

BARRIERS AND FACILITATORS TO NURSE-LED MATERNAL HEALTH INTERVENTIONS IN RURAL AND URBAN HEALTHCARE SETTINGS

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Abstract

Nurse-led maternal health interventions have become increasingly important in addressing workforce shortages, improving antenatal care continuity, and strengthening maternal health service delivery across diverse healthcare settings. This study examined the barriers and facilitators influencing the implementation of nurse-led maternal health interventions in rural and urban healthcare facilities, with particular attention to the role of digital health tools. A convergent mixed-methods design was employed, integrating retrospective clinical performance data from 12 healthcare facilities with qualitative insights from 40 nurses and 10 maternal health administrators. Quantitative indicators included antenatal care attendance, follow-up completion, digital tool utilization, postnatal contact, and referral documentation completeness. Qualitative data were analyzed thematically to identify contextual, organizational, and technological factors shaping implementation outcomes. The findings revealed that urban facilities performed better across all measured indicators, particularly in digital tool utilization and referral documentation, largely due to stronger infrastructure and institutional support. In contrast, rural facilities experienced greater challenges related to connectivity instability, limited technical resources, staff shortages, and patient access barriers. Training adequacy, managerial support, perceived ease of use, low-bandwidth tools, and nurse-patient communication emerged as key facilitators of successful adoption. However, workload pressure and poor system integration reduced nurses' willingness and ability to sustain digital practices. Overall, the study demonstrates that nurse-led maternal health interventions can improve service continuity when supported by context-sensitive digital design, practical training, workflow integration, and sustained institutional investment. The findings highlight the need for rural-specific implementation strategies that address infrastructural inequities while ensuring that digital tools reduce, rather than increase, the burden on frontline nurses.

Keywords: Nurse-Led Care; Maternal Health; Digital Health; Rural Healthcare; Antenatal Care

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INTRODUCTION

A lack of competent health professionals has been a constraint and given the need for strategic delegation of care to nurses and midwives, existing human resources have been used to the best of their ability (Glenton et al., 2013). So this "task-shifting" is based on the rationale to fill that gap in the service provision and thereby enable them to assume responsibility for maternal health interventions without external support. This delegation has great promise, however, it comes with the caveat that it is effective when tackling complex patterns of systemic barriers and locating key enabling factors in different types of geographical contexts, ranging from remote rural to crowded urban settings (Essendi et al., 2015; Munabi-Babigumira et al., 2017). The increased role of nurses in rural areas may be more challenging due to structural deficiencies as well as the high levels of concentrated poverty and access disparities, whereas urban health care settings may create other challenges such as access disparities and high levels of concentrated poverty (Essendi et al., 2015; Kemei & Etowa, 2021; Nwannunu, 2025). This is crucial in developing nurse-led health care models that would impact maternal health outcomes in a sustainable way within the context of these determinants (Nwannunu, 2025; Verma & Mukherjee,

2020). Furthermore, digital messaging platforms are a new facilitator which can help tackle these geographical inequalities by increasing antenatal attendance and ensuring access to critical education messages. Many of these mobile health (mHealth) solutions, such as SMS, voice messaging, and programmed apps, are scalable and can connect patients with nurses, particularly in remote areas where physical distance and mobility are also significant issues, especially where there is limited access (Misago et al., 2023; Wagnew et al., 2018). These technology-based interventions can promote adherence to recommended antenatal schedules and promote the detection of potential complications at the earliest opportunity, improving overall maternal health outcomes (Mishra et al., 2023; Chowdhury et al., 2019). Text reminders for appointments have been proven to increase attendance at prenatal and postnatal visits, even when there are not enough staff to do so in person (Chowdhury et al., 2019; Feroz et al., 2017). Digital platforms can go beyond just reminders, providing mothers with personalized health information, advice, and even direct support, enabling them to be more proactive in their health care and feel more engaged with their healthcare providers (Lee et al., 2015;

