

Digital Determinants of Health: Opportunities and Risks Amidst Health Inequities

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Digital technologies, with their vast transformative potential for healthcare, also come with an accompanying set of Ethical, Legal, and Social Implications, underscored by concerns regarding patient safety, transparency, and impacts on health equity.¹ Traditionally, pursuing health equity has been reactionary, often lagging behind swift changes in healthcare systems. Yet, with the burgeoning of digital health and rapidly increasing healthcare delivery through digital technologies, there is a prime opportunity to change this pattern of behavior. Alongside our growing understanding of social determinants of health (SDoH), the digital health transformation can inform how we effectively deviate from the persistence of health disparities.² Therefore, digitization of care must not be considered solely for efficiency but also as a means to proactively embed safeguards into care delivery processes and mitigate future inequities.³

Emerging from this digital revolution is a new class of health and disease drivers, termed Digital Determinants of Health (DDoH). Stemming from disparities in health data representation and the unequal distribution and usage of data-driven technology, they encompass various factors, including accessibility to digital health information, availability of digital healthcare providers, automation within healthcare systems, and

the degree of individual or communal contributions to digital health knowledge repositories (Box 1).⁴

DDoH echo patterns observed in previous system evolutions, where overlooking group differences led to amplified disparities, subgroup segregation, and structural pathway impacts.⁵ These resulted in SDoH, non-clinical factors affecting health outcomes, which seeped into clinical care as Social Determinants of Care- elements influencing the likelihood of receiving effective and timely diagnostics and treatments.⁶ Digital health technologies promise to improve health outcomes, but their deployment should be approached with an understanding of the pathways of potential inequities. To adequately predict and prevent the marginalization of certain groups during these new developments, our strategies must evolve in tandem with the changing technological landscape, ensuring the promise of digital health benefits all, without exacerbating disparities.

Exploring DDoH in Healthcare

The integrity of digital health technologies hinges on the characteristics of the data used to train and calibrate them. Consequently, overlooking diversity in datasets might cause significant downstream disparities.⁷ Artificial Intelligence (AI) models have become the classic example, learning and subsequently reproducing the biases inherent in training data.⁴ Consider, regional subgroup variations in antibiotic choices or treatment thresholds could influence prediction and optimization, potentially leading to suboptimal or even harmful recommendations. Similarly, treatment delays or varying medical note quality, which can be influenced by factors like patient ethnicity or language proficiency, can also affect model development in unpredictable ways. Additionally, the extent to which baseline measurements are established by pre-acute states as measured in regular hospital visits will operate differently depending on healthcare access and uptake.⁸

Participation in digital health systems increasingly becomes a determinant of health as systems continually evolve and are used to address future health needs. Therefore, access to and utilization of digital health systems becomes crucial to health outcomes. Analogous to health literacy, digital literacy becomes an essential competence for optimally leveraging digital tools.

Box 1. Examples of Digital Determinants of Health

Language Concordance	The language used in digital health tools can present a barrier or facilitator for patient engagement. In multilingual societies, providing digital health services in a language the patient understands is critical to ensure optimal use and to avoid misunderstandings or misuse.
Digital Representation	Ensuring diversity in digital health data, including varying health conditions, socio-demographic factors, and cultural contexts, can help avoid skewed AI model performance. This might mean considering factors like disease etiology, treatment patterns, and patient lifestyles in nephrology.
Device Calibration	The accuracy of digital health technologies, such as remote monitoring devices, can vary based on calibration settings. In nephrology, devices used for home dialysis or remote monitoring of renal function need to be accurately calibrated for each patient, considering individual variations.
Digital Literacy	Like traditional health literacy, digital literacy - the ability to find, understand, and use digital health information and tools - is key to utilizing digital health technologies effectively. This is particularly relevant in nephrology, where patients might engage with technologies for home dialysis, teleconsultations, or digital health records.
Digital Access	This refers to the ability of individuals to access and utilize digital health resources, which is significantly influenced by factors like the availability of high-speed internet, possession of digital devices, and the presence of a reliable electricity supply.

Establishing the Groundwork for Equitable Digital Health Ecosystems

While innovations inherently tend to favor certain demographics initially, it is incumbent on the system to channel these technological breakthroughs for the benefit of all. As we proceed into the realm of digital healthcare and AI, the rules of operation and the requisite infrastructure have yet to be cast in stone. This offers us the unique privilege of shaping the foundation based on goal-oriented ideals, unlike making minor advancements within an already entrenched, mature field. With this foresight, each future digital health initiative can be leveraged as a catalyst for health equity, provided we adopt an equity-centric approach from the inception. However, even as we accept that no revolution has ever resulted in all groups benefiting equally, the predictable replication of existing and historical bias in digital health systems cannot be ignored as an unfortunate inevitability if it is possible to intervene. Furthermore, refraining from proactive intervention to promote equity would operate as an unacceptable passivity when confronted with predictable and unnecessary morbidity and mortality disproportionately affecting segments of the population. Therefore, it is critical to develop an equitable digital health ecosystem that systematically scrutinizes, investigates, devises interventions, and evaluates impacts to interrupt technological pathways to health inequities.⁹

This ecosystem should incorporate measures that proactively and systematically detect disparate effects. Further, they should work to reduce system latency, ensure faster deployment of correcting interventions, and periodically re-evaluate the impact of these interventions over time. An equity-focused approach could also include diversified decision-making bodies and participatory citizen science, allowing varied perspectives to meaningfully inform the agenda that will affect them either directly or indirectly.¹⁰ This coincides with patient education which is rooted in participatory agenda-setting and departs from the deficit model both in process and content. Digitization unlocks unparalleled opportunities to democratize knowledge, disseminate health information, and serve patients beyond the confines of hospitals, affording potentially significant

advantages for prevention and early intervention. Equipping individuals with an understanding of their data, its significance, and how it contributes to improved outcomes and their care capabilities is critical. This will ensure that data collection and analysis are not just a procedural task, but an integral part of holistic patient care.

Charting a Path for Equitable Digitization

Technology is often heralded as the great leveler, uplifting societies through democratizing and decentralizing knowledge and healthcare access. However, it can also intensify disparities through various pathways, including enabling scalable privilege, particularly in AI-driven technologies. This dual nature facilitates a new form of centralization, as those adept at leveraging these advancements can amplify benefits for a broader group.

An emphasis on developing robust equity frameworks during this malleable development period should be viewed, first and foremost, as a rare opportunity to take meaningful action on long-professed commitments and simultaneously promote and support responsible and ethical innovation in healthcare. We must ensure that, as systems mature and practices solidify, we do not find ourselves in digital ecosystems that, through technical infrastructure and norms of practice, perpetuate inequity more readily than fostering health equity. Choices made now will likely dictate the course for the next several decades. It is, therefore, crucial to deliberate and purposefully establish the foundations for using digital health tools and AI that serve society in safe and equitable ways.

Acknowledging the indispensable need for new equity frameworks is crucial to ensure that the long-term implications of technological developments are inclusive and beneficial for all. It is within our grasp to harness the power of technology to create a healthcare system that truly serves everyone, effectively turning the tides towards a future of health equity.

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