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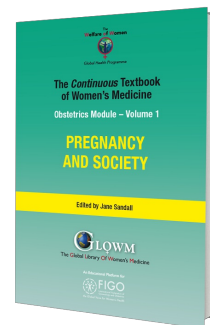
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Chapter

Digital Health and Care

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INTRODUCTION

Over the past 20 years, there has been an exponential growth in digital technologies to improve maternal health and support service provision. Digital technologies refer to 'the use of information and communications technology in support of health and health-related fields'.¹ These digital forms of support include the Internet, mobile technologies (mobile software applications or apps, wearables and text messaging), social media, telecare and remote monitoring devices. An increase in computational power has enabled the generation and storage of complex data within and beyond clinical settings. This together with the use of smart wearables and mobile phones, and artificial intelligence techniques, has enabled the advent of digital forms of diagnostic support and treatment, shifting care interactions away from formal healthcare settings, and facilitating self-management.^{2,3} Apps, for example, take advantage of mobile smartphone's capabilities such as phone calls, messaging (SMS), phone camera, global positioning systems (GPS) and associated digital networks including internet resources, and social media platforms to deliver information and tools to help manage health conditions in both high- and low-resource settings.^{4,5,6}

Potentially digital technologies offer innovative ways of enabling access to health information and services, improving service delivery efficiencies, supporting the acquisition of knowledge and skills, and influencing demand for and quality of health services.^{7,8,9,10,11,12,13,14} They also offer the capability to transform the way in which health services are accessed and delivered, and to facilitate the measurement of performance and quality improvement progress, improving transparency and connecting information systems for reporting and research.⁸ However, currently the evidence base on the effectiveness of digital technologies on healthcare outcomes is insufficient.^{12,13,14,15,16,17} Much of the evidence particularly in low- and middle-income countries comes from low- and moderate-quality studies.^{14,15} Poor descriptions of interventions and their mechanisms of impact present difficulties for interpretation and few have evaluated impacts on

patient outcomes.^{15,18} Programs require further testing before allocating resources to scale-up.¹⁹

However, calls to make digital health and care mainstream within service provision are burgeoning^{2,20,21,22} with the goal of making maternity healthcare increasingly comprehensive in terms of quality (inclusive of safety, equity, effectiveness, patient-centeredness, timeliness and efficiency).²³ Digital developments have been spurred on under the third Sustainable Development Goal (SDG) on health and well-being, which aims to end preventable maternal deaths and reduce global maternal mortality rate (MMR) to less than 70 per 100,000 live births by 2030.²⁴ This is also reflected in the global mobile health market; for example, there are currently more than 318,000 available health apps worldwide, with more than 200 new health apps made available daily.^{25,26} The mobile health market value is anticipated to reach USD 46 billion by 2020.²⁷ Set against this burgeoning commercial market, is the need to establish evidence of effectiveness and potential harms.

WHAT ARE THE WAYS IN WHICH DIGITAL WORKS?

WHO classification

In 2018 the World Health Organization provided a classification framework of digital health interventions (DHIs) to promote an accessible and bridging language for clients, providers, managers and planners.¹⁸ Also referred to as a taxonomy, this classification scheme focuses on the 'digital health intervention' and functionality of the digital technology to achieve health sector objectives.²⁸ A few examples are given below to illustrate the breadth of interventions contained in two of the WHO categories, those that are client and provider focused.

Client focused

Client facing tools offer women (and partners) enhanced capabilities to raise their health and risk consciousness, and engage in personal monitoring and self-management in the preconception, antenatal and postnatal period.^{29,30} Internet resources, forums, apps,³¹ chatbots,³² games,³³ and social media platforms can facilitate access to information about lifestyle, healthy choices, signs and symptoms of complications, treatment and services as well as peer support and sharing of information.³⁴ The rapidly expanding range of reproductive health Apps also has significance in terms of how these are conceptualized, assessed, categorized and regulated, i.e. health and fitness, medical (intervention), lifestyle.^{35,36}