Misago et al., 2023; Prihatini, 2025). However, the success of such technology is not assured, as there are various challenges and barriers to overcome, such as network connectivity, pricing of devices and data, as well as digital literacy among the target audience (Till et al., 2023; Prihatini, 2025; (22793741) et al., 2025). The design of these platforms needs to be deliberately robust, low-bandwidth and culturally appropriate in rural contexts where infrastructural limitations frequently include poor electricity access, and limited internet connectivity (Timbla et al., 2023; (22793741), 2025). Additionally, the use of digital tools among the nursing staff is dependent on their own institutional obstacles, such as role overload, lack of technical training and heavy workloads (Bimerew, 2024; Munabi-Babigumira et al., 2017). The implementation of new digital workflows could unintentionally pose a cognitive load for practitioners who are already facing complex clinical demands, if not supported and trained. (Bimerew, 2024; Prihatini, 2025). Hence, digital health is not simply a replacement for physical infrastructure and a systematic approach should be adopted while also taking into account the existing capacity of the health workforce in technology implementation (Prihatini, 2025; Till et al., 2023). Engaging nurses, community health workers and mothers in the co-developed

process can ensure that mothers' needs are addressed and that digital tools do not place additional strain on the already stretched system (Misago et al., 2023; Till et al., 2023). Moreover, the institutionalization of these digital interventions needs to consider data privacy and security as well, especially in the context of sensitive maternal health work, in order to establish trustworthiness to ensure regular users' engagement. For maximum sustainability, longitudinal evaluations need to be integrated with the deployment of these technologies, and should be refined as new data from the field informs the refinement of patient engagement metrics throughout the process. In conclusion, the integration of technology to support nurse-led healthcare services must be balanced with the practicalities of clinical practice in order to provide an effective and efficient service, ensuring that the technology does not replace nurses and healthcare workers, but enhances their roles and responsibilities (22793741) et al., 2025; Bimerew, 2024; Prihatini, 2025). To do this, health systems must establish an “extrinsic ecosystem” that focuses on the importance of providing the right infrastructure and specialized technical support for informatics, so as to reduce the systemic “noise” (Koch et al., 2008) negatively affecting front line efficiency. Further, systems need to be user-friendly and cognitively light for

frontline staff as digital tools become part of the institutions' processes (Kessel et al., 2021). In addition, it is essential to build capacities of the staff by organizing specific capacity development interventions to avoid creating further stressors for them when taking up digitalization (Charanthimath et al., 2021). In addition, these digital adaptation kits can be incorporated into the existing health information systems, enhancing efficiency in healthcare provision and supporting healthcare professionals in clinical decisions, while also simplifying data collection for future longitudinal studies, lessening the workload for healthcare workers (Alemneh et al. 2024; Nkangu et al. 2025). These can be achieved by integrating competency-oriented digital literacy initiatives into their delivery, which leverage digital assessment tools such as eHEALS and TIGER to measure and track the level of competence. These programs should be embedded in a broader package of care that is harmonized and compatible with local policy and institutional frameworks to maximize impacts (Capasso et al., 2024; Salam et al., 2014). Also, cloud-based monitoring systems can improve accountability, and provide supervisors with clinical help when needed, even in the face of staff shortages.

METHODOLOGY

The study used a mixed-methods research design, combining quantitative data on clinical performance indicators with qualitative data from semi-structured interviews with nursing staff and maternal health administrators (Arab et al., 2025; Nyante et al., 2024). A convergent parallel mixed methods approach was used in this study, in which both quantitative and qualitative data were collected and analyzed at the same time and appropriate triangulation of the results across both data types was warranted in investigating the multiple factors influencing the use of digital health in the clinical practice of a front-line nurse in a maternity nursing care unit. The quantitative part used retrospective clinical performance data from EHRs of twelve strategically selected health care facilities (six urban and six rural) to ensure a balanced representation of health care facilities in terms of their infrastructural capacities and the characteristics of patients. The performance indicators analyzed (attendance at antenatal care, follow-up from the appointments, and use of digital tools) enabled identification of discrepancies in performance by geographic region and technological support available, and a mapping of the comparative effectiveness of the existing digital interventions in different operational

