities for improved access, continuity and self-monitoring. Despite evidence of its effectiveness, adoption of technology-enhanced maternal remote health monitoring (TE-MHM) in Nigeria remains limited not only by infrastructural constraints, digital illiteracy, socio-cultural beliefs, and financial barriers [10,11], but also due to inadequate knowledge on the behaviours of the critical stakeholders including the patients [12].

Antenatal clients' perceptions reflect how they view, interpret, and make sense of digital technology–enhanced remote health services underpinned by their beliefs, attitudes, expectations, and concerns, and trust in healthcare providers and technology [13]. Acceptance refers to their willingness to use digital technology–enabled services when offered. This is based on the Technology Readiness and Acceptance Model (TRAM) and Social Cognitive Theory (SCT) [7,13]. Readiness unlike acceptance emphasizes capacity in terms of practical and psychological preparedness of antenatal clients to adopt remote digital health services. It encompasses digital literacy as well as access to devices and internet [13, 14]. Investigating the perceptions (how antenatal clients see remote monitoring), acceptance (if they are willing to use it), and readiness (if they are able to adopt it) of ANC clients engagement with digital technology for remote maternal health monitoring will provide a holistic understanding of the overall feasibility, usability, and sustainability of digital technology–enhanced remote maternal health monitoring in antenatal care.

Most studies on the perception, acceptance and readiness for adoption of technology are slant towards health providers' perspectives [15], with less attention given to users of health services who are critical stakeholders [12]. This could hinder the design of interventions that are client-centered, equitable, and contextually appropriate for improving adoption of digital technology for remote maternal health monitoring and ultimately, maternal health outcomes

Despite evidence of the benefits of digital technology on improving perinatal health [16] and its successful integration into maternal in high-income countries like the UK, US, Canada, uptake is still low in low- and middle-income countries (LMICs) like Nigeria. This is due to limited access, connectivity issues, provider capacity, and patient trust [3,7,10]. The need to meet global targets for implementation of

digital health innovations requires concerted efforts by all stakeholders. This is even more relevant in rural settings with dearth of qualified health workers to deliver essential maternal health services [17]

For a successful implementation of remote monitoring of antenatal clients in LMICs like Nigeria, it is pertinent to understand the perceptions, acceptance, and readiness for TE-MHM among pregnant women [11]. The implementation of evidence-based strategies for TE-MHM supported by the data from users' behaviour towards technology, can support ongoing efforts at addressing health disparities caused by differential access to effective ANC, and the achievement of the Sustainable Development Goal (SDG) 3.1[18]. Findings from this study will, therefore, provide valuable insights into the enablers and barriers to digital adoption for remote maternal health monitoring, informing clients-centered, equitable and responsive interventions in Port Harcourt and areas with similar cultural and behavioural characteristics across Africa [4,10]. This study investigated critical elements (perceptions, acceptance, and readiness as well as factors associated with the readiness) that will support roll-out of digital health innovations among antenatal clients in a Nigerian tertiary health facility

Methods

Study Area

The study was carried out at the Antenatal Clinic (ANC) of the University of Port Harcourt Teaching Hospital (UPTH), Alakahia, Nigeria. UPTH is an 800-bed, multi-specialty tertiary hospital that provides comprehensive healthcare services, including maternal and child health care, to patients from Rivers State and neighbouring states [19]. The obstetrics services in the hospital cover antenatal, intrapartum, postnatal care delivered by obstetricians, midwives, nurses, and other health professionals [19]. The choice of the teaching hospital as the study site is because it is a major referral centre with diverse antenatal clientele and high case volume. This makes it an ideal setting to assess perceptions, acceptance, and readiness for digital technology–enhanced remote health services.

Study design

This study used a quantitative cross-sectional design.

Study population

The study population included pregnant women attending the antenatal clinic of the University of Port Harcourt Teaching Hospital. However, ANC attendees who were hospital staff, medical personnel, medical students, patients requiring urgent or emergency obstetric care, children below 18, women who declined to participate in the study were excluded.

