ORIGINAL RESEARCH PAPER

Health Care

ADVANCING WOMEN'S HEALTH THROUGH DIGITAL TECHNOLOGIES: OVERCOMING BARRIERS WITH PRIVACY AND TAILORED INTERVENTIONS.

KEY WORDS: digital health, women's health, health equity, privacy, postpartum mental health, low- and middle-income countries, telemedicine, user-centred design

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ABSTRACT

Women in low-resource and culturally conservative settings face structural barriers to health care that men in the same settings often do not face, such as financial dependence, restricted mobility, and stigma around reproductive and mental health. Telehealth, mobile health applications, and patient-controlled records have been proposed as one route to narrow that gap, yet uptake among disadvantaged women remains uneven. This narrative review examines three forces that shape uneven uptake: data privacy concerns, socioeconomic constraints, and cultural fit. Three findings recur across the literature. First, women engage more consistently with digital tools when privacy controls are explicit, granular, and visible at the point of use, rather than buried in terms of service. Second, socio-economic and infrastructural disadvantages interact with, and are inseparable from, digital literacy; bandwidth, device ownership, and time autonomy together determine whether an intervention is usable at all. Third, cultural tailoring is most effective when it goes beyond translation to address local norms around help-seeking, family decision-making, and stigma. We argue that user-centred design grounded in community participation, rather than retrofitted localisation, is the most promising route to closing the digital-health gender gap. We also note where the evidence base is thin: longitudinal outcomes, scalability across regulatory regimes, and equity audits of artificial-intelligence components remain underdeveloped.

INTRODUCTION

Health systems have absorbed digital tools at speed over the past decade. Telemedicine, mobile applications, and patient-held electronic records now form part of routine care delivery in many high-income countries and a growing share of middle-income ones [1]. For women, this shift matters in specific ways. Women in many settings carry a disproportionate burden of caregiving, face restrictions on independent travel, and report higher rates of stigma around mental and reproductive health than men [2]. Each of these constraints is, in principle, addressable by a tool that allows discreet, location-independent, asynchronous contact with a clinician.

Adoption studies repeatedly find that the women who would benefit most are those in lower-income households, those with limited schooling, those in rural or peri-urban settings adopt least [3,4]. The reasons are not mysterious. Data costs, inconsistent power, devices shared with male relatives, and content that assumes a level of literacy or cultural fluency the user lacks all reduce engagement. So does the absence of a trusted clinician or community figure who can vouch for the tool [5].

Women who have been let down by formal health systems do not automatically extend their confidence to a digital version of themselves. Privacy concerns about reproductive data, mental-health disclosures, and intimate-partner-violence histories are particularly acute, and the regulatory landscape, fragmented across jurisdictions, opaque to most users, does little to reassure them [6,7]. This review draws on 33 studies (2013–2024) to map how privacy, socio-economic constraints, and cultural fit interact to shape women's engagement with digital health. The aim is not to catalogue technologies but to identify which design and policy levers matter most for equitable uptake.

2. METHODOLOGY

This is a narrative review conducted in accordance with the PRISMA-S reporting guidance for the literature search description. Three databases were searched: PubMed, IEEE Xplore, and Scopus for English-language publications between January 2013 and December 2024. The search combined three concept blocks: (a) digital health, mHealth, telemedicine, telehealth, digital intervention; (b) women's health, maternal health, postpartum, reproductive health; and (c) equity, privacy, socio-economic, cultural adaptation, LMIC. Boolean strings used "AND" across blocks and "OR" within them.

Records were screened against three inclusion criteria: peer-reviewed publication, focus on women or sex-disaggregated findings, and explicit discussion of at least one of the three barrier domains. Editorials, vendor white papers, and non-peer-reviewed market reports were excluded. Thematic synthesis followed Braun and Clarke's familiarisation–coding–theme-development sequence. Because the review uses only published sources, no separate ethical approval was sought; ethics statements from the original studies were checked at inclusion.

3. Cultural, Socio-Economic, and Geographic Constraints

3.1 Cultural fit

Cultural tailoring of digital health interventions is now well-established as a mediator of engagement, not a finishing touch. In Gilbey and colleagues' systematic review of interventions aimed at sexual and gender minorities, stigma and the absence of inclusive content were the two most cited reasons for disengagement; users who saw themselves represented in the tool used it longer [8]. Lee and colleagues, working with women in the peri-pregnancy period, similarly found that localised content language, exemplars, recommended foods, and family roles were rated more important by users than any single clinical feature [9]. The distinction matters: a translated app and a culturally adapted one are not the same product.

