Governing health futures 2030: Growing up in a digital world

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Section 1 – The scope of the Commission

We want this report to be a wake-up call for health and digital policy-makers. Digital technologies are transforming health, healthcare, and public health systems across the world, and they carry great potential to improve people's health and well-being.

At the same time, weak governance of digital transformations has led to uneven effects globally, endangering democracy, limiting the agency of patients and communities, increasing health inequities, eroding trust, and compromising human rights, including in the field of health.

As health emerges as a key driver of innovation and a business frontier for major tech companies and platforms all around the world, a value-based governance framework based on Health for All values is an urgent requirement if we want to reap the positive potentials of the interface between universal health coverage (UHC) and digital technologies.

The Lancet & Financial Times Commission *Governing health futures 2030: Growing up in a digital world* was tasked to explore the convergence of digital health, artificial intelligence (AI), and other emerging technologies with UHC. The Commission paid special attention to children and young people,[*] convinced that maximising their safety and well-being in an age of digital transformations represents a litmus test for the whole of society and its concern for the most vulnerable. In so doing, the Commission's work builds upon, and interacts with, the efforts of previous *Lancet* Commissions that have highlighted the negative effects of underinvestment in the health and well-being of young people and made a moral and economic case for investing in children's health and development as foundations for better health across the life course and the improvement of societies.[1,2]

The work of the Commission began in 2019, amidst growing awareness about the steep task faced by the international community in its efforts to achieve the Sustainable Development Goals (SDGs) by 2030 despite a financing gap that – before the COVID-19 pandemic - already amounted to at least USD 2.5 trillion per year.[3] In the space of a few months, not only would COVID-19 force us to move much of the Commission's activities online, it would also shine a light on, and raise the political profile of, many of the issues that the Commission was already aiming to tackle.

- First, the pandemic underscored the extent to which our societies – and their health - now depend on digital technologies to function, as well as the power of large providers and platforms.
- Second, it highlighted some of the deep concerns that the Commissioners were expressing about the potential ethical and human rights abuses that could derive from the use of digital technologies in the areas of health and healthcare.
- Third, it influenced the dynamics of digital transformations, as the health and well-being challenges brought by the pandemic boosted the willingness to adopt and develop digital

[*] When speaking of children and young people in this report, the Commission is referring to children and youth of all genders aged up to 25 years old. We are fully aware of structural gender inequalities in development, in healthcare and across all the aspects of digital transformations.

solutions among policy-makers and the general public, or more directly forced them to do so.

- Fourth, it heightened the concerns about the algorithmic reinforcement of discrimination against structurally disadvantaged groups, as well as the role of algorithmic processes in the dissemination of misinformation and disinformation.
- Fifth, it made it clear that these processes are fundamentally interconnected with broader themes of geopolitical competition, political economy dynamics, and related inequalities that are only likely to grow in relevance across potential health futures.

The scope of the Commission goes beyond a narrow technical view of digital health applications and health data use, which represent only partial components of how digital transformations impact health and well-being, now and in the future. Our report targets the broader societal and governance questions that emerge at the interface of digital and health transformations, and in doing so speaks directly to both health and digital communities across the public and private sectors, as well as in civil society.

Owing to the complex, multi-causal, and constantly evolving nature of these transformations, the gaps in the current evidence base represent a significant concern for our analysis. For example, there are ongoing debates about the impact of digital technology use on population health outcomes,[4] including with respect to children and young people.[5] In a similar vein, existing evidence on the broader societal impacts associated with dynamics of data extraction and digital transformations tends to come from the social sciences, rather than medical research. However, we forcefully argue against postponing an analysis of the interface between digital technologies and health until more data becomes available. In line with established public health practice,[6,7] we suggest that a precautionary, value-based approach to the governance of digital transformations of health is necessary in the light of the significant risks and opportunities involved.

Our starting point is represented by the notion that digital transformations, and the technologies that drive them, must be led by public value and governed to benefit health and well-being in everyday life. Governing health futures by harnessing digital transformations means ensuring that the deployment of new tools and innovations serves to promote well-being, achieve UHC, and transform health systems and services to better serve patients and communities and keep them safe.