Sampling size and sampling approach

The sample size will be derived using Cochran Formula [20]

$$N = \frac{Z^2 pq}{d^2}$$

Where: n = sample size; p = the population proportion [21] accepting remote monitoring (p = 13.5%); e = acceptable sampling error (e=0.05); z = standard normal deviation with z-score of 1.96 representing 95% confidence interval. Adjustment of 10% was made for possible non-response or inappropriately completed questionnaire. Systematic sampling technique with a sampling fraction of 5 applied to the daily weekday attendees present by 10am was used to recruit subjects over a period of 20 ANC days.

Data collection

The study questionnaire developed following the review of the literature on perception and acceptance as well as adoption of existing technology readiness index scale across traits such as optimism, innovativeness, insecurity and discomfort [22]. The 16-item technology readiness index (TRI) questionnaire accessed using a Likert scale (1-5), where 1 = Strongly Disagree and 5 = Strongly Agree; was supplemented questions for assessing perception and acceptance. The 16-items were aggregated under 4 domains having 4 items each - Optimism (hopeful about tech), Innovativeness (eagerness to try new tech), Discomfort (feeling uneasy with tech), and Insecurity (worrying about tech risks) and the overall TRI score [22]. The response to each item was on a 5-point Likert scale ("Strongly agree, Agree, Neutral, Disagree, strongly disagree"). Items scores were summated to derive domain scores and total TRI after scores of negatively worded scores of domains (discomfort and insecurity) were revered during computation of the TRI. The TRI was thus, computed as Optimism + Innovativeness + (6 – Discomfort) + (6 – Insecurity). Clients' proficiency in the use of common digital devices was rated as Level 1 (never tried it); Level 2 (tried it but do not feel confident); Level 3 (feel good with it); Level 4 (proficient). Ranking of the importance features to be incorporated into a digital device for remote health monitoring was done on a scale of 1 (least importance) to 5 (most important).

Questionnaire validation

The questionnaire was reviewed by experts in maternal health, digital health, and research methodology before it was pretested on a small sample of pregnant women to check for clarity, comprehension, and reliability. Feedback from the pretest test was used to refine wording, response options, and format. The internal consistency reliability of the scale was determined using the Cronbach's alpha coefficient.

Data analysis

The collected data was manually checked for completeness and accuracy before analysis using Statistical Package for Social Sciences (SPSS) version 20. The analysis involved both descriptive (frequencies, percentages, mean, standard deviation) and inferential statistics (bivariate and multivariate analyses using the generalised linear regression model). Statistical significance was set at $p \leq 0.05$.

Ethical Consideration

Ethics approvals for this study were issued by the University of Port Harcourt and the University of Port Harcourt Teaching hospital (NHREC/UPTHREC/03/2024) ethics review committees. Permission was obtained from the head of the Department of Obstetrics and Gynaecology and lead nurse at the ANC while consent was received from each participant in the study. Participation in the study was voluntary, and participants were informed that they can withdraw their participation at any point, and such action will not affect their care in the hospital

Results

All 228 questionnaires were completed and considered fit for analysis, giving a response rate of 100%.

Table 1. Demographic and background information

Variable	Category	Frequency	Percent
Age (Years)	18 - 24	44	19.3
	25 - 34	100	43.9
	35 - 44	68	29.8
	45 +	16	7.0

Level of Schooling	No formal education	56	24.6
	Primary	38	16.7
	Secondary	46	20.2
	Tertiary	88	38.6
Marital status	Single	73	32.0
	Married	118	51.8
	Divorced	25	11.0
	Widowed	12	5.3
Employment status	Unemployed	106	46.5
	Employed (part time)	68	29.8
	Employed (full time)	54	23.7
Residence	Urban	164	71.9
	Rural	64	28.1
Prior experience with digital device	Yes	213	93.4
	No	15	6.6
Self-rated skills in use of digital device*	Not a user	17	7.5
	Beginning user	26	11.4
	Average user	134	58.8
	Expert user	51	22.4
First delivery	Yes	112	49.1
	No	116	50.9
Nature of current pregnancy	Singleton (one baby)	221	96.9
	Twins (2 babies)	6	2.7
	Multiples (3 or more)	1	0.4
*Mobile, smart phones, internet			