settings. To complement this, semi structured interviews were held with 40 nursing staff and 10 maternal health administrators who were purposefully sampled, covering a range of professional levels, years of clinical experience, and digital literacy among the interviewees. The interviews focused on the constructs of the Consolidated Framework for Implementation Research, reflecting the specific decision to systematically examine constructs including inner setting organizational readiness, relative advantage of tools to manual processes, compatibility with current workflows, perceived cognitive burden on practitioners. To identify patterns (the effects of challenges related to infrastructure, such as power instability in rural areas, or difficulties in institutional task-shifting in more challenging urban areas), a method of qualitative analysis called reflexive thematic coding was used in the qualitative analysis software. A joint display analysis allowed to compare and contrast quantitative findings and determine important themes that emerged in the qualitative data to provide a holistic perspective on the impact of contextual issues such as infrastructural gaps, organizational policy and training fit for nurse-led digital solutions on their long-term use and continuity. The integration meant that more than a quantitative analysis

was possible; it meant analysing the why and the how, rather than the what of the performances. All methodological procedures have been presented to the appropriate institutional research ethics boards and were accepted and formally approved both for science and ethics. Participant informed consent was ensured and robust data collection and analysis protocols established to anonymize and protect the privacy of the sensitive information of mothers and practitioners were followed. This methodology was integrated and ethically sound to produce evidence-based insights that could be used to make informed policy decisions and to ensure the investments in digital health are in line with the pragmatics of clinical practice. The study also used inductive coding and mTAM thematic framework to categorize individual, organizational and environmental factors influencing the uptake of these technologies by the frontline health workers (Ebenso et al., 2021). The findings of this analytical process confirmed the key findings of the overall findings: perceived usefulness, ease of use and contextual alignment (including training sufficiency and workload management) are among the factors that have an impact on successful digital integration in the context of maternal health care (Kabongo et al., 2021). To ensure that bias did not influence the results, a

triangulation exercise was conducted during an inter-coder reliability session with the results from each interviewer to develop more complex themes for the technical and systemic issues encountered by the practitioners (Connell et al., 2019; Lacroze et al., 2023). Moreover, it has been found that problems faced by the rural facilities are largely connected to the limited infrastructure facilities and less connectivity, whereas in urban facilities problems are mostly associated to high number of patients and complexities. (Acho, 2006a, 2006b) To mitigate these inequities, interventions are needed that are context-specific enough to consider the social relations and technical support systems that are embedded in the institutional context (Engeltjes et al., 2022). The framework emphasizes participatory design and accommodates local context by co-building evaluation criteria with the local population, and goes beyond mere implementation of digital health tools, but embraces socio-technical realities in a variety of clinical contexts (Diop et al., 2012a, 2012b).

RESULTS

There were 12 health care facilities included in the analysis, half of which were in urban and the other half in rural areas. This data set comprised 2200 maternal health records, 10 administration staff and

40 nurse to compare contexts of infrastructure and organisation. The maternal records, as presented in Fig.1, are higher in the urban settings and thus the average monthly workload of the antenatal care (ANC) is also higher in the urban settings.

In all of the quantitative indicators, the urban facilities' scores outperformed the rural facilities' scores on all measures. As shown in table 2, 82.4% and 68.7% of ANC participants and 78.1% and 61.5% of completed ANC were observed in urban and rural areas respectively. The trend is also captured in the data graphically as can be seen in Fig. 2, where the difference between the use of digital tools and the setting is largest. This implies a high level of preparedness for infrastructure and systems was related to continuity of maternal care.