Panel 1: key glossary

Digital transformations: the multiple processes of integration of digital technology and data into all areas of everyday life, including health, and the resulting changes that they bring about.

Digital health: "the field of knowledge and practice associated with the development and use of digital technologies to improve health".[8] According to the US Food and Drug Administration, "The broad scope of digital health includes categories such as mobile health (mHealth), health information technology, wearable devices, telehealth and telemedicine, and personalized medicine [...] Digital health technologies use computing platforms, connectivity, software, and sensors for healthcare and related uses. These technologies span a wide range of uses, from applications in general wellness to applications as a medical device. They include technologies

intended for use as a medical product, in a medical product, as companion diagnostics, or as an adjunct to other medical products (devices, drugs, and biologics). They may also be used to develop or study medical products."[9]

Health data: information, covering paper and digital records, which relates directly to the health and well-being status of an individual or to the health services that the individual receives, whether collected by healthcare providers or by patients themselves.

Data for health: (also referred to as health-related data) data that is not immediately related to the health and well-being of an individual but may be used to support health decisions, such as demographic data, telecommunications data and weather data. This data may also include personal data that is not directly health-related (e.g. location data, customer shopping data or social data collected through smartphones or self-tracking devices) but which can potentially be used by healthcare providers, insurers or decision-makers.

Data solidarity: an approach to the collection, use and sharing of health data and data for health that safeguards individual human rights while simultaneously building a culture of data justice and equity, and ensuring that the value of data is harnessed for public good.

Health equity: "the absence of unfair and avoidable or remediable differences in health among population groups defined socially, economically, demographically or geographically."[10]

Digital rights: human rights and child rights applied in the context of digital environments, digital technologies, and the data they generate.

Civic technology (civic tech): an approach to the co-creation and use of digital technologies that has the aim of improving transparency and public participation in democratic and decision-making processes.

Precision medicine: an approach to disease treatment and prevention that seeks to maximise effectiveness by taking into account individual variability in genes, environment, and lifestyle [for each person]."[11] In this report, the rapid advances in the area of genomics are considered (and referred to) as part of broader dynamics of digital transformations, owing to the facts that the evolution of genomic sequencing techniques is strictly related to the dramatic expansion of possibilities offered by digital technologies (i.e. decreasing computing costs, growing capacity for big data and data analytics); and that precision medicine depends on the combination of genomics and machine learning techniques.

Precision public health: an approach to improving population health through the use of digital and genomic technologies which enable health organizations, policy-makers and wider health systems to guide public health practice by generating more individually- or community-tailored interventions and policies.

The report

This report aims to outline the governance approaches and initiatives that are required to shape health futures and transform UHC in an age of increasing digital transformations. Its findings are shaped by an inclusive and participatory process, with the writing of the report taking place alongside broader efforts to inspire global public and private stakeholders and involve the

imaginations and voices of youth. In the last two years, the Commission's work has become increasingly visible through online events and policy dialogues, social media activities, and targeted stakeholder engagement. The Commission hosted or co-hosted online policy and youth dialogues with partners including Wilton Park, the International Federation of Red Cross and Red Crescent Societies (IFRC), the World Health Organisation (WHO), the World Health Summit, the European Health Forum Gastein, Fondation Botnar, The International Federation of Medical Students Associations (IFMSA), and the Global Health Young Professionals Initiative. Consultations with private sector partners were organised by the Financial Times. Together with UNICEF, the Commission also launched an initiative called *Imagining Health Futures*, which invited published science fiction authors to speculate about the future of health in writers' room workshops with global youth, culminating in short story visions of health futures.[12]