Digital resources can enable women's decision making around choice of place of birth. Searching for online resources on pregnancy complications can be quick, easy and accessible, and can provide legitimacy for women unsure of the significance of their symptoms to seek professional help.^{37,38} Mobile health technologies using short-message services (SMS) to pregnant women can facilitate the exchange of information for health promotion,³⁹ uptake of services,⁴⁰ as well as support the self-report of women's psychological well-being.⁴¹ Mobile health technologies also have the potential to help overcome stigma and support disclosure.⁴² In addition, forums, social media and wearables are providing social support facilitating the sharing of maternal experiences and knowledge.⁴³ For instance, a physical wearable maternity waistband is making it possible for women to share the activity of their babies and movements with their partners and extended social networks.⁴⁴ Avatars and new forms of immersive environments provide women with the opportunity to engage with others experiencing similar circumstances preserving their anonymity.⁴⁵ Self-monitoring and wearable devices enable women to engage in tracking activities of health parameters, making these visible not only for them, but also for their partners facilitating self-reflection.⁴⁶

However, there are potential adverse and unintended consequences associated with increased access to information. The term 'cyberchondria' refers to the escalation of health anxiety prompted by Internet searching.⁴⁷ Women can experience feelings of heightened anxiety and awareness of risk and blame, particularly regarding their decision making around help seeking for perinatal complications.^{22,48} Baby monitors and wearable devices can also enhance anxiety through continued use and overuse⁴⁹ as well as frequent alarms.⁵⁰ In Barkin and Jani's focus group study of new motherhood, women described a sense of responsibility regarding health advocacy, leading to a search for more

information.⁵¹ The moral weight to be a 'good parent' and comply with medical advice is particularly great in pregnancy.⁵²

In high-income countries (HICs), in particular, there is a concern that digital resources operate within a separate 'social space' to clinical encounters and consultations.⁵³ The risk averse nature of online symptom checkers tend to 'over-diagnose' and encourage care seeking,⁵² potentially adding to already overstretched services. Use of online resources is reported to be influenced by professional and organizational factors such as decreased antenatal visits,³⁸ timing of visits,⁵³ time pressures and reduced midwifery contact time and provision of individualized responsive care.⁵³

The desired outcome of using digital technologies to transfer health care and health resources is also often undermined by sociotechnical challenges, the mismatch between designs and user needs as well as barriers specific to at-risk populations.⁵⁴ Zibrik *et al.*⁵⁴ found language and cultural barriers inhibit engagement with digital tools. In a multivariate analysis of the US 2011–2015 National Health Interview Survey data, Wang *et al.*⁵⁵ argue that immigrants with higher English-language proficiency are more likely to use digital health services than are immigrants with lower English-language proficiency. Further research found that country-of-origin media (including the Internet) are important health information sources for Chinese immigrants in Seattle and Vancouver.⁵⁶

Concerns have also been raised about the quality of information available on the Internet.⁵⁷ Studies have highlighted variability in digital health information and apps in terms of content reliability and trustworthiness.^{58,59,60} Other constraints include the competency required for users to assess the accuracy of information given the accessibility and readability of many online resources.⁶¹ A woman's level of health literacy influences her ability to source information and subsequent health knowledge and behavior.⁶² In low-income countries (LICs) women and their partners are engaging in health-related conversations through SMS,⁶³ and receive health education and feedback by community health workers through the use of mobile multimedia resources.⁶⁴ In India, interactive radio shows⁶ and videos⁶⁵ are enabling women's access to maternal health information and services as well as sharing experiences and receive support from their communities. In Ethiopia, a serious game (a digital game with an explicit educational purpose) has been implemented to provide nutritional and maternal health information to women.⁶⁶ However, women have been shown to face multiple difficulties in use of mobile phones, demonstrating important gender inequalities, in terms of access to phones, credit and functionalities of the phone.⁶⁷ The variety of opportunities/constraints offered posed by digital technologies and their role in reconfiguring women's health literacy, is forming a new area of study on digital literacy.⁶⁸

Provider focused

Digital technologies can enable timely management of maternal complications at the point-of-care and via referral processes. Telemedicine and telecare are examples of digital systems that extend access to specialist services beyond the physical confines of the clinic. These systems are designed mainly for or by healthcare professionals and introduced into the homes of women identified as high risk (e.g. with diabetes or pre-eclampsia) to support for example video consultations^{44,69} as well as remote monitoring and transmission of health parameters from the home to the hospital.⁷⁰

Digital technologies can improve care provision and provide sources for physicians for information/knowledge seeking.⁷¹ They can also facilitate exchange of educational and informational resources among health professionals in open or closed professional networks. One example is Sermo, the largest online physician communities in the US with over 115,000 members.⁷² While there is rapid development of physician-only communities like Sermo and Medscape's Physician Connect, researchers argue that physicians need to be educated to manage the risks of using professional networks such as violating HIPAA (Health Insurance Portability and Accountability Act) Compliance.⁷³ Virtual reality interfaces have been also used not only to support training of healthcare professionals⁷⁴ through simulations, but also to help managing anxiety associated with procedures, e.g. episiotomy repair.⁷⁵

