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Original Research Article

Telemedicine and mobile clinical entrepreneurship as catalysts for healthcare access in Benin city, Nigeria: a sequential explanatory mixed-methods study

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ABSTRACT

Background: Healthcare access in Benin City, Nigeria is constrained by inadequate infrastructure, workforce shortages, and high out-of-pocket costs. Telemedicine and mobile clinical entrepreneurship represent viable delivery innovations, yet their comparative effectiveness and sustainability remain insufficiently understood.
Methods: A sequential explanatory mixed-methods design was employed. Quantitative data were collected from 287 adults using a structured questionnaire and analysed with descriptive statistics, chi-square tests, ANOVA, and logistic regression. Qualitative data were obtained through in-depth interviews with 28 key informants and analysed thematically; findings were integrated at the interpretation stage.
Results: Mobile clinics demonstrated stronger access outcomes, with greater reductions in travel time (66.7% vs 53.3%, $p<0.001$) and waiting time (71.1% vs 46.7%, $p=0.013$), alongside higher satisfaction (mean 3.5 vs 2.9). Adjusted odds of reporting travel-time reduction were higher for mobile clinic users (AOR 14.8, 95% CI 5.9 to 37.1) than telemedicine users (AOR 7.3, 95% CI 2.9 to 18.6). Telemedicine showed a comparative advantage for chronic disease management. Awareness remained low, with 75% of respondents unaware of any telemedicine service. Key barriers included poor infrastructure, limited training, and low insurance coverage.
Conclusions: Both models improve healthcare access through complementary mechanisms. Mobile clinics effectively address geographic barriers while telemedicine supports chronic care continuity. Infrastructure investment, clinical training, and sustainable financing are critical prerequisites for long-term integration.

Keywords: Benin City, Digital health, Healthcare access, Mobile clinical entrepreneurship, Mobile clinics, Telemedicine

INTRODUCTION

Access to quality healthcare remains a critical public health challenge in Nigeria. The health system faces inadequate infrastructure, chronic underfunding, professional shortages, and weak governance that together severely constrain service delivery.[1,2] Only approximately 20% of Nigeria's 34,076 primary health centres were fully functional as of 2022, and the country ranked 187th of 191 nations in WHO health system performance.[3,4] With approximately 40,000 practising doctors serving 220 million people (roughly 4 per 10,000), Nigeria falls far below WHO recommendations.[5]

Benin City, capital of Edo State, has approximately 1.9 million residents and is growing at 3.5% annually. The city faces long waiting times, high transport costs, geographically concentrated facilities, and out-of-pocket

spending that accounts for 75.1% of total health expenditure.[6,7] These barriers disproportionately affect low-income and peri-urban communities, contributing to delayed diagnoses and persistently poor health outcomes.

Telemedicine uses digital technologies to enable remote consultations, patient monitoring, and health data exchange without physical attendance at a facility.[8,9] The WHO Global Strategy on Digital Health 2020 to 2025 recognises it as a core component of health system strengthening in low- and middle-income countries (LMICs).[10] In Nigeria, teleconsultation and mobile health platforms have shown capacity to reduce burdens on facility-based care and expand access to specialist services.[11] Mobile clinical entrepreneurship, which involves deploying mobile clinics and outreach units to bring essential services directly to underserved populations, has demonstrated similar utility across sub-Saharan Africa. Over 12,000 individuals were treated in three months through mobile outreach clinics in Niger, and improved health-seeking behaviour has been reported in rural South Africa following mobile clinic engagement.[12,13]

Despite this promise, both models face significant implementation challenges: power outages, poor connectivity, low digital literacy, absent regulatory frameworks, high start-up costs, and limited multi-stakeholder collaboration.[14-17] This study examines the comparative roles of telemedicine and mobile clinical entrepreneurship in enhancing healthcare access in Benin City, with the aim of contributing evidence for policy and practice in LMIC settings.[18]