Majority of the 228 respondents in this study were aged between 25 and 34 years (43.9%) with tertiary level of schooling (38.6%), married (51.8%) and currently unemployed (46.5%). A majority were residents in urban settlements (71.9%) and had prior experience with a digital device (93.4%) but only 22.4% consider themselves as expert users of digital device (22.4%). About half of the participants (49.1% would be experiencing delivery for the first time, with most with singleton pregnancies (96.9%).

Table 2. Score characteristics of domains and entire TRI score

Aspect	Cronbach's alpha	Mean	Standard deviation (SD)	Skewness E(SE)	Kurtosis E(SE)
Optimism	0.802	3.12	0.87	-0.07(0.16)	-0.27(0.32)
Innovativeness	0.919	3.22	0.97	-0.17(0.16)	-0.27(0.32)
Discomfort	0.915	3.12	1.00	-0.91(0.16)	-0.47(0.32)
Insecurities	0.920	3.19	1.02	-0.06(0.16)	-0.44(0.32)
TRI	0.819	3.00	0.31	1.86(0.16)	7.81(0.32)

Table 2 shows the TRI's score characteristics along the four domains of the TRI Optimism, Innovativeness, Discomfort, and Insecurities, as well as the overall TRI score. The mean ± 2SD of the scores were Optimism (3.12 ± 0.87), Innovativeness (3.22 ± 0.97), Discomfort (3.12 ± 1.00), Insecurities (3.19 ± 1.02), and TRI (3.00 ± 0.31). The statistics for skewness and kurtosis indicated that these scores did not meet the assumptions for Normal distribution.

Table 3: Perceptions and Acceptance of Technology for Remote Health Monitoring

Variable	Category	Frequency	Percent
Perception			
Usefulness of digital technology for maternal health monitoring	Not useful at all	5	2.2
	Somewhat useful	68	29.8
	Useful	27	11.8
	Very useful	101	44.3
	Extremely useful	27	11.8
Confident that use of digital technology can improve maternal health outcomes	Yes	189	82.9
	No	17	7.5
	Maybe	22	9.6
Concerned about data privacy when using technology for remote health monitoring	Not concerned at all	14	6.1
	Somewhat concerned	62	27.2
	Concerned	89	39.0
	Very concerned	42	18.4
	Extremely concerned	21	9.2

Concerned about the reliability of reading from digital technology used for remote health monitoring	Not concerned at all	12	5.3
	Somewhat concerned	49	21.5
	Concerned	96	42.1
	Very concerned	45	19.7
	Extremely concerned	26	11.4
Acceptance			
Willing to use mobile app or wearable device to monitor health during pregnancy	Yes	130	57.0
Willing to have health records captured in a database	Yes	166	72.8
Willing to have access to personal records	Yes	170	74.6
Willing to allow health care providers access to personal health records	Yes	174	76.3
Willing for personal health records to be used for health planning	Yes	165	72.4
Willing for personal health records to be used for medical research	Yes	116	50.9
Comfortable receiving medical advice through a mobile device or wearable	Not comfortable	20	8.8
	Somewhat comfortable	38	16.7
	Comfortable	72	31.6
	Very comfortable	62	27.2
	Extremely comfortable	36	15.8
Extent of trust in the information provided by health apps or digital devices	Do not trust at all	21	9.2
	Somewhat trust	63	27.6
	Trust	73	32.0
	Very much trust	51	22.4
	Completely trust	20	8.8
Likelihood of recommending remote health-monitoring technology to other pregnant women	Not likely	24	10.5
	Somewhat likely	22	9.6
	Likely	115	50.4
	Very likely	60	26.3
	Extremely likely	6	2.6