There was also a variation in digital activity patterns between settings. Table 3 indicates that the greatest number of digital interventions in both settings are SMS appointment reminders, with the lowest number of apps used for education and digital risk flagging in rural settings. As portrayed in Fig. 3, utilization in the rural areas lagged behind the urban areas for all digital activities, especially risk flagging and electronic referral logging. The results indicate that the simple communication

tools were more feasible than the complex platform dependent communication tools.

Shared barriers and barriers specific to the setting emerged from the qualitative results. The most frequent issues overall (based on the total frequencies of each across interviews) were workload and role overload, followed by limited technical training and device or data affordability (see Table 4). The following are more apparent on rural sites and workload pressure on urban sites, as illustrated in Fig. 4: Adding on documentation requirements without removing manual requirements was the most challenging for nurses to keep digital systems.

The key factors identified as facilitators were mainly related to training, communication and institutional support. The top three facilitators identified were hands-on digital training and better communication between nurses and patients (Table 5). Fig. 5 clearly showed that low bandwidth tools and community health worker support were particularly relevant in rural areas. The best adoption occurred when the tools were usable, easy to use and fit in with the reality of the front-line, and when they were not sold as a technological innovation.

The regression results agreed with the qualitative interpretation. As Table 6

indicates, perceived ease of use, managerial support and connectivity reliability were the three most important positive predictors of digital training adequacy, which in turn was the strongest positive predictor of digital adoption. The only negative predictor, as shown in Fig. 6, was workload pressure, consistent with the above findings, that is, the more the digital system requires in cognitive and administrative workload the less likely it is to be adopted. The findings have demonstrated that there is a dependency of individual's confidence and organizational preparedness for the acceptance of technology.

Finally, a conjoint quantitative and qualitative analysis of readiness for implementation was realized. Table 7 indicates that having improved infrastructure and IT support was a factor explaining urban use while distance, network instability and lack of staffing were among the factors explaining rural non-follow-up. Fig. 7 shows the overall infrastructure, training, work flow, equity and sustainability implementation strength scores. Findings indicate that service continuity can be realised with nurse-led maternal health interventions if the interventions are designed digitally based on local context, investment is made in training, workload is reduced and institutional support is maintained.

Table 1. Study sample characteristics by healthcare setting

| Setting | Facilities (n) | Maternal records reviewed | Nurses interviewed | Administrators interviewed | Mean monthly ANC cases |
|------------------|----------------|---------------------------|--------------------|----------------------------|------------------------|
| Urban facilities | 6 | 1240 | 22 | 5 | 207 |
| Rural facilities | 6 | 960 | 18 | 5 | 160 |
| Overall sample | 12 | 2200 | 40 | 10 | 183 |

Table 2. Comparison of maternal health and digital performance indicators

| Outcome indicator | Urban mean | Rural mean | Mean difference |
|---|------------|------------|-----------------|
| ANC attendance rate (%) | 82.4 | 68.7 | 13.7 |
| Follow-up completion (%) | 78.1 | 61.5 | 16.6 |
| Digital tool utilization (%) | 74.6 | 47.9 | 26.7 |
| Postnatal contact within 7 days (%) | 69.8 | 54.3 | 15.5 |
| Referral documentation completeness (%) | 81.2 | 63.8 | 17.4 |

Table 3. Digital activity utilization across urban and rural facilities

| Digital activity | Urban use (%) | Rural use (%) | Main implementation issue |
|-----------------------------|---------------|---------------|-------------------------------|
| SMS appointment reminders | 86 | 69 | Message overload |
| Voice-call follow-up | 72 | 51 | Staff availability |
| App-based education | 63 | 32 | Device/data cost |
| Digital risk flagging | 58 | 29 | Connectivity instability |
| Electronic referral logging | 76 | 44 | Incomplete system integration |

