The opportunities and challenges of women's digital health

A research agenda

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Editorial

The opportunities and challenges of women's digital health: A research agenda

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Background

The global women's digital health market, commonly known as 'FemTech' is rapidly expanding. As of 2020 it is valued at ~ $22 billion with a growth rate of 15 % between 2020 and 2025 [1]. Women's digital health technologies (DHTs), or FemTech, include mobile health (mHealth), wearables, health information technology (IT), and personalized health with Artificial Intelligence for women's health. With the ongoing digital transformation in healthcare, these technologies have enormous potential to improve global women's health and advance gender equity. Investing in women's DHTs is even more crucial in the aftermath of the COVID-19 pandemic. The rate of change in gender parity (i.e. the percentage of the global gender gap that has been closed), has slowed down [2]. Further, online violence against women has increased [3], burn-out among healthcare staff [4] (a majority of whom are female), has surged, and alarming increases in global maternal deaths have been reported [5]. To fully realize the potential of women's DHTs, it is imperative to examine its current limitations. Here we highlight the current opportunities and challenges of women's DHTs based on a Digital Health Equity framework [6], which builds on the National Institute on Minority Health and Health Disparities (NIMHD) Research Framework [7]. It includes the Digital Determinants of Health (DoH), which are defined as conditions in the digital environment that affect a wide range of health, functioning, and quality of life outcomes and risks[6]. We discuss a future research agenda.

The opportunities of women's DHT's

Women live longer on average but spend more years in poor health and with disability [8]. This is partly due to a gender gap in medical knowledge [9], as well as the barriers women face towards accessing healthcare. The persisting challenges they encounter, such as gender discrimination, low education, and limited economic participation all influence health [10]. Technology can have a unique role in advancing women's health and bolstering gender equity [11]. DHTs such as mobile apps, wearables and websites can remove barriers for accessing healthcare, including childcare responsibilities, financial constraints, and a lack of time for clinical visits [12]. They can also help women make better informed health decisions and find health education [12,13]. DHTs can also provide support with family planning [14], avoiding early pregnancy [15], and escaping gender-based violence [16,17].

In addition to these health benefits, DHTs can improve working conditions for (lower paid) healthcare workers, who are more often female, through increased efficiency in health and welfare systems [18] and accessible online training for women's career advancement in healthcare [19].

For researchers and policymakers, data collected through DHTs can enable insights into typically understudied and underfunded women's health topics [11], which can narrow the gender medical knowledge gap and improve women's healthcare. Thus, women's DHTs can play a key role in improving the access to healthcare services, quality of care, empowerment in health, and progress in women's health research, management, and leadership.

Academic research in high income countries shows that DHTs may be clinically effective in improving women's health, especially for pregnancy related conditions. For instance, a systematic review and meta-analysis of 28 studies found medium to high certainty evidence that DHTs improve glycemic control and reduce the need for cesarean delivery in women with gestational diabetes [20]. Another meta-analysis of 15 RCT's found that social media and mobile health apps are effective in promoting maternal physical and mental health and knowledge about pregnancy with high to moderate effect sizes [21].

DHTs are also gaining popularity in low- and middle-income countries (LMICs) [22–24]. For example, a systematic review on DHTs for pregnant women in LMICs at high risk of preeclampsia found high acceptability of DHTs and positive results on blood pressure reductions [23]. Another review showed that DHTs, either phone calls or SMS, were feasible and acceptable for improving contraceptive uptake and maternal healthcare in Ethiopia [24]. However, due to a lack of clinical trials, evidence on effectiveness was sparse [23,24]. Thus, DHTs show promise for improving women's health, both in high-income countries and in LMICs, although more evidence is needed.

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Current challenges

Despite the importance of DHTs in closing gaps in access to quality and timely care and improving overall health care delivery of women's health across the life span, numerous challenges to women's DHTs remain persistent and prevalent. In this section, we explain these challenges according to levels of the socioecological model (individual, interpersonal, community and society level) with a focus on the digital environment. We use the Framework for Digital Health Equity, an expansion of the NIMHD Research Framework. The framework categorizes the social determinants of health according to levels of the socio-ecological model. It includes the Digital Determinants of Health as a social determinant–in addition to the healthcare system, biological, behavioral-, physical-, and socio cultural- environment–because of its critical role in Health outcomes and care services(6). Based on this framework we provide a future research agenda (Fig. 1). Based on this framework we provide a future research agenda (Fig. 1).

