Digital Health Equity

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Abstract: Digital health technologies have the potential to improve healthcare access, utilization, and experience for patients; at the same time, their development and use can reinforce, exacerbate, and even create health disparities. Applying a health equity lens to digital health innovations can help inform the equitable design and development of digital health tools. Specifically, areas of health equity impact that can be targeted in the development of a digital health technology include: the tool itself, including its design, technical development, integration into the healthcare environment, and evaluation; the technology's relationship to various end-users, including individuals, tech proprietors and developers, and the larger healthcare system; and its impact on identified health and social determinant outcomes. Targeting one or more of these areas can help support the design, development, and deployment of digital health tools that actively work to reduce health disparities and promote health equity for socially disadvantaged patient populations. More research is needed to understand the full effect of digital health technology on health disparities, and to develop best practices for equity-centered digital health implementation and evaluation.

Keywords: digital determinants of health; digital health equity; health disparities; health equity; the digital divide

INTRODUCTION

Despite remarkable progress in medical care over the last century, significant differences in healthcare access, experience, and outcomes continue to exist for many communities and individuals. *Health disparities* (sometimes referred to as *health inequalities*) are "differences in the burden of disease, injury, violence, or opportunities to achieve optimal health that are experienced by socially disadvantaged populations," as defined by race or ethnicity, sex, geographic location, socio-economic status, or other social factors (e.g., sexual orientation, disability, income) (1). Disparities in healthcare access, utilization, and outcomes contribute to significant global morbidity and mortality, and have profound impacts on quality of life, work, education, and wellbeing. Studies of health disparities in the United States have repeatedly found inequalities in morbidity and mortality, chronic disease burden, healthcare utilization, substance use disorder, and mental health and wellbeing among racial and ethnic monitories, women, the LGBTQ population, and indigenous Americans (2). Globally, significant disparities in health have been observed between high-, middle-, and low-income countries, as well as among vulnerable populations within countries (3).

While some health *differences* are attributable to variations in individual biology, physiology, or genetics, health *disparities* are the result of social and structural factors that confer a social disadvantage on an individual or population, disfavorably impacting their lived experience with healthcare. Disparities in health systematically put people who are already disadvantaged at further disadvantage with respect to their health, resulting in negative downstream effects on their ability to achieve social, political, and economic gains (4). Health disparities often stem from *health inequities* – "systematic differences in the health of groups and communities occupying unequal positions in society that are avoidable and unjust" – which are themselves influenced by *social determinants of health* (SDOH)*, or the conditions in which people are born, grow, live, work and age (5). Examples of SDOH include: safe housing and transportation; education, job opportunities, and income; food access and security; exposures to pollution and climate change; language and literacy skills; and racism, discrimination, and structural violence. These social and structural factors are distributed unevenly among individuals and communities, often as the result of social policies and practices that intentionally withhold or underinvest in them for specific populations, creating an environment of inequity that negatively impacts health and healthcare. SDOH are thought to account for between 30–55% of health outcomes and represent a major area of focus in health disparities care provision, policy, and research (5).

Health equity is the commitment to reducing and/or eliminating disparities in health. Ingrained within the various definitions of health equity are the concepts of human rights, social enfranchisement, distributive justice, and an effort to combat structural violence and institutional discrimination. Increasingly, a focus on health equity can be found in clinical care, research, health innovations, and commercial health products and services (6); however, challenges remain the pragmatic implementation of equity in health and to the clear identification and actualization of health equity-centered goals, processes, outcomes, and measures.