In section 2, we provide a conceptual framework for the report which situates health futures at the interface of digital transformations and the other transformations affecting health, public health, and health systems, and emphasise the specific implications that such transformations have for children and young people. Section 3 introduces the processes of digital transformations that impact health and qualifies them as a new determinant of health and well-being. Section 4 discusses the required transformations of UHC in a digital age, with a focus on the specific conditions, and approaches under which digital solutions can be used by different actors to strengthen public health and expand the quality, affordability, and accessibility of health services. Section 5 describes the diversified experiences and challenges of growing up in a digital world that children and young people are facing, and discusses the importance of putting their views, skills and needs at the centre of a digitally-transformed UHC. Section 6 outlines the foundational entry points of a value-based framework that should guide governments and societies in preparing for, and governing, digital transformations to benefit health and well-being. Finally, section 7 proposes four action areas for the governance transformations that are required to prepare for, and shape, the intersection of digital and health transformations.

Panel 2: Youth expectations of the Commission

The Co-Chairs and Commissioners advocated for a holistic and strategic approach to engage youth and amplify their diverse voices in the work of the Commission, agreeing that the involvement of children and young people in (digital) health decision-making spaces is key to positively impacting the health futures of all people.

Along the lines of the existing efforts on youth engagement (e.g. the WHO's recent strategy on *Youth-centred Digital Health Interventions*),[13] the Commission adopts the perspective that it is important to fully embed youth and youth organisations within institutions of power,[14] in order to fully create structures for meaningful youth participation, ensure that the health and well-being issues affecting young people are defined by young people themselves, and deliver improved (digital) health outcomes.

A central tenet of the Commission was thus the necessity of steering clear of tokenism, developing a more integrated approach to involving youth in its work. With support from the Swiss Agency for Development and Cooperation, the Secretariat of the Commission was able

to create several work streams for and with youth, including the establishment of a Youth Team within the Secretariat itself.

While the work of the Youth Team and that of the Commission were separate, they were also complementary. The Commission focused on the interface between children and young people's health and well-being and digital transformations of health. Drawing from its Youth Strategy 2020–2023, the Youth Team instead aimed to: (i) collaborate with a broad range of youth networks to amplify the voice of youth in the work of the Commission; (ii) expand on the issues relevant to youth identified by the Commission, bridging this report's recommendations and a specific Youth Call for Action; and (iii) identify how the work of Commission can be further developed in ways identified as meaningful to youth.

In collaboration with Wilton Park, the Youth Team of the Secretariat co-organised a series of consultations to co-create a standalone GHFutures2030 Youth Statement and Call for Action,[15] seeking to inform the Commission's report and guide future advocacy and dissemination activities. This global youth consultation series brought together 26 youth leaders from 23 global youth networks, representing 22 countries. Discussions focused on themes including 'the equity and participation gap', 'the choices we have', and 'the future we want', and sought to answer the following questions: *what do youth want to see in the future of health governance? What are the expectations of the Commission's report?* (figure 1).

Figure 1: Summary of the results of the GHF2030 youth consultations. Source: the authors.

[Insert Figure 1 here]

Section 2 – Conceptualising health futures in the digital age

Imagining health futures

Different health futures are possible. These have been described mainly from the perspective of epidemiology, healthcare delivery or technology and focused primarily on healthcare, medicine, and individual patients. COVID-19 has changed the world and put many of the expected health futures into question. It has underscored the need to include social and political perspectives as well as highlighted the relevance of public health and population health-based applications of digital technologies.

Ever since the launch of the Millennium Development Goals (MDGs) in 2000, and especially in the lead-up to the adoption of the SDGs in 2015,[16] the dramatic improvements achieved by many countries across multiple areas of human health and well-being have been described as one of the great success stories of global cooperation. In keeping with these achievements, the SDGs envision a future which ensures healthy lives and promotes well-being for all ages by 2030.