Individual level

At the individual level, challenges to women's DHTs include a lack of access to technology and internet access, digital literacy, a skill of understanding and utilizing information from different digital sources [25]–and attitudes towards use. A gender digital divide: inequalities between men and women in terms of access and use of digital technologies, persists. In 2022, 269 million more men were using the Internet than women, and 143 million more men were mobile phone owners [26]. Women in low-income African countries are the least likely to be online globally [27,28]. Access to digital technologies is thus influenced by factors beyond gender, such as socioeconomic status and geographic location.

Marginalized groups such as racial or ethnic minority women, those with lower income or education, and with complex health needs tend to have lower levels of both digital access, literacy, and trust in DHTs [29, 30]. They are under-represented in DHT research and uptake [31,32] despite facing worse health outcomes [33]. DHTs are often not designed with their health needs and digital capabilities in mind [34,35]. For example, qualitative research reveals that women's digital health content is rarely adapted to digital skills, age, ethnicity, socioeconomic status, or existing health conditions [36].

Further, a systematic review found that only 17 % of apps for managing gestational diabetes during pregnancy assessed cultural appropriateness (i.e. whether app's content and instructions are in line with the patients' culture, language, religion, customs, and beliefs), and 25 % assessed digital literacy [34]. Additionally, studies testing privately developed digital health tools often do not include women from underserved populations or those with complex medical needs [37]. If DHTs are only tailored towards a specific group of women, such as those who are white, highly educated, healthy, and affluent, women from underserved populations do not benefit, with increasing health inequities consequently.

Interpersonal level

Interpersonal challenges in the women's DTH field include interdependence, the tech-doctor-patient relationship, and interpersonal discrimination. Interdependence, the dependence on others for the skills and equipment necessary to use digital tools, is especially significant when women share phones with family members, which is more common in low-income countries or households [28]. Sharing devices may impede women from freely and safely using DHTs, especially for sensitive health issues such as sexuality, fertility, or domestic abuse. Further, over reliance on data gathered by apps can also negatively change the patient-doctor relationship, for example, by shifting the focus away from women's preferences and needs to decision making based on data [38]. In addition, the responsibility to use patient DHTs might mainly fall on the shoulders of lower paid healthcare workers such as nurses and midwives, who are more often female, which risks increasing the burden on female healthcare workers rather than alleviating it [38].

Further, women face more interpersonal sexism and discrimination than men, which impacts their health. Their experiences must be viewed through an intersectional lens, depending not only on gender, but also on other factors such as age, working ability, geographical location, religion, disability, work-support, socio-economic status and ethnicity [39,40]. For instance, women are at greater risk of (online) violence and abuse, with women of color more likely to be victims [41]. This may also influence their interest in using health technology. Most current DHTs reduce women's experience to a list of 'symptoms' without taking these contextual and intersectional factors into account [42]. This unfairly places the full responsibility on women to manage their health issues, in