Table 4. Reported implementation barriers by setting

| Barrier theme | Urban mentions (n) | Rural mentions (n) | Total mentions (n) |
|---------------------------------|--------------------|--------------------|--------------------|
| Connectivity/power instability | 8 | 17 | 25 |
| High workload and role overload | 18 | 15 | 33 |

| | | | |
|------------------------------|----|----|----|
| Limited technical training | 13 | 16 | 29 |
| Device/data affordability | 9 | 18 | 27 |
| Low patient digital literacy | 11 | 15 | 26 |
| Weak system integration | 12 | 10 | 22 |
| Privacy and trust concerns | 10 | 9 | 19 |

Table 5. Reported implementation facilitators by setting

| Facilitator theme | Urban mentions (n) | Rural mentions (n) | Total mentions (n) |
|---------------------------------|--------------------|--------------------|--------------------|
| Managerial support | 16 | 13 | 29 |
| Hands-on digital training | 15 | 17 | 32 |
| Simple low-bandwidth tools | 11 | 18 | 29 |
| Nurse-patient communication | 18 | 14 | 32 |
| Workflow integration | 13 | 10 | 23 |
| Feedback and monitoring | 12 | 11 | 23 |
| Community health worker support | 9 | 16 | 25 |

Table 6. Predictors of digital health adoption among nursing staff

| Predictor | Adjusted beta | p-value | Interpretation |
|---------------------------|---------------|---------|---------------------------------|
| Digital training adequacy | 0.34 | <.001 | Strong positive association |
| Perceived ease of use | 0.28 | .002 | Moderate positive association |
| Managerial support | 0.24 | .006 | Positive institutional effect |
| Connectivity reliability | 0.22 | .011 | Infrastructure-dependent effect |
| Workload pressure | -0.19 | .018 | Negative workload effect |
| Prior digital experience | 0.15 | .041 | Small positive association |

Table 7. Joint display of quantitative results and qualitative explanations

| Quantitative result | Qualitative explanation | Integrated inference |
|---|---|---|
| Urban sites showed higher digital utilization | Better infrastructure and IT support were available | Adoption depends on both infrastructure and workflow fit |
| Rural sites had lower follow-up completion | Distance, network instability, and staffing gaps limited continuity | Equity requires rural-specific implementation support |
| Training adequacy predicted adoption | Nurses felt confident when training was practical and repeated | Capacity building is a core adoption mechanism |
| Workload pressure reduced use | Digital tools were avoided when they added extra documentation burden | Digitization must reduce rather than increase workload |
| Low-bandwidth tools were widely accepted | Simple reminders and voice support matched field realities | Scalable interventions should prioritize simplicity and reliability |