Much of the progress relates to survival and increased health and well-being of children and young people. From the extraordinary global fall of maternal and child mortality to scaled-up access to anti-retroviral therapy, from continued progress towards the eradication of poliomyelitis to rapid increases in life expectancy, health futures have been imagined and discussed through the lenses of fighting disease and achieving a 'grand convergence' in health in the space of a few generations.[17] A future of health opportunities, albeit with important caveats, has also been envisioned by other landmark *Lancet* Commissions, including the possibility of reaping very large payoffs coming from investing in health[17] or the objective of ending AIDS as a public health threat by 2030.[18]

This disease-based perception of the mission of global health is changing, as is the development model that drives it. As political momentum grows around the objective of achieving UHC by 2030. SDG 3.8. reads: "achieve universal health coverage, including financial risk protection, access to quality essential healthcare services, and access to safe, effective, quality, and affordable essential medicines and vaccines for all." This key SDG target was also reaffirmed in the outcome document of the High-Level Meeting on UHC held by the United Nations General Assembly in September 2019,[19] together with the need to address the determinants of health.

But this optimism no longer holds as a series of interconnected crises emerges to confront health world-wide, from the short- and long-term impacts of the COVID-19 pandemic to the health insecurities brought about by climate change. It becomes increasingly clear that narratives of linear progress fail to capture the complexities of our potential health futures, confirming the main health challenges the *Lancet* Commissions on Global Health 2035 and Planetary Health highlighted: the health challenges of vulnerable people in low- and middle-income countries (LMICs), the shifting demographics and disease burden of non-communicable diseases (NCDs), the lack of financial arrangements to ensure UHC, and the health effects linked to dynamics of global environmental change (with an emphasis on climate change and biodiversity loss).

As we look closer at the future of the children and young people who are born in the years from 2000 to 2030 and in the context of the COVID-19 pandemic, we see they have an increased risk of falling into poverty, missing out on education, not being ensured decent work, and growing up in the midst of a climate crisis.[20,21 (p39-51)] Their health futures are unfolding in an era of dramatic political, economic, societal, technological and environmental transformations, which impact on all areas of health and well-being while simultaneously being affected by them. For these purposes, calls to rethink the concept of UHC to include not just health and clinical services, but also promote healthier societies and build resilience against future health risks, have increased.[22]

Digital transformations

> ***All* health futures will be shaped by digital transformations, which we define as the multiple processes of integration of digital technology and data into all areas of everyday life, including health, and the resulting changes that they bring about. Digital transformations are major societal transformations.**

In the context of health and well-being, our definition of digital transformations aligns with broader existing definitions of 'digital health', such as the one offered by Paul Sonnier: "the convergence of the digital and genomic revolutions with health, healthcare, living, and society."[23]

This definition reflects how for many people, albeit with strong differences across and within countries, lives are no longer imaginable without digital access. The impact of digital transformations has been so pervasive that they might soon become a dominant prism through which to understand and address health and well-being dynamics, including for those who will remain unconnected. Indeed, in the future we might not even speak of 'digital health', as digital technologies become integral to how health is understood and delivered – in keeping with what has happened to other sectors such as banking. But these transformations are not value-neutral, and they come with clear social and political costs. As new technologies are progressively introduced and replaced, the boundaries of digital transformations in health and healthcare are pushed forward at an accelerating pace, often without concern for their public purpose and impacts on health equity and human rights.

In this context, digital transformations are also changing our conventional understanding of the health economy. Within each country, the configuration of the actors involved in the health economy has always varied, depending on the public or private provision of health services. For example, in many LMICs, private sector companies provide a significant share of health services. At the same time, their governments are more involved than those of HICs in health product supply chains. Now, however, the health economy increasingly interacts with the digital economy. In the US alone, venture funding for digital health companies has increased constantly in recent years, with the year 2020 representing a 72 percent increase over the record set in 2018 and a total venture funding of USD billion 14.1.[24] When it comes to specific technologies such as AI, it is estimated that the global market for AI-based hardware, software and services in healthcare will reach USD 34 billion by 2025,[25] with a potential value created by 2030 of USD 300 billion.[26]