METHODS

Study design and setting

A sequential explanatory mixed-methods design was used, comprising a dominant quantitative phase followed by a qualitative phase to contextualise statistical findings.[19,20] The quantitative strand took priority (QUAN + qual notation), with integration at the interpretation stage.[21] The study was guided by a pragmatist philosophical stance and conducted over six months (February to August 2025) in Benin City, Edo State, across three Local Government Areas: Oredo, Egor, and Ikpoba-Okha.[22]

Participants and sampling

Quantitative phase: Stratified random sampling ensured representation across healthcare setting (public versus private), geographic zone (urban versus peri-urban), and service exposure group. Using a formula for comparing two independent proportions[23] (P1=0.67, P2=0.53; alpha=0.05; power=0.80), the minimum sample was 246; 300 questionnaires were distributed to allow for a 20% non-response rate. Of 293 returned, 287 met full inclusion criteria (response rate 95.7%).

Qualitative phase: Purposive sampling recruited 30 key informants with direct experience in telemedicine, mobile clinic operations, or health system governance. Participants included public health physicians (n=6), registered nurses (n=9), community pharmacists (n=4), telemedicine entrepreneurs (n=5), mobile clinic operators (n=3), and health policymakers (n=3). Recruitment continued until theoretical saturation was reached.[24] Two pilot transcripts were excluded, leaving 28 for analysis.

Data collection

Quantitative: A structured questionnaire developed for this study incorporated items adapted from the Technology Acceptance Model (TAM), the Health Belief Model (HBM), and the Patient Satisfaction with Telemedicine Scale.[25-27] Five sections covered sociodemographics, telemedicine utilisation, mobile clinic utilisation, implementation barriers, and willingness to pay (67 items total, five-point Likert scale). Content validity was established by five expert reviewers (Content Validity Index $\geq$0.78).[28] Pilot testing (n=30) yielded Cronbach's alpha of 0.77 to 0.81 across subscales, exceeding the recommended threshold of 0.70.[29]

Qualitative: A semi-structured interview guide comprising nine open-ended anchor questions addressed service impact, sustainability challenges, infrastructure barriers, and policy recommendations. Interviews lasted 45 to 75 minutes, were audio-recorded with participant consent, transcribed verbatim, and returned to participants for member checking.

Data analysis

Quantitative: Data were analysed using IBM SPSS version 27. Descriptive statistics, chi-square tests, and one-way ANOVA examined group differences. Binary logistic regression modelled associations between service exposure and each access outcome, controlling for age, sex, education, income, and residential zone. Model fit was assessed with the Hosmer-Lemeshow test and discrimination with the area under the ROC curve.

Qualitative: Thematic analysis followed the six-phase framework of Braun and Clarke.[24] NVivo 14 (QSR International) managed coding. Independent dual coding of a 20% subsample yielded Cohen's kappa=0.82, indicating strong inter-rater agreement.[31] Integration of quantitative and qualitative findings used a contiguous presentation strategy, with an integration matrix mapping themes to corresponding quantitative variables.[32,33]

Ethical considerations

Ethical approval was obtained from the Health Research Ethics Committee of the University of Benin Teaching Hospital (UBTH/EC/2023/042) and the Edo State Ministry of Health Research Ethics Committee (ESMOH/REC/2023/11). All participants provided

written informed consent prior to enrolment. Data were anonymised throughout, and audio recordings will be destroyed three years after study completion in accordance with Nigerian health research ethics guidelines.[34]

RESULTS

Of 300 questionnaires distributed, 287 met inclusion criteria (response rate 95.7%). Table 1 summarises participant sociodemographic characteristics; the sample was evenly split by sex and residential zone.

Table 1: Sociodemographic characteristics of survey participants (n=287).