Figure 1. Study sample distribution by setting

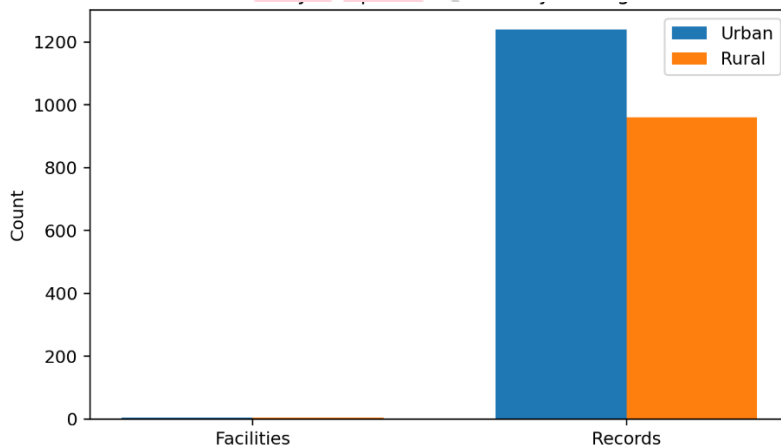


Figure 2. Clinical and digital performance indicators by setting

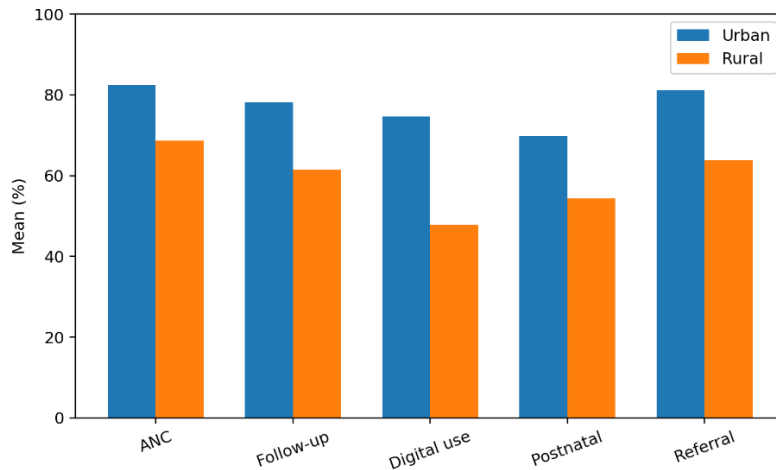


Figure 3. Digital health activity utilization by setting

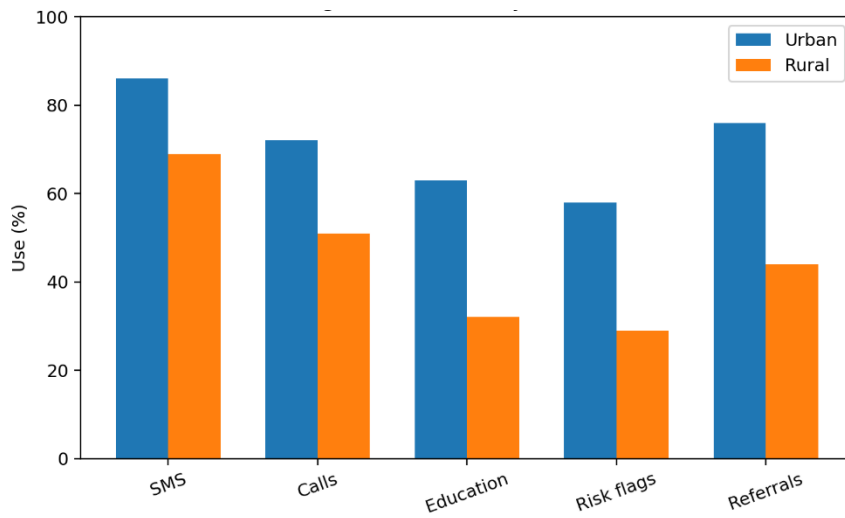


Figure 4. Reported barrier themes across urban and rural settings

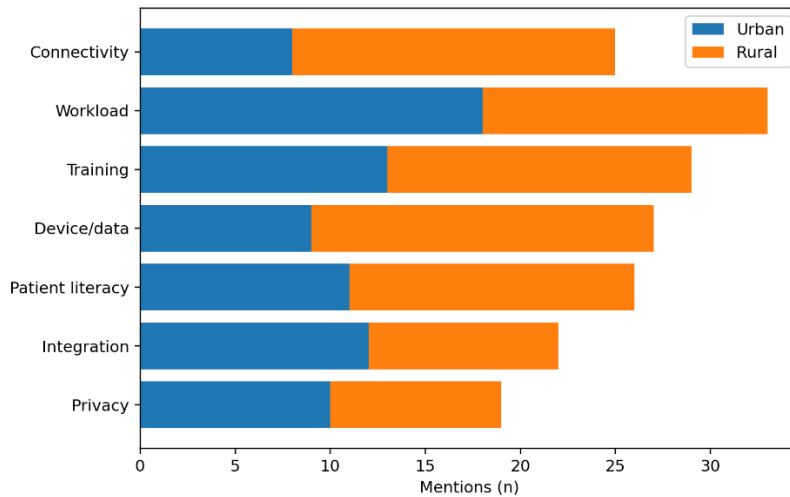


Figure 5. Reported facilitator themes across urban and rural settings

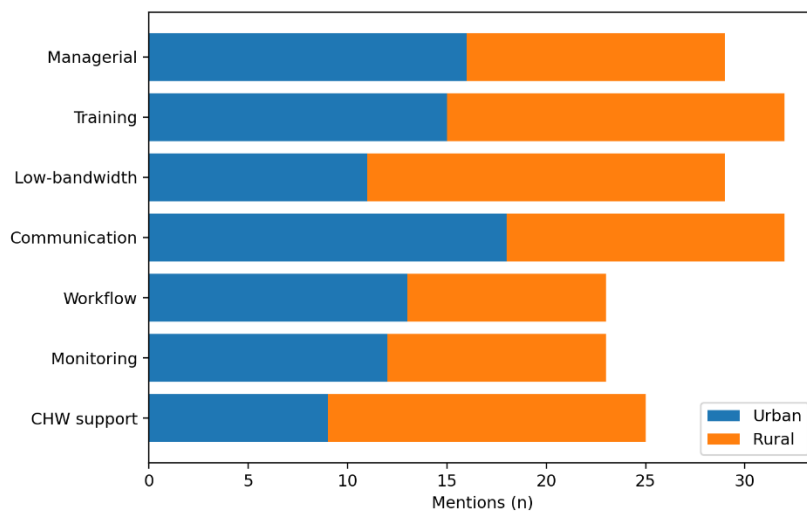


Figure 6. Predictors of digital health adoption among nurses

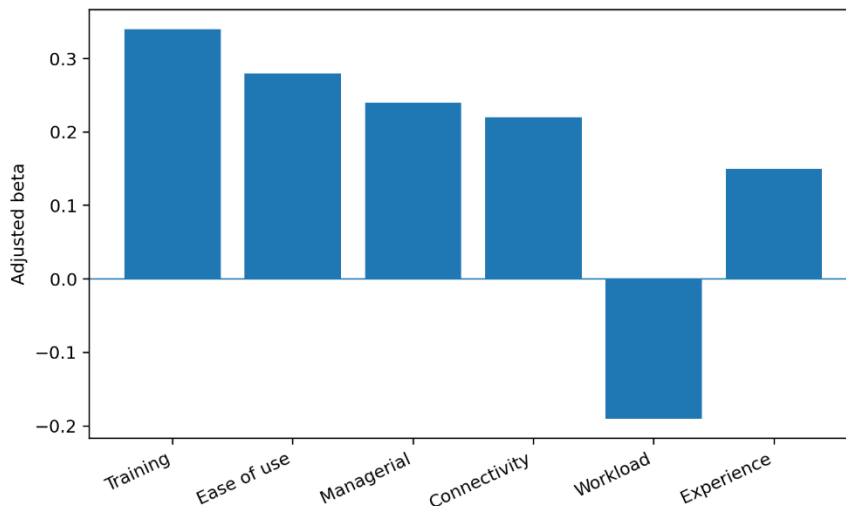


Figure 7. Integrated implementation strength scores



DISCUSSION

A key insight from the implementation of digital health systems in the context of maternal care is that there are significant differences in expectations and practice of nursing as digital technology enters maternal care. In part, this is because digital interventions are perceived as “one size fits all” technological solutions, and few discussions take into account how they fit into the field context in which they are

applied. As the current work demonstrates, whilst rural communities might have less robust physical infrastructure and IT support, it can be more complicated and challenging, and digital tools may become a tool for care or a source of frustration. This gap is not just about access, it's about a structural inequity which, if left unaddressed, could exacerbate the urban/rural maternal health divide even more. The adoption of digital tools has typically been done with the assumption