In the new dynamics of the digital health economy, 'traditional' actors remain important, from governments financing digitally-enabled health systems to healthcare providers acting as venture capital investors for digital health innovations (a recent, US-based study noted 184 such investments by healthcare providers in 105 companies over the 2011-2019 period).[27] Moreover, pharmaceutical and biotechnology firms which conduct research and development on new medicines, vaccines, diagnostics and medical devices are also increasingly taking advantage of digital technologies, whether to reduce costs, collect more diverse and higher-quality data, improve and accelerate clinical trials, or advance predictive modelling of drug treatments.[28]

At the same time, the digital health economy is a key business frontier for new actors who have not traditionally focused on health. First, all major technology giants – Alibaba, Alphabet, Amazon, Apple, Facebook, Jio, Microsoft, TenCent – are now expanding their reach in the health sector through the development of mobile phone-based health records, AI for health programmes, digital assistants, and apps that provide health advice, wearable technologies, and other tools for health and well-being. Amazon Care[29] and the TenCent Smart Hospital[30] are examples of the technology industry's ambition to move even further into healthcare, while Amazon Pharmacy signals parallel developments in health products delivery.[31] Secondly, telecom companies, Internet providers, information and communications technology (ICT) hardware and software companies, and data brokers have also become essential for developing and running the infrastructure and systems required for a digital health ecosystem, from service provisioning to financial services gateways. The most data-driven companies collect, collate, analyse, and often trade enormous volumes of health data and other personal data that are used to predict disease outbreaks, identify health risks, and target individuals with personalised health promotion messages.[32] Although these trends long predate COVID-19, the pandemic has made them more visible (section 3).

Some authors note the growing alliances between these and other powerful actors in the health sector (e.g. doctors' networks, health insurers), and argue that in the future they may serve to push the privatisation of health services and normalise health data infrastructures built on the principle of large-scale data collection and exchange.[33] Together, private actors in the digital health ecosystem also give rise to 'networks of control' that can nudge consumer behaviour through the tracking and profiling of personal data, and ultimately have an impact on the determinants of health.[34,35] As multinational technology companies embed themselves deeper within countries' health systems, it will be harder to disentangle them from being an integral part of health networks and service architecture.[36] In this sense, the current dynamics of data extraction are increasing the risk of concentrating economic and political power in the hands of those companies that hold the greatest amount of data and technical capacity to extract value from it or, in more state-centric models, in those of government authorities and bureaucracies.[37(Ch 31-33)]. While such attempts are by no means recent, and not always successful, the pace of innovation intensifies the need to address the power imbalances and equity concerns that come with this new digital health economy as a key governance challenge.

Transformations of public health and UHC

The impacts of digital transformations in health must be judged on two different axes. First, by the changes they bring to the ways in which societies define and achieve health. Secondly, by their ability to transform and accelerate UHC.

Following the COVID-19 pandemic, health itself has emerged as an accelerator of digital trends – this provides the opportunity to be bold and shape digital transformations to align with the mission of UHC to achieve Health for All.

At present, at least half of the world's population still do not have full coverage of essential health services. By 2030, almost 40 per cent (3.3 billion) of the world's population will be under 25, and UHC will need to respond to their needs and aspirations. Although overall risks of disease and disability are projected to continue falling for children and young people, a larger burden of disease from NCDs will likely affect a growing number of them. In addition, injuries, chronic physical health, and mental health issues will continue to be a concern for young people everywhere,[1] raising questions around health promotion, prevention, healthcare costs, and care coverage.[38,39]

The increasing health and well-being impacts of climate change and biodiversity loss will include the emergence of new infectious diseases and the degradation of critical ecosystem services upon which the livelihoods of billions of people depend.[40] The long-term effects of the COVID-19 pandemic could also persist for years, affecting issues as disparate as the life opportunities of children and young people,[41,42] access to prevention and treatment services,[43] and broader dimensions of well-being such as emotional distress and mental health disorders.[44]

These trends in individual and population health, which already contribute to our understanding of possible health futures, will interact in significant ways with the dynamics of the digital and data-driven transformation of health systems. On the one hand, technology continues to provide biomedicine with new and more effective ways to predict, diagnose, and treat physical and mental health challenges. Digital health, which as a concept can be said to encompass aspects including mobile health (mHealth), health information technologies, telemedicine, precision medicine, and precision public health, offers opportunities for physicians to offer more personalised care, for individuals and communities to track, manage, and improve their own health and well-being, and for authorities to make use of vast amounts of data for public health purposes. Digital tools are being used to address broader determinants of health, including applications in the areas of income inequality, insurance, education, and the physical environment.