Characteristic	Number	Percent	Notes
Sex			
Male	141	49.1	
Female	146	50.9	
Age group (years)			
18-29	82	28.6	
30-44	109	38.0	
45-59	67	23.3	
60+	29	10.1	
Residential zone			
Urban (Oredo LGA)	144	50.2	
Peri-urban (Egor /Ikpoba-Okha)	143	49.8	
Education			
No formal education	18	6.3	
Primary	41	14.3	
Secondary	112	39.0	
Tertiary	116	40.4	
Service exposure group			
Telemedicine users	30	10.5	Used >=1 teleconsultation, past 12 months
Mobile clinic users	45	15.7	Attended >=1 mobile clinic visit, past 12 months
Non-users of either service	212	73.9	

LGA=Local Government Area. Percentages may not sum to 100.0 due to rounding

Mobile clinic users reported greater reductions in travel time (66.7% vs 53.3%, p<0.001) and waiting time (71.1% vs 46.7%, p=0.013) compared to telemedicine users (Table 2). Logistic regression confirmed that both service models were independently associated with travel-time reduction, with stronger effects for mobile clinic users (AOR 14.8) than telemedicine users (AOR 7.3).

Overall satisfaction was highest among mobile clinic users (60% satisfied; mean score 3.5), followed by traditional care attendees (50%; mean 3.1) and telemedicine users (40%; mean 2.9). Between-group differences were statistically significant (one-way ANOVA, p<0.001; Table 3).

Among 52 service operators, mobile clinic operators accessed government contracts (61.5%) and NGO funding (73.1%) more frequently than telemedicine operators (26.9% and 46.2% respectively; Table 4). Insurance penetration remained minimal across both models, below 12% in each case.

Infrastructure barriers (unreliable internet and electricity) were the dominant telemedicine challenge (59.9%), and were more than twice as prevalent in peri-urban zones than urban zones (72% vs 34%, chi-square=44.7, p<0.001). Staff training gaps were the primary mobile clinic barrier (55.1%). Low awareness affected both models, with 75% of respondents unaware of any telemedicine service (Table 5). Cultural resistance was substantially lower among respondents who had actual experience with either service compared to non-users.

Provider credential visibility was the most important trust factor for telemedicine adoption (68%), while mobile clinic adoption was most strongly influenced by live service demonstration (82%) and community leader endorsement (78%; Table 6). Stratified analysis confirmed significant urban-peri-urban heterogeneity in the effectiveness of different communication approaches.

Among 66 health professionals surveyed, pharmacists showed the highest entrepreneurial motivation (67% citing income potential), nurses responded most strongly to training provision (68%), and physicians were most deterred by equipment access barriers (72%). A business and financial management skills gap was identified universally across all professional cadres (62%; Table 7).

Table 2: Impact of service exposure group on self-reported travel and waiting time reduction.

Indicator	Telemedicine Users (n=30)	Mobile Clinic Users (n=45)	Non-Users (n=212)	P value
Reduced travel time, n (%)	16 (53.3)	30 (66.7)	25 (11.8)	<0.001
Reduced waiting time, n (%)	14 (46.7)	32 (71.1)	19 (9.0)	0.013
Willing to adopt for time-saving, n (%)	19 (63.3)	37 (82.2)	59 (27.8)	<0.001
Adj. OR for travel reduction (95% CI)	7.3 (2.9-18.6)	14.8 (5.9-37.1)	Reference	<0.001

Adj. OR=adjusted odds ratio from binary logistic regression, controlling for age, sex, education, income, and residential zone. p-values from Pearson's chi-square test for prevalence comparisons

Table 3: Patient satisfaction by service modality.

Service model	Very satisfied, N (%)	Somewhat satisfied, N (%)	Neutral, N (%)	Dissatisfied, N (%)	Mean
Telemedicine (n=30)	3 (10.0)	9 (30.0)	9 (30.0)	9 (30.0)	2.9
Mobile clinics (n=45)	9 (20.0)	18 (40.0)	9 (20.0)	9 (20.0)	3.5
Traditional care (n=212)	32 (15.1)	74 (34.9)	64 (30.2)	42 (19.8)	3.1

Mean score on a 1 to 5 Likert scale. Between-group differences significant at p<0.001 (one-way ANOVA)

Table 4: Reported sustainability mechanisms among service operators (n=52).