Provider focused technologies are also targeted at LICs given the scope for improvement in maternal mortality and morbidity. They include interventions focused on providing training content about pregnancy and childbirth pathologies to healthcare providers including community health workers and midwives⁷⁶ as well as community monitoring and identification of a deterioration in maternal health.⁷⁷ One such example is the CRADLE device (a hand-held, upper-arm,

semi-automated device measuring blood pressure and pulse) which was found to be accepted by healthcare workers from a range of countries and levels of facility, including those with no previous vital signs measurement experience. The device motivated women to attend primary care and encouraged them to accept treatment and referral.⁷⁸

Other interventions focus on escalation of care and communication of concerns to provider units. One of the earliest interventions to demonstrate improvement in mortality rates involved training community based traditional birth attendants (TBAs) on the signs and protocols for pregnancy complications, and equipping them with walkie-talkies linked to health units, alongside basic clinical obstetric instruments in rural Uganda.⁷⁹ Providing mobile phones and phone credit enabled community level midwives to link with specialists and helped build their confidence and capacity to deal with complex cases.⁸⁰

Diagnostic and clinical decision support technologies are also of special interest in low-resource settings because of their value in expanding service delivery capacity by redistributing responsibilities and improving health workers' performance.^{9,81} However, questions still remain regarding their cost-effectiveness, accuracy and clinical impact in low-resource settings.^{9,82,83} These technologies can have unintended consequences including increasing workload, duplicating workflow processes, and undermining trust within teams, when the expertise of decision support systems conflicts with the knowledge and expertise of health workers.⁹

Constraints with these health provider-focused interventions include local attitudes and beliefs (e.g. distrust of new technologies) and structural constraints, such as unreliable emergency transport, and poor quality of services at health facilities which have been found to restrict benefits at health outcomes level.³⁹ Whilst digital technologies can mediate care processes and extend boundaries systemic and contextual challenges such as resource shortages and geographical inaccessibility are not easily overcome.^{84,85}

WIDER INFRASTRUCTURES AND IMPLEMENTATION STRATEGIES

Experts from academia, government and private health organizations have identified four broad priority domains where digital health infrastructure needs to be developed: technical advances and innovation, knowledge generation and use, engaging patients and the population and fostering stewardship and governance.⁸⁶ For digital technologies to be sustained and integrated into routine use for both patients and healthcare professionals alike, initial and refresher training of users, technical and supervisory support, trust in decision recommendations and well-resourced health systems have been found to be necessary.⁹ Beyond usability and viability studies, advocates of innovative technologies for maternal care need to consider how implementation strategies and contextual factors, such as existing collaborations and supervision styles, trigger mechanisms that influence program outcomes.⁹ Socio-cultural factors and community power dynamics are important to consider when designing digital health interventions that are culturally and linguistically appropriate.^{87,88}

Design rationale in the development of digital technologies has traditionally relied on the medical perspective and the clinical or healthcare provider perspective.^{89,90} In clinical settings, digital technologies tend to be embedded in an environment where healthcare professionals have the medical knowledge and the equipment, and resources and IT support are usually available. Here, system designers usually perceive the hospital as an environment where healthcare professionals or service workers, and not the women, take an active role in the performance of healthcare practices, e.g. a nurse or midwife requesting transport.⁸⁹ However, introducing digital technologies into hospital care is different from introducing technologies into the home and in people's everyday life.⁴⁴ The home and other non-clinical settings and the hospital are very different social worlds with their own cultural and socio-technical practices that challenge the way designers and researchers can address specific issues and difficulties, while developing digital health technologies.⁹⁰ Indeed, one of the main reasons of failures of medical devices is the mismatch between the design of a particular device and the context of its use.⁹¹ Digital technologies designed under the traditional model of medical care are unable to consider the complexities and experiences of performing self-care activities as part of women's and partner's everyday life.⁴⁴

Applying user- and patient-centered and participatory design approaches^{41,92} can help balance the influence that

different stakeholders might have in the design of digital health interventions in order to enhance the health and well-being of women and the provision of healthcare services. There is the risk that social inequalities are reinforced in information networks and communication processes unless policies are implemented to address this – unequal competencies and skills to access resources and navigate the system are reinforced by unequal positions in social, economic and political networks.⁹³ Papers discussed in this chapter have already highlighted the risk faced by socially disadvantaged groups. With regard to the general population, Kontos and colleagues' study found significant differences in digital use determined by socioeconomic status (SES) in the US.⁹⁴ They argue clinical care and public health communication should acknowledge differential digital health usage to address inequalities in health communication and health.