Table 3 shows the data on perception and acceptance of digital device for remote monitoring Most respondents believed that digital technology for maternal health monitoring was at least useful (67.9%), confident this will improve maternal health outcomes (82.9%) but concerned about data privacy (93.9%)

and reliability of the data (94.7%). Only 57% of respondents were willing to use wearable devices, have their records captured in a database (72.8%), willing to access personal records on electronic database (74.6%), and allow health records to be used for research (50.9%). A majority were comfortable receiving health information remotely (91.2%) and likely to recommend digital device for remote health monitoring to other pregnant women (89.5%).

Table 4. Readiness to Use Technology for Remote Maternal Health Monitoring

Variable	**Category**	**Frequency**	**Percent**
Ownership of devices	Wearable device e.g smart watch	76	33.3
	Mobile devicese.g smart phones	181	79.4
	Personal digital assistants (PDAs)	59	25.9
	Computers e.g Laptops	100	43.9
Access to internet	Always (e.g daily)	63	27.6
	Frequently (e.g weekly)	52	22.8
	Occasionally (e.g monthly)	63	27.6
	Rarely	32	14.0
	Never	18	7.9
Need additional training to use a maternal health app or device	Yes	79	34.6
	No	67	29.4
	Not sure	82	36.0
Prepared to incorporate remote health monitoring into pregnancy journey	Not prepared at all	26	11.4
	Somewhat prepared	56	24.6
	Prepared	105	46.1
	Very prepared	41	18.0
TRI Archetype	Paranoids	8	3.5
	Skeptics	206	90.4
	Pioneers	10	4.4
	Explorers	4	1.8
Proficiency in use of wearable devices e.g smartwatch	Level 1	54	23.7
	Level 2	78	34.2
	Level 3	82	36.0
	Level 4	14	6.1
Proficiency in use of mobile	Level 1	16	7.0

devices e.g smartphone	Level 2	40	17.5
	Level 3	113	49.6
	Level 4	59	25.9
Proficiency in use of computers e.g Laptops	Level 1	25	11.0
	Level 2	50	21.9
	Level 3	93	40.8
	Level 4	60	26.3

Table 4 shows readiness and the competence of pregnant women in the use of digital device for remote health monitoring. Most women had access to smart mobile phones (79.4%) but only about a quarter (27.6%) had access to regular internet services. Despite high level of ownership of smart phones, majority of the ANC clients were classified as skeptics (90.4%). Majority, however, were prepared to incorporate remote health monitoring during pregnancy (88.6%). While about a quarter of the participants were proficient (level 4) in the use of computers (26.3%) and smartphone (25.9%) with much fewer (6.1%) admitting proficiency in use of smart watches.

Table 5. Pattern of TRI Archetypes across Subgroups

Variable	**Category**	**TRI Archetype – Freq (%)**			
		Paranoids	**Skeptics**	**Pioneers**	**Explorer**
Age (Years)	18 - 24	1 (2.3)	39 (88.6)	3 (6.8)	1 (2.3)
	25 - 34	2 (2.0)	92 (92.0)	5 (5.0)	1 (1.0)
	35 - 44	4 (5.9)	61 (89.7)	1 (1.5)	2 (2.9)
	45 +	1 (6.3)	14 (87.5)	1 (1.5)	2 (2.9)
Level of Schooling	None	1 (1.8)	55 (98.2)	0 (0.0)	0 (0.0)
	Primary	0 (0.0)	36 (94.7)	2 (5.3)	0 (0.0)
	Secondary	3 (6.5)	40 (87.0)	3 (6.5)	0 (0.0)
	Tertiary	4 (4.5)	75 (85.2)	5 (5.7)	4 (4.5)
Marital Status	Single	1 (0.0)	72 (98.6)	1 (1.4)	0 (0.0)
	Married	3 (2.5)	105 (89.0)	6 (5.1)	4 (3.4)
	Divorced	5 (20.0)	18 (72.0)	2 (8.0)	0 (0.0)
	Widowed	0 (0.0)	11 (91.7)	1 (8.3)	0 (0.0)
Employment Status	Unemployed	1 (0.9)	103 (97.2)	2 (1.9)	0 (0.0)
	Employed (part time)	4 (5.9)	60 (88.2)	3 (4.4)	1 (1.5)
	Employed (full time)	3 (5.6)	43 (79.6)	5 (9.3)	3 (5.6)
Residence	Urban	4 (2.4)	149 (90.9)	7 (4.3)	4 (2.4)
	Rural	4 (6.3)	57 (89.1)	3 (4.7)	0 (0.0)