Sustainability mechanism	Telemedicine operators, N (%)	Mobile clinic operators, N (%)	P value
User fees as primary funding	10 (38.5)	10 (38.5)	1.000
Government contracts	7 (26.9)	16 (61.5)	0.008
NGO/donor funding	12 (46.2)	19 (73.1)	0.041
Insurance partnerships	3 (11.5)	2 (7.7)	0.638
Hybrid/corporate wellness model	6 (23.1)	3 (11.5)	0.293

Operators could endorse multiple mechanisms; percentages do not sum to 100. Fisher's exact test used where cell counts <5

Table 5: Implementation barriers by service model (survey respondents, n=287).

Barrier	Telemedicine, N (%)	Mobile clinic, N (%)	Chi-square (df=1)	P value
Low awareness	207 (72.1)	172 (59.9)	8.1	0.004
Infrastructure (internet/power)	172 (59.9)	105 (36.6)	27.4	<0.001
Staff training gaps	75 (26.1)	158 (55.1)	42.6	<0.001
Cultural/trust resistance	115 (40.1)	86 (30.0)	5.8	0.016
Affordability/cost	130 (45.3)	92 (32.1)	9.0	0.003

Respondents could endorse multiple barriers; percentages are of total N=287

Table 6: Trust-building factor importance by service model.

Trust factor	Telemedicine % very/extremely important	Mobile clinic % very/extremely important	P value
Provider credential visibility	68	55	0.042
Community leader endorsement	32	78	< 0.001
Live service demonstration	51	82	< 0.001
Pricing transparency	63	47	0.011
Integration with religious/community organisations	44	61	0.008

P values from chi-square tests comparing proportions endorsing 'very important' or 'extremely important' between service models.

Table 7: Professional adoption factors by cadre among healthcare professionals (n=66).

Motivating/deterring factor	Doctors (n=18), %	Nurses (n=36), %	Pharmacists (n=12), %	P value
Income potential as primary motivation	45	38	67	0.048
Scheduling flexibility as motivation	28	55	42	0.047
Equipment access as key barrier	72	35	25	0.001
Training availability as prerequisite	33	68	50	0.015
Business/financial skills gap	61	64	58	0.841

The business skills gap item showed no significant between-group difference (p=0.841), indicating a universal need irrespective of professional cadre.

Figure 1 shows that 75% of respondents are unaware of telemedicine services, while only 25% are aware, indicating a substantial awareness gap. This suggests that low awareness is a major barrier to telemedicine adoption, directly limiting its utilization. The finding implies that despite the potential of telemedicine to improve healthcare access, its impact remains minimal

due to inadequate dissemination of information and public sensitization.

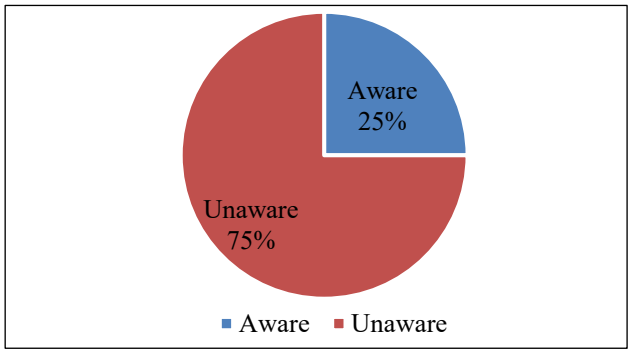

Figure 1: Awareness and utilization of telemedicine.

The Figure 2 indicates that 60% of users are satisfied with mobile clinic services (20% very satisfied and 40% somewhat satisfied), while 40% are neutral or dissatisfied. This suggests that mobile clinics are generally well-received and effective in delivering healthcare services. However, the relatively high proportion of neutral/dissatisfied users highlights existing service gaps, possibly related to quality, consistency, or resource availability.