On the other hand, the increasing extraction of personal data by public and private actors can lead to a wide range of negative consequences for individuals and societies, ranging from human rights infringements and extensive surveillance practices to interference with electoral and other democratic processes.[45,46] Health and health-related data represent an important aspect of these dynamics, with the healthcare sector predicted to be the fastest-growing industry in terms of data produced.[47] In addition, there is increasing evidence that the digital ecosystem itself can negatively impinge on human health and well-being through its impacts on the wider social, political, commercial and environmental determinants of health (see section 3). Lastly, the uptake of digital technologies in health and healthcare relies heavily on trust from patients, doctors, and other

health system professionals.[48] However, recent research suggests that such trust can be eroded by several personal, technological, and institutional factors, including fear of data exploitation, lack of accessibility and digital skills, and poor reputation of service providers.[49]

Transformations impacting on children and young people

> **The intersecting transformations of health and digital technologies demand that special attention be paid to future generations, who will inherit the models designed (or neglected) in today's digital- and data-driven world, as well as to children and young people, who are estimated to represent one in three Internet users and are therefore in an unprecedented position to be engaged in architecting new models of digital and data governance.[50]**

Although subjected to a significant digital divide, the exposure of children and young people to digital transformations is already higher than for the rest of the population and will increase everywhere. The lived experiences of many children are already, effectively, experiences of 'growing up in a digital world' – an expression that describes a process whereby digital technologies and digital connectivity often permeate (almost) every aspect of their lives. However, the datafication of bodies and activities[51] that represents the dominant aspect of 'growing up in a digital world' will also affect the experiences of those who will remain unconnected - in other words, their experiences and life opportunities will be defined by this very lack of access to connectivity.

The consequences of this generational shift of experiences and practices – which we express in the notion of "digital childhoods" – are multi-faceted. The ecosystem of digital transformations may already constitute a determinant of children and young people's health and well-being, both positively and negatively.[52] Children and young people are increasingly exposed to the harms and human rights risks digital technologies may cause, for example in the context of their ability to manage privacy, commercial targeting, reinforcement of gender norms and stereotypes, and hate and abuse in online environments. At the same time, and as emphasised by the Commission's Youth Statement, youth communities around the world consistently showcase the potential use of such technologies to support greater civic and political engagement and participatory research,[53,54] and have developed new forms of 'digital resilience' and mutual support against online harms. [5(p 33-38),55] As agents of change, young people are also fully contributing to the development and use of new technologies and content, including for health. The extent to which they are enfranchised and involved in co-shaping health futures, wherever they live, will shape the direction and dynamics of digital transformations for *all* people.

Section 3 - Digital transformations as determinants of health

Dynamics of digital transformations

We define digital transformations as the social, technical, and political processes of integration of digital technologies and platforms into all areas of life, including health.

Digital transformations arise "from what economists call a general-purpose technology—that is, one that has the power to continually transform itself, progressively branching out and boosting productivity across all sectors and industries."[56] They have proceeded at a variable pace, and exerted uneven effects, across different countries and communities, highlighting the importance of pre-existing inequalities and foundational infrastructures.

Digital transformations:

- are data-driven and move important dimensions of human relationships into digital territories, allowing for new economic and social developments;
- bring about a foundational change in how our societies are organised and how we relate to our environment, one another, and ourselves;
- require a shift in our understanding of health and in our management of health promotion, public health, and the healthcare system;
- accelerate the entry of new stakeholders into the health arena, providing opportunities for innovation, as well as new business models;
- still lack a clear foundation in social values and ethical principles in relation to health and its digital determinants, challenging the vision embedded in the SDGs and in the concept of UHC;
- reinforce, and create, new asymmetric power relationships and methods of control, but also provides new spaces of agency and interaction – in society, economy, politics – the ultimate dynamics and impact of which we do not yet fully understand.