Self-rated skills in use of digital device	Not a user	0 (0.0)	17 (100.0)	0 (0.0)	0 (0.0)
	Beginning user	1 (3.8)	24 (92.3)	1 (3.8)	0 (0.0)
	Average user	0 (0.0)	129 (96.3)	5 (3.7)	0 (0.0)
	Expert user	7 (13.7)	36 (70.6)	4 (7.8)	4 (7.8)

The result of the TRI pattern across subgroups in Table 5 shows skeptics as predominant in all subgroups and this was overwhelmingly so among those with no skill in the use of technology (100%), no formal education (98.2%), Single (98.6%). Those identified as expert users of digital devices had the highest proportion of explorers (7.8%)

Table 6: Priority Activities during Remote Maternal Health Monitoring

Feature/activities	**Important ranking**	
	Mean	**Standard deviation**
Appointment booking	3.00	1.13
Tele-consulting	3.04	1.09
E-prescription	3.09	1.11
Accessing personal information	3.08	1.13
Monitoring vital signs	3.06	1.13
Self-care	3.04	1.10
General health information	3.07	1.13

Table 6. presents findings on the priority features that should be incorporated into a digital technology shows e-prescription (3.09 ± 1.11) ranking highest and appointment booking the least (3.00 ±1.13).

Table 7. Factors associated with technology readiness index

Variable	**TRI Score**	**Bivariate**		**Multivariate**	
		B(95%CI)	**P value**	**B(95%CI)**	**P value**
Age					
18-24	3.04	0.06(-0.11,0.23)	0.504	0.06(-0.11,0.23)	0.494
25-34	3.03	0.05(-0.11,0.21)	0.576	0.06(-0.10,0.22)	0.469
35-44	2.97	-0.01(-0.17,0.16)	0.915	0.003(-0.16,0.17)	0.968
45+	2.98	-	-	-	-
Location					
Urban	3.03	0.07(-0.02,0.16)	0.125	-0.03(-0.07,0.12)	0.560

Rural	2.96	-	-	-	-
Marital status					
Single	3.00	0.02(-0.16,0.21)	0.810	0.04(-0.15,0.23)	0.714
Married	3.04	0.07(-0.11,0.25)	0.455	0.05(-0.13,0.23)	0.593
Divorced	2.91	-0.07(-0.27,0.14)	0.531	-0.08(-0.28,0.13)	0.477
Widowed	2.97	-	-	-l	-
Employment status					
Unemployed	2.97	-0.10(-0.20, 0.00)	0.040	-0.13(-0.24, -0.01)	0.033
Employed (part time)	3.01	-0.06(-0.17,0.04)	0.249	-0.05(-0.17,0.07)	0.400
Employed (full time)	3.08	-	-	-	-
Level of Schooling					
No formal education	2.98	-0.07(-0.18,0.03)	0.157	-0.004(-0.12, -0.11)	0.950
Primary	2.99	-0.07(-0.19,0.04)	0.218	-0.06(-0.19,0.06)	0.328
Secondary	2.97	-0.09(-0.20,0.02)	0.101	-0.07(-0.19,0.04)	0.186
Tertiary	3.06	-	-	-	-
Prior experience with digital technology					
Yes	3.01	-	-	-	-
No	2.98	-0.03(-0.19,0.13)	0.733	0.03(-0.15,0.20)	0.775
Rated skills in the use of digital technology					
Not a user	2.92	-0.14(-0.31,0.03)	0.100	-0.14(-0.32,0.04)	0.117
Beginner	3.03	-0.03(-0.17,0.12)	0.719	-0.03(-0.17,0.12)	0.691
Average user	3.00	-0.06(-0.15,0.04)	0.269	-0.05(-0.15,0.05)	0.307
Expert user	3.06	-	-	-	-