HEALTH (IN)EQUITY IN THE DIGITAL AGE

The digital age has brought about profound transformations in connectivity, access, and convenience for millions of people. This includes the field of digital health – "the field of knowledge and practice associated with the development and use of digital technologies to improve health" (3) including virtual health, mobile health apps (m-health), wearable devices, the Internet of medical things, artificial intelligence and machine learning, blockchain, and tools enabling the storage, exchange, advanced analysis and visualization of data. Prior to the novel coronavirus (COVID-19) pandemic, digital health represented a global market of between US $150 and $350 billion across multiple subcategories, with the markets for technologies in every category expected to grow annually by at least 8 percent (7). During the COVID-19 pandemic, digital health innovations – particularly telemedicine and remote patient monitoring (RPM) – were rapidly implemented and scaled across a variety of healthcare systems in an effort to address disruptions in in-person care delivery. These novel services provided ongoing access to healthcare and offered successful test-cases for technologies that had, prior to the pandemic, been limited in their use due to constraints at the levels of individual patients, providers, healthcare systems, payors, and regulatory and policy bodies.

Innovations in digital health technology have shown potential to improve health outcomes, patient safety, and healthcare quality and experience for patients (8, 9). However, digital health solutions may have unintended consequences for socially marginalized and disadvantaged populations, and may contribute to, exacerbate, or even create health disparities. The *digital divide* is a term that refers to gaps between individuals, communities, or larger populations of people that do or do not have access to critical technologies, including health technology. Globally, digital divides have been identified among racial/ethnic, gender, geographic, age, and income demographics, and include things like smart-phone use, access to broadband, Internet use patterns, affordability of technologies and services, and digital literacy and confidence (10).

Unfortunately, to date, very few studies have systematically looked at the relationship between digital health technology and health equity across the spectrum of socially disadvantaged populations, and the complexity of its interactions with SDOH is only beginning to be explored (1). *Digital determinants of health* (DDOH) is a term of growing popularity that describes the unique elements of people's experiences with the digital health ecosystem that impact their experience of health and healthcare. Like their SDOH counterparts, DDOH incorporate individual, community, and systems level factors (Figure 1). *Individual factors* describe an individual's experiences with digital health technology, including use patterns and habits (e.g., frequency of Internet use, amount of screen time), as well as digital skills such as digital health literacy, digital confidence, and digital self-efficacy (11). Of note, *biological factors* are also sometimes included in this level – as mentioned earlier, however, while biological traits such as genetic race or age may contribute to small differences in an individual's health, it is more often the social constructs *around* those factors such as racism or ageism that contribute to health disparities. *Social and community factors* incorporate the larger representative population's relationship with technology, including cultural beliefs and communal
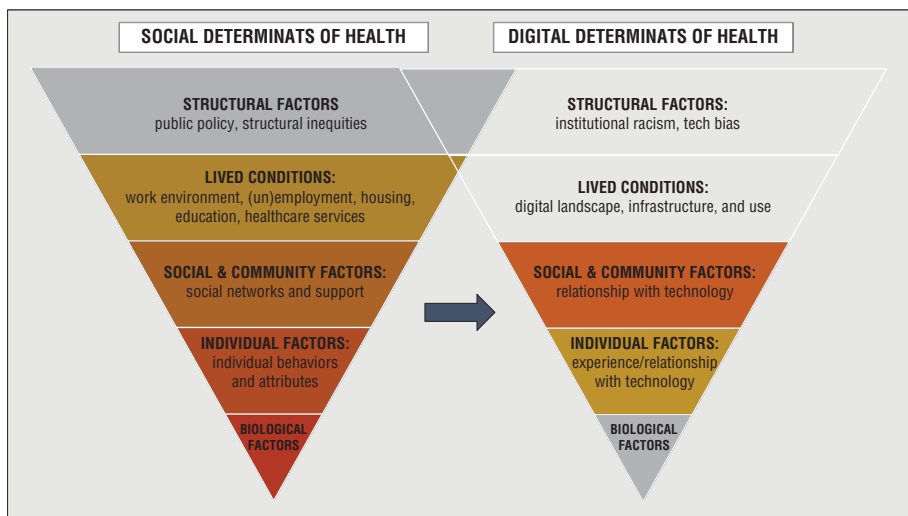
Figure 1. **Social and Digital Determinants of Health.**

attitudes; these include perceptions of usability and usefulness, as well as trust, privacy and security, surveillance, and experiences with tech bias or discrimination. *Lived conditions* are the digital environments a person or community experiences, including infrastructure and services; geographic areas that lack access to affordable quality technologies such as Internet broadband, known as "digital deserts" is one example. Finally, *structural factors* are the larger policies, practices, and beliefs of a society that influence and (re)inforce a socially disadvantaged group's interactions with technology and include things like structural racism and tech bias.