GAPS IN EXISTING EVIDENCE BASE

Technical advances in digital resources have so far 'outpaced the development of ethical and regulatory frameworks needed to ensure their appropriate implementation'.³ Digital technologies are often rapidly developed and tend to 'iterate, update, and improve, rather than provide a stable common intervention'.⁹⁵ Opinions differ as to whether digital medicine should be held to the same standards as new drugs or devices. Arguably oversight is required to ensure that technology supports healthcare staff and healthcare systems effectively, and complies with patient safety.⁹⁶

The role of private industry in driving digital health transformation is of concern particularly given this may not involve users in the development process or link to robust evaluations. The relatively low barriers to market entry have encouraged innovative small and medium sized companies, often new to the health market. Research, especially for artificial intelligence (AI) work, remains centered on machine learning outcomes, and the shift to clinical outcomes has not kept pace with the products' move into clinical practice. Inherently, digital products collect a wealth of data in real time, and other methods of evaluation might be better suited to this sector.⁹⁷

In addition, in relation to app development, boundaries between those that are deemed as lifestyle orientated and those that are health focused are increasingly blurred, and intertwined with regulatory demarcations.⁹⁸ This raises questions about the role of what is deemed public and private, and provides an alternate framing to medicalization and ways maternal 'health is done'.⁹⁹

OPPORTUNITIES FOR FUTURE RESEARCH/IMPLICATIONS FOR CARE

Digital health continues to extend techno-scientific approaches to information management, risk identification and clinical management beyond the traditional physical boundaries of the clinic. Expert scientific knowledge focuses on specific technical risks (e.g. spontaneous preterm birth, blood pressure, age, weight gain, physical (in) activity). This expert scientific knowledge is expressed through an increasingly diverse number of digital applications, and form part of the complex network of discourses and practices directed at identifying and containing risk in pregnancy. Future research could usefully interrogate what is *new* and *distinct* about digital health and care⁹³ and how digital health can be at the same time *enabling* and *disempowering*.^{100,101}

As digital technologies become increasingly normalized within routine practices, there is also a need to move from a focus on specific forms of digital technology to more generic functionalities and 'blended' forms of the digital, including the internet, mobile programs (apps and text messaging) and social media.¹⁰² Digital research is often in the foreground and has as its focus the digital aspect, including who has access to it and how it is used, rather than selecting a particular social system as the focus, and exploring intersections between the digital, practices and relationships within it. It is crucial for researchers and designers to have an overview of the relevant concerns and key aspects surrounding the design space of digital technologies for a particular social system. By situating the digital within the social system in future research this would enable us to understand the multiple actors involved (digital designers, journalists, policy makers as well as users) and expand the field beyond individual experiences of health and illness to broader social, cultural and political influences.¹⁰³ Within maternal health, this would shift the focus to the biological and social process of reproduction that occurs on multiple levels, from individual embodiment to media influence and state policy, and

affect all the population.¹⁰⁴

Finally, it is important for further research to continue to interact with the gendered, age, and class dimensions of networked interaction.¹⁰⁵ Of particular importance is how traditional masculinities and femininities are associated with technologies. Apps and tracking devices seek to use data science to impose order on otherwise chaotic and disorderly female bodies. It is important to understand how women position these data in relation to their own embodied knowledges of their own bodies or others' experiences (shared through online communities).

PRACTICE RECOMMENDATIONS

- **Consider digital technologies as offering innovative ways of enabling access to health information and services, improving service delivery efficiencies, supporting the acquisition of knowledge and skills, and influencing demand for and quality of health services.**
- **Recognize that digital health interventions are not a substitute for functioning health systems, and that digital health is limited in what it can address.**
- **Pay careful attention to unintended and adverse consequences of digital technologies.**
- **Ensure training of users, technical and supervisory support, trust in decision recommendations and well-resourced health systems are in place to support implementation of digital technologies.**
- **Ensure digital health interventions are ethically, culturally and linguistically appropriate and that care is taken to address socio-technical challenges associated with introduction of digital technologies.**

CONFLICTS OF INTEREST

The authors of this chapter declare that they have no interests that conflict with the contents of the chapter.

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