The implication for designers is that cultural adaptation should be built into the development cycle rather than retrofitted. Participatory co-design with women from the target population during the prototype stage produces more durable engagement than post-launch focus testing.

3.2 Socio-economic factors

Zandian and colleagues' cohort of women aged 35–70 in Ardabil, Iran, linked reproductive health behaviour to household socio-economic status and found that women in lower-income households were less likely to access digital health resources, in part due to cost and in part to low awareness of such resources [10]. The pattern is not specific to one country. Yaya and Ghose, analysing demographic and

health survey data across sub-Saharan Africa, found that wealthier respondents were substantially more likely to access health information online than poorer respondents, a finding that, at scale, suggests digital tools may widen rather than narrow existing inequities unless deliberately counteracted [11]. What works against that drift is subdued: subsidised data access, device-loan programmes through community health workers, and digital-literacy training paired with the intervention itself. Each has been piloted; none has been scaled.

3.3 Geographic constraint

Rural and remote communities face a compounded version of the same problem. Connectivity is intermittent, devices are older, and the local health infrastructure to which a digital tool is meant to refer the user is often itself thin. Offline-capable applications and low-bandwidth telemedicine protocols partly address this; they do not resolve it. The presence of a human intermediary, a community health worker, an auxiliary nurse-midwife, remains the strongest single predictor of sustained use in low-connectivity settings.

4. Data Privacy and Trust

Privacy is not a peripheral concern in women's digital health; in several studies, it is the deciding factor for engagement. Guendelman and colleagues' mixed-method study of disadvantaged mothers and pregnant women in the United States found that women routinely searched for health information online but withdrew from tools that asked them to log in, link to insurance, or share location data without a clear explanation of how that information would be stored [12]. Lim and colleagues, in a systematic review of postpartum women's perspectives, identified data security and a visible link to a clinician as the two factors most consistently associated with continued use [13].

The privacy concern is sharper when the data are intimate. Period-tracking apps, reproductive-health platforms, and mental-health applications collect categories of data whose disclosure carries social, legal, or relational consequences that ordinary clinical data do not. The United States Federal Trade Commission's enforcement action against Flo Health for sharing menstrual data with third parties is a well-documented illustration of how that risk plays out [14].

Technical responses to the privacy problem exist. Fang and colleagues' systematic review of blockchain-based personal health records found that distributed-ledger architectures can support user-controlled consent, tamper-evident audit trails, and granular access permissions, three properties consistently linked to user trust in qualitative work [15]. Whether these properties translate into sustained engagement among women in low-resource settings remains untested at scale. Two cautions are worth stating directly: the energy footprint of public blockchain implementations is nontrivial, and the operational complexity of consent revocation in distributed systems is poorly documented for non-technical users.

A simpler intervention may matter more in practice. Hardy and colleagues' observational study of the SlowMo therapy app for paranoia in psychosis found that explicit, plain-language privacy framing within the user journey, rather than in a terms-of-service document, was associated with higher engagement, particularly among women, who reported higher current and intended use than men [16]. The lesson generalises beyond psychosis: privacy communication is part of the user interface, not the legal apparatus.

5. Mental Health in the Postpartum Period

The postpartum period concentrates several of the barriers described above. Sleep deprivation, hormonal change, and shifting family roles produce a window of elevated risk for depression and anxiety that, in most settings, is poorly covered by formal services. Digital tools have been proposed as a bridge.

Feldman and Perret, writing in npj Digital Medicine, set out both the promise and the limits with care: telehealth, mental-health applications, and digital phenotyping can extend reach into a population that struggles to attend in-person care, but the same tools risk surveilling women who already feel scrutinised by health and child-welfare systems [17]. Their warning that "not all digital resources are good resources" most commercial postpartum apps in their audit were not evidence-based should be read as binding rather than rhetorical.

Socio-economic disadvantage compounds the difficulty. Hansotte and colleagues' systematic review of low-income postpartum women in Western countries found that positive depression screening rarely translated into follow-up treatment, with digital barriers and referral attrition both contributing [18]. Kamarudin and colleagues' work with Asian mothers identified culturally specific reluctance to disclose distress and a preference for tools that frame mental-health support as part of maternal well-being rather than as psychiatric care [19]. Ellis and colleagues' meta-analysis of culturally adapted digital mental-health interventions found small-to-moderate effects favouring adapted versions over generic ones, with the strongest effects in trials that involved community members during development rather than only during evaluation [20].