Each of these determinants impacts the ability of a digital health technology to improve health outcomes and contributes to a technology's effects on health disparities. DDOH are often multi-factorial and can be complexly inter-related, in addition to interacting with SDOH at multiple levels.

APPROACHING AND ADVANCING DIGITAL HEALTH EQUITY

While the concept of digital health equity is still emerging, at its center is the acknowledgement that digital health technology has the potential to both ameliorate *and* exacerbate health disparities. As stated by the World Health Organization (WHO) in their global strategy on digital health 2020–2025 "Digital health should be an integral part of health priorities and benefit people in a way that is ethical, safe, secure, reliable, equitable and sustainable" (12). This includes emphasizing key principles such as transparency, accessibility, scalability, privacy, security, and confidentiality – all factors that can contribute to the equitable design, development, use, and impact of digital health tools. At the same time, there is growing

recognition that industries supporting digital health innovation – such as bio- and med-tech startups, big pharma, and Silicon Valley – must themselves be more diverse, equitable, and inclusive (DEI) in order for their products to be both effective and valid as tools to reduce disparities. As such, digital health tools must strive to: (i) improve health outcomes, equitably; (ii) mitigate or actively reduce general digital inequity; and (iii) be themselves equitably designed, developed, and implemented.

To attain this goal, target areas for equity considerations in the digital health technology ecosystem and pipeline include: the digital health tool itself, including its design, technical development, deployment into the healthcare environment, and evaluation; the technology's relationship at various levels to the individual end-user, its proprietors (e.g., a digital health startup or corporation, the design team, developers), and the larger healthcare system; and its effects on target health and health determinant outcomes (Figure 2). At each of these points are opportunities for and challenges to promoting equity; these can either be selectively targeted for intervention or incorporated into larger strategies of equity promotion or inequity mitigation.

This model presents one of many ways of conceptualizing digital health equity, in a field that is continuing to grow and expand. Other models include the Digital Health Equity Framework (DHEF) and the Framework for Digital Health Equity, adapted from the U.S. National Institute on Minority Health and Health Disparities Research Framework (13, 14).

Building equitable digital health tools

Equitable digital health *product design* and *technical development* can benefit from the complementary strategies of human-centered design (HCD) and Agile software development, two processes that are well-established in the tech industry
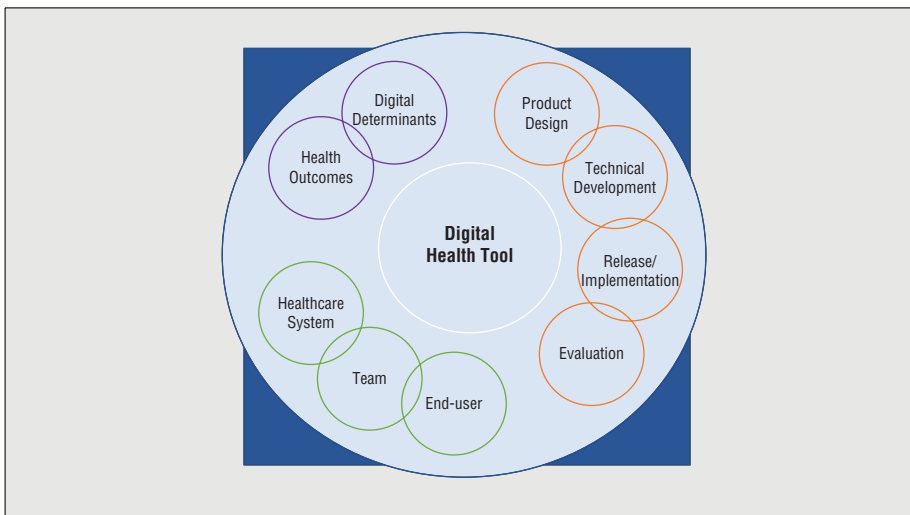