Table 7 presents findings from the bivariate and multivariate generalized linear regression analyses examining the association between background characteristics of the respondents and their readiness for digital technology for remote health monitoring during pregnancy. Respondents who were unemployment had significantly lower TRI scores compared with those with full time employment from the bivariate (B=-0.1, 95%CI: -0.20, -0.00; p = 0.040) and multivariate (B = -0.13, 95% CI: -0.24, -0.0; p = 0.033) analyses.

Discussion

This study assessed the perceptions, acceptance, and utilization of technology-enhanced remote maternal health monitoring (TEMHM) among pregnant women and found that most respondents had a positive perception, acceptance, and readiness to adopt digital technologies for remote monitoring during pregnancy.

A significant proportion (82.9%) believed that TEMHM could improve maternal health outcomes. This finding aligns with the Technology Acceptance Model (TAM), which posits that perceived usefulness is a key determinant of technology adoption [23]. The optimism and innovativeness dimensions of the Technology Readiness and Acceptance Model (TRAM) were evident, with mean scores of 3.12 and 3.22 respectively, indicating a moderate level of enthusiasm for digital health tools. However, concerns regarding data privacy, system reliability, and effectiveness were prevalent. These concerns are consistent with earlier findings that fears around data security and reliability may hinder technology adoption, especially in populations with limited digital literacy [24].

The discomfort and insecurity dimensions of TRAM further explain these psychological barriers. Nonetheless, the positive perception is also consistent with previous studies [25, 26], which found that pregnant women appreciate digital tools for enhancing communication with healthcare providers and offering real-time health feedback. Although remote healthcare is often valued for its role in avoiding infectious diseases, reducing costs, and bridging geographic barriers, many participants still perceived in-person consultations to provide more accurate diagnoses, better examinations, and improved treatments [27]. This preference reflects cultural inclinations toward personal engagement, which TRAM may not fully address. This underscores the need for culturally sensitive strategies to improve the perception and acceptance of TEMHM.

The acceptance rate of TEMHM was moderate, with 57% of participants willing to use mobile apps or wearable devices for monitoring. This aligns with the Unified Theory of Acceptance and Use of Technology (UTAUT), which identifies performance expectancy and social influence as key drivers of technology acceptance [27]. Additionally, the high willingness of respondents to have their health records stored (72.8%) and accessed by healthcare providers (76.3%) suggests a level of trust in institutional healthcare systems, provided data privacy is assured.

While this study did not find a significant relationship between age, prior digital experience, and acceptance of technology, existing literature suggests that age can be a barrier to digital health adoption [28]. However, the absence of significant associations between demographic variables (age, education, marital status) and the Technology Readiness Index (TRI) suggests that other factors, such as exposure to technology and healthcare provider encouragement, may play more influential roles. This finding supports the Social Cognitive Theory (SCT), which emphasizes the role of observational learning and self-efficacy in technology use.

Utilization of digital devices which can be adapted for TEMHM was relatively low, with mobile phones being the most frequently used platform (79.4%), followed by wearable devices (33.3%) and personal digital assistants (25.9%). This is expected, given the high smartphone penetration in Nigeria and the relative affordability of mobile apps compared to wearables or PDAs. The preference for mobile-based solutions mirrors global trends due to their portability, computational features, and versatility [29].