Two cross-cutting design implications follow. Postpartum mental-health tools should be embedded in maternal-health programmes that women already trust, rather than offered as standalone mental-health products. And they should be evaluated against follow-through to actual care, not against in-app engagement metrics.

6. Scaling Across Health Systems

Scaling digital health interventions across health systems exposes a different set of problems from those that constrain individual uptake. Infrastructure varies. Regulation varies. Workforce capacity varies. Pilot studies in well-resourced research settings rarely survive the transition to routine LMIC service delivery, and the reasons cluster around four themes: fragmented institutional support, short-term funding cycles, unclear regulatory pathways for software classified as falling between health information and medical devices, and a tendency to design without the sustained involvement of frontline clinicians [21,22].

Three responses have shown promise. Local partnerships with established providers, community health workers, or NGOs lend social legitimacy that an externally branded tool cannot generate on its own. Open-source and offline-capable architectures lower the cost of adaptation across settings. And explicit equity audits during scale-up, examining who is enrolled, who drops out, and which sub-groups benefit surface inequity early enough to correct it [23]. None of these is technically novel; what is novel is the willingness of funders and implementing agencies to require them as conditions of investment.

Two unresolved tensions sit underneath this work. The first is the conflict between standardization, which scales demands, and local adaptation, which engages demands. The second is the gap between research-grade evidence built around randomized trials in well-resourced sites and the practical evidence implementers actually need, which concerns workflow fit, supervision burden, and cost per averted clinical event.

7. DISCUSSION

Privacy is a usability problem, not just a legal one. The studies that report the strongest engagement among women describe privacy controls that are visible, in plain language, and granular at the moment a user is asked to share data. Compliance with GDPR or HIPAA is a floor, not a ceiling, and it is largely invisible to the user deciding whether to enter a

sensitive disclosure. Designers who treat privacy as part of the interface rather than the legal footer observe different engagement curves [12,13,16].

Equity does not arrive by default. Several large studies in this review document the same uncomfortable pattern: when a digital tool is launched without specific equity safeguards, it is adopted first and most by women who are already best served by the formal system [11]. The digital gender gap is not narrowed by the existence of digital tools; it is narrowed by deliberate design choices subsidising access, community intermediaries, offline-capable interfaces, and content built around the user's actual literacy and language. Each of these adds cost. Treating that cost as discretionary is the single most common reason equity goals are not met.

Cultural adaptation is design, not localisation. Translation does not produce engagement. Co-design with women from the target population, sustained through the prototype phase rather than parachuted in at evaluation, repeatedly outperforms post-hoc tailoring [9,20]. This is well established in the implementation science literature and underapplied in commercial product development.

The evidence base is thinner than the volume of publication suggests. Long-term outcome data are scarce; most studies report engagement metrics over weeks rather than clinical outcomes over years. Cross-jurisdictional comparison is constrained by differences in privacy law and reimbursement structure. And the rapid integration of generative AI components into consumer health applications is outpacing the equity-audit literature.

8. LIMITATIONS

This review has several limitations worth stating plainly. It is narrative, not systematic; the selection of sources was guided by relevance to the three thematic domains, and another reviewer might select sources differently. Screening was conducted by a single reviewer, which raises the risk of selection bias. The search was restricted to English-language publications, which under-represents work from non-English-speaking LMIC settings, precisely the settings most relevant to the equity questions the review raises. Finally, the field is moving quickly; some of the technical claims made here, particularly about distributed-ledger and AI components, may be superseded by evidence within 12 to 18 months of publication.

9. CONCLUSION

Digital health tools can narrow the gap between the care women need and the care they receive, but they do so unevenly and only where design and policy choices make equity an explicit objective. Privacy controls that users can see and act on, intermediaries who can vouch for the tool, and co-design with the women the tool is meant to serve are the most consistent predictors of equitable uptake across the literature reviewed here. Three areas need stronger evidence before the field can claim more: long-term clinical outcomes, equity audits of AI-augmented products, and scalability across regulatory regimes. Until those gaps close, claims of transformative impact should be made carefully.

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