Figure 2. **Target areas for equity considerations in the digital health technology development.**

and are emerging as effective tools for product development in healthcare delivery and research. HCD utilizes repeat cycles of ideation, prototyping, testing, and refinement to develop digital health interventions that incorporate the needs and preferences of end-users (e.g., patients, clinicians, caregivers). Agile is an iterative process first used in software development that involves reviewing the software or product requirements at every stage of development and generating partial deliverables for stakeholders and end users. Both strategies allow for rapid, iterative development of technology products, and for stakeholders to be actively involved in the development process from inception to implementation. Both are also increasingly informed by equity-centered perspectives; equity-centered design approaches (in particular, equity-orient human computer interaction design [HCI]), critical design, and liberatory design are some examples from the world of product, HCI, and experience design (15–17). It is important to recognize, however, that while HCD and Agile offer blueprints for equitable design and development of digital health tools, the strategies themselves are not inherently equitable; explicit commitment is needed on the part of those using these strategies to prioritize equity, inclusion, and representativeness, and to ensure that the perspectives of socially disadvantage and underrepresented parties are included.

Once digital health tools have been developed, their release into the live environment of the healthcare system offers critical moments for evaluating and addressing any impacts on health inequity; this is the case for all digital health technologies, not only those expressly designed to address health disparities. Unfortunately, systematic long-term assessments of the impact of digital health technologies on health disparities are lacking, and requirements for ongoing evaluation, validation, and/or remediation of adverse effects of a technology on health disparities have been largely absent. Approaches to evaluating a digital health technology's impact on health disparities and/or equity can be effectively adapted from existing clinical, research, or industry models. For example, *implementation science* (sometimes known as knowledge translation science) frameworks such as "RE-AIM" (Reach, Effectiveness, Adoption, Implementation, and Maintenance) and Proctor's Implementation Outcomes Framework (IOF) offer means to understand *how* evidence-based interventions are taken up in real-world contexts, and to optimize specific intervention goals such as adoption, sustainability, or cost (18); these frameworks can be applied to digital health technologies, and can be adapted to incorporate equity goals more explicitly (19–21). Similarly, business development approaches to product metrics such as the Pirate Metrics (acquisition, activation, retention, referral, and revenue) (22) can be repurposed to highlight equity-centered goals for digital health products – for example, redefining *acquisition* (how a company attains customers) to focus on the recruitment of diverse patient end-users and *retention* (how a company keeps customers) to focus on empowerment, representativeness, or enfranchisement. Whatever the approach, having a plan in place that incorporates equity into the implementation and evaluation of digital health tools can help ensure these technologies do not contribute to health disparities.

Incorporating stakeholders in equitable digital health innovations

Key stakeholders in the development of a digital health technology include: *individual end-users*, or those who are the intended customers or recipients of a digital

health tool; the *technology team,* including proprietors (e.g., startup founders, intellectual property owners, patent holders), technologists, and designers and developers; and players in the larger *healthcare system.*

At the individual level, participatory design frameworks from research and consumer insights fields that serve to actively identify, incorporate, and enfranchise disadvantaged stakeholders in the process of building health interventions can be leveraged to ensure that digital health tools are effective, appropriate, and equitable across a diversity of users. Care should be taken to ensure that representatives of disadvantaged communities are appropriately acknowledged, incorporated, and supported at each step of the technology development pipeline, that feedback is regularly and actively solicited, and that changes to digital health products are reflective of this feedback.

Increasingly, the global technology industry (particularly Silicon Valley) has been criticized for its lack of diversity and equity, where people of color and women are grossly underrepresented and are unable to make professional advances at the same rate as their white and male colleagues (23). To address equity at the level of a digital health technology team – such as a startup, corporation, or non-profit organization – requires meaningful investment in diversity, equity, and inclusion (DEI) efforts that promote representativeness and enfranchisement of its diverse employees, members, or contributors. It also means critically evaluating the processes used by teams to develop digital health technologies (including corporate culture), and putting into place procedures that explicitly center equity, address bias, and mitigate potential harms.