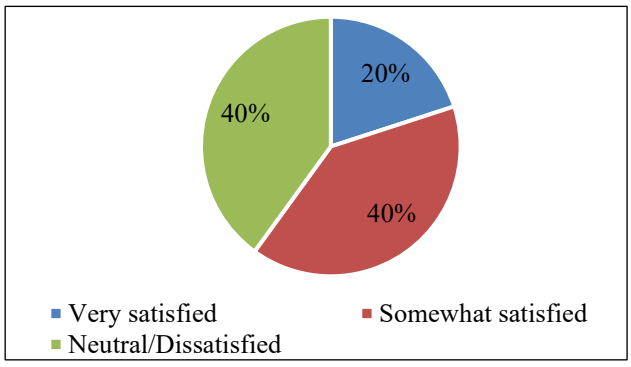

Figure 2: User satisfaction with mobile clinics.

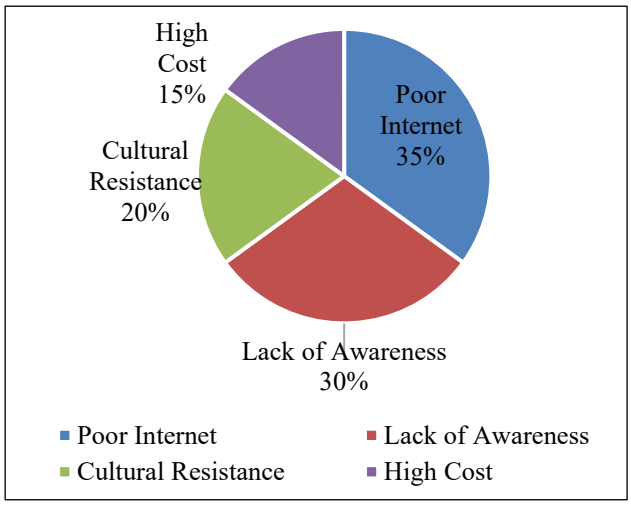

Figure 3: Obstacles to telemedicine adoption.

The Figure 3 reveals that the primary barrier to telemedicine adoption is poor internet connectivity (35%), followed by lack of awareness (30%), cultural resistance (20%), and high cost (15%). This indicates that infrastructural and informational barriers are the most significant constraints, outweighing economic and cultural factors. The findings emphasize that improving digital infrastructure and increasing public awareness are critical to enhancing telemedicine uptake (Figure 3).

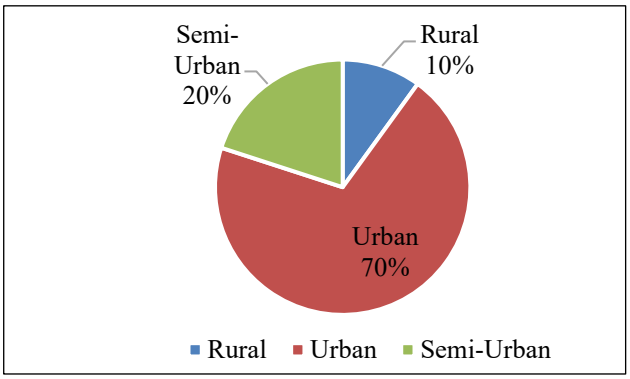

Figure 4: Telemedicine utilization by location.

The Figure 4 reveals a significant concentration of telemedicine usage in urban areas, which account for 70% of total utilization. In contrast, semi-urban and rural locations represent a much smaller share of the market at 20% and 10% respectively, indicating that despite the potential benefits for remote healthcare, adoption remains heavily skewed toward city centers (Figure 4).

DISCUSSION

This study provides integrated evidence on telemedicine and mobile clinical entrepreneurship in a Nigerian urban context. Mobile clinics outperformed telemedicine in reducing travel and waiting time burdens, consistent with the view that physical proximity to care is a stronger access determinant than digital reach when infrastructure quality is low.[35] The regression-controlled effect sizes (mobile clinics: AOR 14.8; telemedicine: AOR 7.3) extend prior descriptive literature with quantitatively modelled estimates for Benin City. Qualitative findings identified scheduling irregularity as the primary factor attenuating mobile clinic benefit, suggesting that logistics management and fixed-schedule operation represent a higher-yield improvement target than further technology investment for this model.

