Digital health at the age of the Anthropocene

In 2019, *The Shift Project*[1] published a report to increase awareness of the environmental effects of information and communication technologies (ICTs), particularly smartphone production and use, the multiplication of connected Internet of things (IoT) devices (eg, smartwatches), and data traffic and storage. The conclusion of the report is straightforward: trends in digital consumption are not sustainable with respect to required energy and materials and systems-wide action is needed. Here, we aim to promote reflection on the environmental implications of ICTs in the health sector.

Digital technologies production and their use overall is likely to rise sharply in the 2020s, increasing global energy consumption.[1,2] The digital health sector follows these trends, driven in part by precision medicine—ie, growth in the physical activity and sleep devices market, health apps, and IoT health-care devices, which contribute increased data traffic and storage. The specific environmental effects of this industry are threefold. First, digital technology production and use are consuming a greater proportion of worldwide electricity, which ultimately increases greenhouse gas emissions and seriously undermines the energy objectives of the 2015 Paris Agreement.[1,2] Second, digital technology production requires metal consumption, and the extraction and life cycle of metal significantly contributes to greenhouse gas emissions and soil pollution, particularly since digital devices are not well recycled.[1] 28 million metric tons of electronic waste are generated yearly worldwide (65% from Europe and North America),[3] with much of the waste exported to low-income and middle-income countries. To access the metals, devices are commonly broken or burned to remove plastic casings, which leads to significant health issues among workers and local residents living near places where e-waste is processed.[3] Third, some metals that are needed to produce

Panel: **Guiding principles and concrete actions towards a more sustainable digital health system**

Digital temperance instead of overconsumption and overpromotion

By temperance, we refer to a shift in attitudes towards restraint in production, use, and promotion of digital technologies, whenever possible (ie, the benefits outweigh the costs).

- Environmental audits of ICTs used in digital health research could be done to estimate effect and guide strategies to reduce the potential negative effects of a given digital health research project
- Methods selection should account for resource efficiency, particularly in the early phases of research projects; for example, well designed small data approaches (eg, n-of-1 crossover designs [appendix]) could enable more information from less resources when testing pilot interventions
- Academics and clinicians could teach digital temperance to their students and patients

Lifecycles instead of waste

A product's lifecycle is the steps a product passes through from production to end of life. Sustainable products are defined by the low-tech movement as repairable, recyclable, and designed to have minimum ecological effect across the design, creation, production, storage, and reuse, recycle, or destruction of the device.

- Researchers and clinicians should pay attention to low-tech criteria (eg, remanufactured, easy to repair, responsibly sourced) within their digital health work and put pressure on manufacturers to prioritise these criteria; this action could accelerate progress towards effective lifecycles of digital health products
- Digital health products with more sustainable lifecycles could be highlighted either via labels or as recommended or even required products by funders
- Shared resource pools should become the default over buying new; universities, companies, and health-care organisations should develop (or optimise) shared platforms to pool resources with others and share digital health devices; such initiatives already exist (eg, RecycleHealth collects and refurbishes fitness trackers for underserved populations)

Complex systems approach instead of reductivism

A reductionist approach (ie, investigating a system through its isolated parts) is, arguably, incapable of providing accurate information to address environmental problems, which are highly interconnected, thus requiring a complex systems approach.

- Interdisciplinary and cross-sector collaboration is needed to estimate the state and future trends of the digitalisation of the health sector and its direct and indirect environmental effects (ie, beyond its effects on health); such work might help, for example, to estimate potential rebound effects (eg, a situation in which improvements in the technical efficiency of energy use lead to greater direct or indirect energy consumption) or antagonistic effects that might occur through the promotion of digital health technologies
- Digital health researchers and clinicians should move to a complex systems approach, seeking out interdisciplinary collaborations and systematically considering both the short-term and long-term effects on health but also environmental and ethical implications of particular digital health technologies before promoting such solutions to larger audiences

These recommendations are based on previous work (appendix).

See Online for appendix

For more on **RecycleHealth** see https://www.recyclehealth.com

digital technologies (eg, niobium and tantalum, from the metallic ore coltan) could be extracted unethically or illegally, such as via child labour and slavery.[4] Moreover, most rare metals are produced in conflict zones or controlled by monopolistic entities, which causes environmental problems and creates fragility in supply chains.[1] These issues, coupled with inherent planetary limits, raise questions about our capacity to continue to access and build health devices in the future.[5]

To be sure, the health sector is not solely responsible for the negative impacts of ICTs. Most data flows are attributable to services from the GAFAM/BATX group (ie, Google, Apple, Facebook, Amazon, and Microsoft; Baidu, Alibaba, Tencent, and Xiaomi).[1] Moreover, digital health (because of its laudable goals) might deserve prioritisation over other sectors. Digital health technologies have revolutionised medical practice and could feasibly reduce carbon emissions via strategies such as telemedicine. We are not arguing to stop scientific and medical progress. Rather, our goal is to raise awareness and offer possible actions towards a more sustainable digital health system. In the panel, we present three guiding principles and tangible recommendations for researchers and clinicians to minimise the environmental repercussions of digital health technologies. Additional reading material supporting our statements are available in the appendix.

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