A final key stakeholder in digital health is the *larger healthcare system*, which drives specific use-cases for digital health technologies (e.g., artificial intelligence for radiology practices) and can support or hinder the effective wide-spread adoption and use of digital health tools. Priorities areas for healthcare systems to support digital health equity include the development of infrastructure for data integration, interoperability, and analysis in a way that promotes "data solidarity" – an approach to health data that emphasizes data justice and equity and centers those potentially disadvantaged by health data and technology use (24). Additionally, beyond individual healthcare systems is the network of health policies, payor environments, and regulatory practices that interact with digital health tools to create healthcare experiences and may inadvertently (or explicitly) drive health inequities – health technologists committed to advancing digital health equity should have an understanding of these players and be able to identify key priorities for equity promotion and disparity reduction.

Using digital health tools to improve health outcomes

Measurement of health disparities and health equity continues to evolve as our understanding of their contexts and complexities improves. In general, the most common measurements of health disparities look at "preventable" differences in health outcomes across specific demographics (e.g., race, income, zipcode); interventions that reduce the difference in these outcomes are considered to be effectively addressing health disparities and/or promoting health equity. But the clinical effectiveness of an intervention is only one way to measure its impact – as discussed, equity can be defined and evaluated in a number of ways across a variety of metrics, priorities, and goals, as well as at multiple points in time.

If achieving health equity is the goal, the outcome may not always be tied to a specific disease; rather, it may focus on specific SDOH or DDOH such as healthcare delivery outcomes (e.g. access, utilization, or experience), or structural outcomes (e.g., broadband access, algorithmic bias, or DEI in the healthcare workforce).

Currently, concrete measurement tools that assess the impact of digital health technologies on health disparities *beyond* health outcomes are lacking. However, concrete examples of measures that can be adapted to digital health in the United States include Medicare's value-based purchasing (VBP) programs, which target quality improvement outcomes through service enhancements, patient engagement activities, and adoption of best practices; the Measurement Framework for Evaluating How Well an Organization Meets National CLAS Standards; the National Quality Forum (NQF) Disparities-Sensitive Measure Assessment, which operationalizes existing quality metrics for specific use in health disparities efforts in the ambulatory care setting; and CAHPS and HEDIS data for Medicare Beneficiaries (25). These measures capture important healthcare metrics *beyond* health outcomes, and can be used to assess disparities and prioritize digital health interventions among socially disadvantaged populations. More work is needed, however, to rigorously define, capture, and analyze health equity outcomes; doing so will help guide more effective and targeted development of equity-focused digital health innovations.

CONCLUSION

Digital health is a growing area of healthcare delivery that increasingly impacts the healthcare experiences of patients, providers, and others across the industry. Digital health technologies have the opportunity to significantly improve care for individuals and populations; at the same time, however, digital health tools can contribute to and even create health disparities for socially disadvantaged groups. Approaches to digital health that focus on health equity – the active commitment to reducing health disparities and improving the experience of healthcare for diverse, marginalized, and underrepresented patient populations – can help ensure that digital technologies in healthcare are designed, developed, and deployed in an effective and equitable manner. Solutions for building and implementing equitable digital health tools can be found along multiple places in the development pipeline and within the digital health ecosystem; these include the design, technical development, release, and evaluation of a digital technology into the healthcare system, as well as its relationship to a variety of stakeholders, health outcomes, and social and digital determinants. Ongoing work in industry, research, and clinical practice continues to identify strategies for the prioritization of health equity, as well as to diversity, equity, and inclusion within the industry itself. More research is needed to develop validated processes and measures to identify, prevent, and mitigate inequity in digital health. The active participation of digital health corporate interests, advocacy groups, regulatory and policy bodies, and patients themselves is critical to creating a future of digital health that supports those who most stand to benefit from a more equitable, fair, and just healthcare system.

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