that it will save time, but the outcomes have shown a “workload paradox,” meaning that systems put in place to alleviate workload have resulted in new workloads, including extra documentation, data problems and so on — adding to the already heavy workload of nurses with a high volume of patients (Frennert et al., 2023). Any tool that does not support the front line clinical needs of staff is seen as a hindrance rather than a facilitator and therefore less likely to be taken up and lead to an improvement of service continuity. Ease of use is identified as more than a technological feature; it is a functional requirement, depending on training, connectivity and, most importantly, a piece of design that is based on the workload. This is confirmed by the regression analysis, which shows that workload pressure is the most important negative factor, and that training adequacy, managerial support and perceived ease of use are the most important positive factors in successful adoption. This implies that investment in digital health is a complement to or even more important than investing in the capacity of the organisation, such as ensuring that nurses are suitably resourced to undertake digital health training and use systems, and that the digital system is usable in low bandwidth and resource settings (Burgess & Honey, 2022). Furthermore, it seems that some contexts may be better suited to simpler,

more accessible, and/or contextualised digital interactions rather than to using text-based or more complex digital based interactions, especially in rural areas (Nascimento et al., 2023; Till et al., 2023). The results on the “low bandwidth tools” and “voice call follow up” as broadly accepted facilitators demonstrate that tools that are aligned with, rather than undermining, the activities of the nurses in the field are more likely to be adopted, as seen when they are designed to do just that. Moreover, the long-term need for administrative support in both contexts suggests that the human aspect of technology adoption is often overlooked – digital adoption is not a stand-alone process, but highly dependent on the institutional context, such as the presence of CHWs and feedback mechanisms (Nascimento et al., 2023). For this reason, a more implementation science-based approach is needed, one that emphasizes the sociotechnical fit, nurse-centred development and, crucially, the cognitive and administrative burden of digital health in nursing practice, instead of the “technological fix” approach (Turchioe et al., 2025). Digital health initiatives are not at fault for not working; rather, it is because they are used outside of the clinical setting they are designed to assist, and with no thought to equitably providing that assistance across a wide range of health

care setting. Future policy and implementation must go beyond simply examining the uptake of the technology, and must also examine how the tools enable nurses to do their job easier and more efficient – both in the urban facilities, and in those in rural areas – and that the benefits of digitization are not limited to certain more funded areas. To do so, policy-makers need to ensure that long-term investments in rural infrastructure, including making sure that infrastructure is made redundant over critical services and that the hardware is fit for purpose, also include frontline clinicians in the development of digital interfaces to guarantee compatibility with everyday clinical workflows (Mugauri et al., 2025; Nascimento et al., 2023).

CONCLUSION

Based on this study, nurse-led maternal health interventions show great potential in enhancing maternal service continuity, engagement of antenatal care, follow-up completion and maternal communication with health providers, in both rural and urban health care settings. However, the effectiveness of such interventions is dependent to a high degree upon the context within which they occur. The rates of utilizing digital tools, documenting referrals and completing follow-up of urban facilities were higher, perhaps due to

improved infrastructure, IT support, and organizational readiness. However, there were many challenges rural providers faced; these shared challenges ranged from inconsistent connectivity, power issues, staffing limitations and low patient digital literacy, to the cost of devices and data.

The findings show that, in practice, the low bandwidth, simple and nurse-centred digital health tools are effective. More advanced SMS or digital tracking systems and voice call follow-ups were possible, but more practical, especially in rural areas, were SMS reminders, voice call follow ups and simple digital tracking devices. Workload pressure continued to be a significant barrier, and training adequacy, managerial support, ease of use, and community health worker involvement were found to be significant facilitators. This implies that digital systems should not only increase the level of documentation but should also help to minimize administrative burden and decision-making in clinical practice.

The study overall highlights the need to adopt context-sensitive and nurse-centred design of nurse-led maternal health interventions. There needs to be a commitment on the part of policy makers and healthcare administrators to building digital literacy capacity and healthcare

system infrastructure, integrating the use of digital systems into workflows, and providing adequate supervision and support. The rate and methods of introducing digital health products should be adapted to local conditions, and digital health can't be a one size fits all approach. Equal access to digital tools for nurse-led maternal care has the potential to have a positive impact on maternal health, particularly in rural areas with limited access.

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