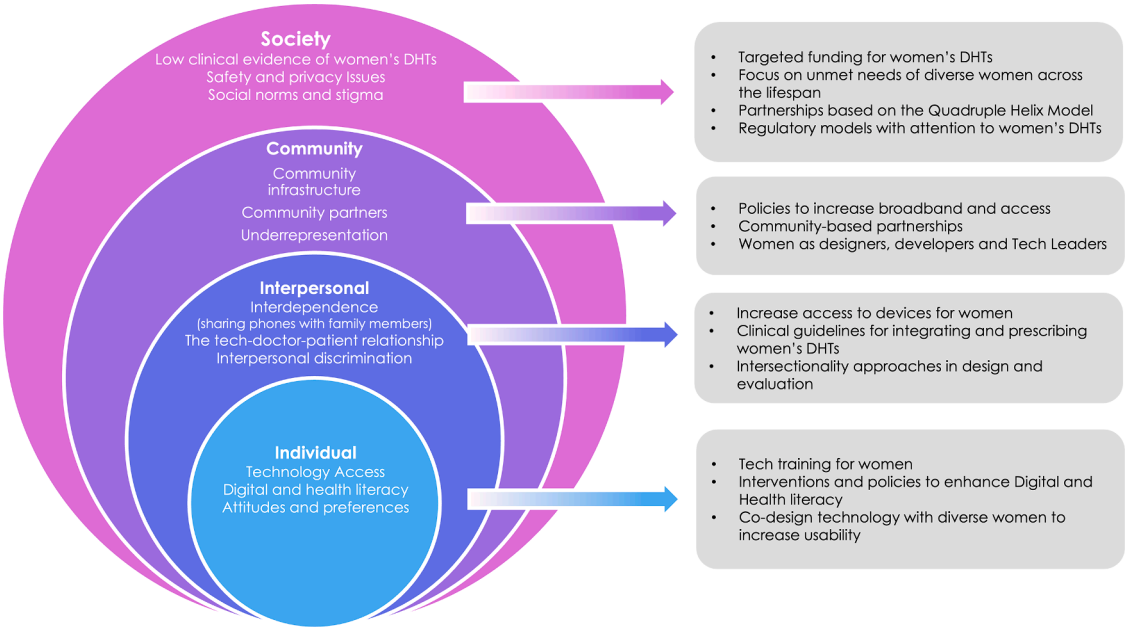

Fig. 1. Challenges in Women's Digital Health and proposed research agenda based on the framework for Digital Health Equity.

a society where they encounter structural challenges to achieving good health.

Community level

Determinants at the community level include community infrastructure, community partners, and underrepresentation for both culture, religious and political local domains. Because more women live in poverty than men, they face more barriers to using DHTs such as poor cellular, wireless, and broadband access [43]. Broadband internet access is considered an important determinant of health [44]. Without it, functions such as telehealth visits, remote monitoring and messaging *via* patient portals are not possible. Further, most DHTs are not developed in languages other than English, nor use the technologies most often used by marginalized groups (e.g. text-messaging instead of smartphone apps) [29]. Local community workers can play an important role in helping women with access to and use of digital health services. However, (women's) community organizations are not often included in the DHT design, evaluation, and implementation process [29].

Further, women are underrepresented in the community digital health ecosystem on various levels. They are less often the designers, funders, and researchers of women's DHTs. For instance, in the US women only make up 15 % of venture capital firm partners [45], and women leaders of color are particularly lacking [46]. Black women are the least likely to be founders and receive less venture capital funding [47]. This all contributes to DHTs benefiting the more advantaged groups and widening global health inequities.

Societal level

Challenges at the societal level include low clinical evidence, tech policy, and social norms. Though women's DHTs show promising effects, the evidence of improved health outcomes is still sparse [48]. For instance, various systematic reviews on different health topics, such as health apps for pregnant women at high risk of preeclampsia [49,50] breast cancer survivors [51]; lifestyle during pregnancy [52]; urinary incontinence [53]; preeclampsia (in LMICs) [23]; and cervical cancer screening (in LMICs) [54], report insufficient effectiveness due to a low number of participants and a lack of randomized clinical trials. Further, many women's DHTs use poor theory or are not described in a way that allows replication [55,56]. Thus, we lack studies based on real-world evidence needed to prove the effectiveness of women's DHT's in improving health.

An important reason for this is a disparity in funding for women's DHTs. In industry, women's DHT companies receive only 3 % of all digital health venture capital [57]. Progress has been made in policy, funding, and research into women's health, such as the formation of the National Institutes of Health (NIH) Office of Research on Women's Health. However, we still have a long way to go. For example, the NIH still disproportionately funds research on diseases that affect primarily men, at the expense of funding for women's health [58,59]. In addition, women are still underrepresented in clinical trials compared with their proportion of the disease population, including for CVD, cancer, and psychiatric disorders [60].

The field is also disproportionately focused on selected women's health issues. For instance, 75 % of the revenue share of FemTech companies goes to 'pre-menopausal' care, e.g. fertility solutions, pregnancy care, menstrual care, and pelvic health [46,61]. DHTs research on women's cardiovascular disease, cognitive decline, depression [62], and lifestyle factors, including later-life support such as peri-menopausal care and promotion of healthy aging, is particularly lacking [63]. The authors of this paper conducted a Google Scholar search for articles with "women'' and "digital health" in the title from 02/2003 until 03/2023. This search revealed 94 articles and abstracts, with 31 (33 %) focused on pregnancy or postpartum health. Other research also reported a lack of research on DHTs in later stages of women's lives, such as managing menopause symptoms [64]. For instance, several studies found that the content of health apps is currently tailored to "young white able-bodied cisgender heterosexual women who (eventually) wish to procreate" [65]. Overall, women's DHTs' majority activity thus appears focused on 'pre-menopausal care' and tailored towards white heterosexual women.

Another important issue is the safety of apps. Many popular commercially available women's health apps currently have poor data privacy, sharing, and security practices and do not follow regulations such as the EU GDPR [66]. In the US, several policies address health information privacy such as the HIPAA (Health Insurance Portability and Accountability Act) [67]. However, HIPAA allows reproductive health information to be used for legal investigations and court cases without a patient's consent. This is especially crucial considering the reversal of the landmark decision in Roe v. Wade by the United States Supreme Court in June 2022, which restricted women's privacy and healthcare autonomy. Compromised privacy could leave women vulnerable to targeted advertising, attackers for monetary gain threatening to spread women's sensitive information, abusive relationships, and law enforcement [68].