Connectivity-related consultation disruptions represent a form of access degradation that has received insufficient attention in the literature. Existing telemedicine quality frameworks, largely developed in high-income settings, do not adequately capture interrupted consultation episodes as patient experience outcomes.[36] This study provides grounding for incorporating connectivity stability metrics into LMIC-appropriate quality assessment tools. Mobile clinics' higher overall

satisfaction (60% vs 40%) replicates findings from across sub-Saharan Africa where patient preference for in-person care consistently limits teleconsultation adoption.[37] The identified mechanism of care continuity fragmentation, arising from the absence of electronic health record integration, is modifiable and represents a specific, actionable intervention target. Telemedicine's comparative advantage for chronic disease management (68% NCD satisfaction) is consistent with trial evidence from Kenya and South Africa demonstrating non-inferiority for established patient-provider relationships.[35,38]

Funding fragility, characterised by NGO dependency, minimal insurance penetration, and limited government recurrent expenditure, mirrors patterns documented across West African telemedicine programmes.[39,40] The emergence of hybrid corporate-community cross-subsidy models is a notable finding: only 23% of telemedicine operators currently use this approach, indicating significant scale-up potential. This model aligns with social entrepreneurship principles in which mission and market co-exist productively rather than in tension. The finding that cultural resistance was lower among respondents with actual service experience supports the trialability construct of Innovation Diffusion Theory: low-risk exposure through free demonstration sessions is likely to reduce resistance more effectively than awareness campaigns alone. The peri-urban concentration of infrastructure barriers (72% vs 34% urban) has direct implications for equitable programme targeting.

Distinct trust pathways were identified: telemedicine adoption depends primarily on epistemic trust (provider credential verification), while mobile clinic adoption relies on social trust (community leader endorsement and peer validation). These findings extend the Health Belief Model's cues-to-action construct by specifying mechanisms that differ importantly between technology-mediated and in-person service models, and that require correspondingly distinct communication strategies.[40] The universal business management skills gap identified across all professional cadres (62%) is an immediately actionable finding: integrating health enterprise management training into continuing professional development curricula for nurses, pharmacists, and physicians would address the gap identified across all groups.

This study has several limitations worth noting. The cross-sectional design precludes causal inference. The sample was confined to Benin City and may not generalise to rural settings or other Nigerian states. Self-reported outcomes are subject to recall and social desirability bias. The operator survey (n=52) had limited power for subgroup analysis. Future research should use longitudinal cohort designs with rural comparators to strengthen causal evidence and generalisability.

CONCLUSION

Both telemedicine and mobile clinical entrepreneurship can meaningfully improve healthcare access in Benin City, but each model operates through distinct mechanisms and serves different access needs. Mobile clinics are more effective at reducing travel and waiting time burdens and achieving higher population satisfaction, particularly for maternal and child health and preventive care. Telemedicine offers scalable advantages for chronic disease monitoring and specialist follow-up in areas with adequate connectivity. A deliberate policy strategy of complementarity, rather than competition, between the two models is warranted and supported by this evidence.

Recommendations

For policymakers, priorities include developing a national telemedicine regulatory framework covering licencing, data protection, and reimbursement through the National Health Insurance Authority; expanding broadband infrastructure in peri-urban wards; establishing a recurrent government budget line for mobile clinic services; and creating enabling conditions for hybrid corporate-community cross-subsidy models. For practitioners, mobile clinic operators should adopt fixed, publicly communicated schedules and invest in community engagement, while telemedicine platforms should prioritise electronic health record integration as a foundational feature. Nurse-pharmacist collaborative mobile clinic models should be piloted as a structurally viable service expansion pathway. For researchers, longitudinal cohort studies, cost-effectiveness analyses, and rural comparator studies are needed to build the causal and economic evidence base.

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Ethical approval: The study was approved by the Health Research Ethics Committee of the University of Benin Teaching Hospital (UBTH/EC/2023/042) and the Edo State Ministry of Health Research Ethics Committee (ESMOH/REC/2023/11)

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