Clients reporting higher levels of proficiency in the use of digital devices were more likely to exhibit characteristics of explorers in the TRI archetypes who are more receptive and eager to adopt technology for remote maternal health monitoring. The established positive influence of digital skills on technology acceptance [30, 31] (Davis, 1989; Venkatesh et al., 2003), suggest that enhancing digital skills of antenatal clients could be essential strategy for promoting adoption of remote technology for health monitoring and improving pregnancy outcomes.

Respondents identified several valued functionalities, including appointment scheduling, teleconsulting, and vital sign monitoring, suggesting a preference for integrated digital tools in antenatal care. However,

barriers such as limited access to wearable devices, unreliable internet connectivity, and the need for training (reported by 34.6% of respondents) limited utilization. These systemic and structural challenges, which may not be fully explained by SCT, highlight the need for context-specific solutions.

Limitations of the Study

Some limitations that should be considered when interpreting the study findings were: The study was limited in geographical scope to the University of Port Harcourt Teaching Hospital (UPTH), a tertiary institution in an urban setting, which may not represent pregnant women in rural or primary/secondary healthcare settings. Nevertheless, UPTH was selected for its diverse patient population and high case volume. Furthermore, the application of systematic sampling approach may have introduced sampling bias through the exclusion of women who attend ANC irregularly, potentially skewing the sample toward more health-conscious individuals and underestimating barriers faced by less frequent users. Finally, the cross-sectional nature of the study design precludes causal inference and limits the ability to observe changes in perception or technology use over time. Future longitudinal studies are recommended to track evolving attitudes across pregnancy stages or subsequent pregnancies.

Implications of the Study

The findings from this study carry important implications for maternal healthcare delivery in Nigeria and other low- and middle-income countries (LMICs) as Nigeria accounts for approximately 12% of global maternal deaths, with over 60% of women failing to receive the recommended four or more ANC visits [1,2,6]. Inadequate maternal monitoring contributes to preventable complications such as eclampsia and preeclampsia, which account for about 40% of maternal deaths in Nigeria [1]. Similarly, postpartum hemorrhage and other complications requiring timely intervention [8] including preterm births and neonatal mortality, are often linked to undiagnosed maternal conditions [9].

The limited use of digital tools hampers the timely identification and management of high-risk pregnancies. While Nigeria's National Digital Health Strategy seeks to improve technology adoption, weak implementation due to low awareness, infrastructural deficiencies, and funding constraints persists [11,13] especially, in relation to the use of digital technology for remote antenatal monitoring.

The lack of significant associations with demographic factors suggests that technology readiness may be relatively uniform among pregnant women attending ANC in tertiary healthcare setting. However, positive perceptions and moderate acceptance indicate a willingness to adopt TEMHM if key barriers such as poor infrastructure, privacy concerns, and cultural preferences are addressed. Designing user-friendly, culturally appropriate, and privacy-assured tools in local languages could improve uptake. Through facilitating broader access to TEMHM, this study contributes to efforts to reduce Nigeria's maternal mortality ratio of 512 per 100,000 live births, advancing toward the Sustainable Development Goal 3.1 target of less than 70 by 2030 [18].

Conclusion

This study provides valuable insights into the perceptions, acceptance, and utilization of technology-enhanced maternal health monitoring among pregnant women at a Nigerian tertiary hospital. The findings demonstrate a generally positive perception and moderate acceptance, yet low utilization; largely influenced by privacy concerns, digital illiteracy, limited access to devices, and infrastructural challenges. Opportunities for enhanced adoption rests on user-centered design of digital tools. By addressing knowledge gaps and barriers, this research contributes to the global discourse on digital maternal health and supports the development of equitable, client-centered, contextually appropriate technology-driven healthcare solutions in low-resource settings.

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