A future research agenda

Based on these challenges, we make recommendations for a future research agenda.

Training in using and prescribing women's DHTs

For women from diverse backgrounds to fully benefit from DHTs, capacity development in tech literacy for women are needed, as are support in using DHTs. The delivery-mode of DHTs should also be considered. For example, text-messaging may be more successful than smartphone apps or wearables for those with lower digital literacy skills, and DHTs should be available in various languages. Community based partners, such as community health workers and libraries, can help ensure access to digital devices, internet, and digital skills training. For clinicians, training on prescribing women's DHTs needs to be developed, with best practices of using data to complement care whilst keeping women's voices central in medical decision making. Similarly, guidelines and integration into the clinical workflow of DHTs are needed to minimize the burden on healthcare staff and ensure that DHTs are valuable for improving the quality and efficiency of healthcare.

Involve women in the DHT development process

Gender inequities in digital health systems can be partly disrupted through involving women from the start of DHT development [69,70]. Co-designing DHTs enables a better understanding of women's experiences and priorities and bridges the gap between technology and patient preferences [71]. This is especially relevant for women's DHTs because of the gender gap in medical knowledge. Further, women ascribe a greater value to participation in technological research than men [72]. Co-design can also ensure the use of gender-inclusive language and design that minimizes gender biases [30]. More dedicated resources for inclusive women's DHT's design with considerations for underserved populations should be developed.

Broaden representation of diverse women as users, developers, and leaders

To achieve a gender equitable digital health ecosystem, marginalized groups such as racial or ethnic minority women and women with low-income or education should be included as users, developers, and investors of DHTs. One example of a women's Digital Health Equity research initiative is the FemTech collaborative at the Center for Innovative Research on Gender Health Equity, which studies the use of technology for the advancement of reproductive health equity [73]. More initiatives, tools, and networks that focus on digital health gender

equity, with a focus on diversity, could help women's DHTs have a wider reach and be more effective.

Invest in research for DHTs targeting diverse women's unmet needs across the lifespan

For DHTs to benefit all women in different phases of their lives, increasing research on DHTs for the unmet needs of women across the lifespan is needed. This includes a life-course approach, from adolescents and young adults to later life [74]. To address unmet needs, studies should focus on person-centered outcomes, i.e., outcomes based on women's beliefs, needs, and wishes [75,76]. To generate robust evidence, we need more studies beyond the piloting phase, and studies evaluating the evidence of commercially available apps. Designs to study effects can include randomized trials, multiphase optimization studies, and N-of-1 studies [77]. Future research should also examine the potential of novel designs for digital health evaluation that are less costly and more agile, such as simulation-based methods [78].To enable high quality research, women's digital health funds could be created, similar to funds for specific diseases such as mental health, diabetes and cardiovascular disease.

Finally, in interpreting and evaluating DHTs, researchers should use a model of feminist intersectionality [30], which includes considering intersectional differences in digital literacy and health outcomes, social contexts and environments, and gender dynamics in digital health (e.g., DHTs influencing relationships) [28,30]. The analysis and development of women's DHTs from an equity dimension is necessary to achieve health for all, leaving no one behind.

Form partnerships within the quadruple helix model

To ensure that digital health interventions are accessible, useful, and effective for women from diverse backgrounds, partnerships with multiple stakeholders in DHT design and evaluation are crucial. One approach is the quadruple helix model, in which regulatory bodies work with academics, industry, civil society and citizens to develop digital health policies that can increase access to DHTs (e.g. providing digital devices and high-speed internet), and ensure they are safe and effective. These partnerships can also enable guidelines to evaluate the safety and quality of health apps for clinicians and citizens [79]. Evidence-based regulatory frameworks should pay particular attention to unique considerations related to women's DHTs, including efficacy, safety, and gender biases.

Conclusion

Women's DHTs have a great potential to improve global women's health and gender equity. However, the field currently encounters various pressing challenges. Women's DHTs fall short in serving diverse women, lack robust evidence, face inadequate funding, and grapple with safety and security issues. To unlock the full potential of women's DHTs, we need an intersectionality approach, dedicated women's health funds, and strong partnerships between academia, industry, government, and citizens. A targeted research agenda is needed to ensure that all women have access to equitable, effective, and safe Women's Digital Health Technologies.

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All authors declare no financial or non-financial competing interests.

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