These changes can bring enormous long-term benefits to many different sectors, at the same time they bring significant disruption. In turn, digital transformations are themselves closely connected with, and shaped by, the larger political, societal, and economic dynamics in which they are embedded (figure 2).

Figure 2: Conceptualising digital transformations of health. Source: the authors.

[Insert Figure 2 here]

These dynamics, ranging from the increasing economic relevance of health data and data for health to the emerging geopolitics of digital governance, and including the growing appetite for digital solutions in the healthcare sector, all concur to make health a 'high-stake' domain – both economically and politically.

> **Digital transformations are embedded into, and negotiated within, broader political, societal, and economic processes. This means that different societal preferences, socio-economic contexts and political and institutional configurations may lead to a variety of ways through which digital technologies are integrated into people's lives and socio-technical systems.[57]**

In figure 2 above, the elements of this configuration are illustrated as the outer boundaries of the ecosystem of digital transformations, which determine its variable shape.

First, the digital hardware and software available in a country represents a fundamental base for the integration of digital technologies in people's lives and determines the ability to bridge existing digital divides and build digital readiness. This starts with baseline infrastructure such as fibre and submarine cables, goes on to ownership of digital devices, and reaches all the way to the richness of digital content in the domestic languages. As health systems become increasingly digital and interconnected, elements such as access to connectivity, data interoperability and data security have also become critical to the variable capacity of a country to leverage such technology to equitably achieve health goals.[58]

Secondly, laws, regulations, and governance arrangements are also critical to understand and shape the dynamics of digital transformations, including in the context of health. For example, regulatory choices around data control, data sharing, and data protection are likely to prove particularly important in the context of health and health-related data, as the use of such data is uniquely characterised by the need to manage a range of competing interests between patients, governments, and other health system actors. Similarly, the governance of the Internet often determines market access for technology providers, the accessibility of content, and the proliferation of misinformation or disinformation – including on health issues. As the Internet has become entrenched in daily life, competing views and models about how it should be governed have begun to emerge and be championed at the national level, where they are playing a geopolitical role and contributing to the evolution of the global order.[59]

Third, societal institutions have a major impact in shaping the ecosystem of digital transformations, at the same time as they are shaped by it.[57] For example, the way in which the reuse of personal health data for public health or research purposes is regulated across different countries may be influenced by broader societal preferences around data protection and data governance models, which include different arrangements around overall data policies and strategies, data regulations, and data architectures, infrastructures, and value chains.[60] This is inevitable, since "data are in fact framed technically, economically, ethically, temporally, spatially and philosophically [...]" and they "do not exist independently of the ideas, instruments, practices, contexts, and knowledge used to generate, process, and analyse them."[61(p1-2)] In this sense, future models of health and health-related data governance will likely depend on the balance struck by different social contracts around the nature of such data, the extent to which such social contracts will uphold ethical values and human rights, and the ability of societies to freely negotiate them vis-à-vis large private companies and geopolitical powers.

Lastly, the digitalization of transactions has led to a new political economy of innovation, not only in HICs. In many sectors, online platforms[62] are at the centre stage of transformed markets, touching upon a wide range of aspects of life and relying on different business models to monetise data.[63] In a digital economy, data represents a good to be extracted, hoarded, and protected,[64(p 89-91)] and health and health data are key entry points owing to the growing trend towards the self-governance of health behaviours through wearables and mobile applications.[65] New groups of actors, from Big Tech companies to health service providers specialising in virtual models of care, such as Teladoc, Babylon Health or Apollo, are transforming the ways this health information is collected and shared, and the way healthcare is delivered.[66,67]

Today's health ecosystem thus encompasses a diverse community of interconnected stakeholders that use digital technology and data for different purposes, from improving health outcomes to profit-making, and increasingly operate under a variety of different governance regimes (i.e. from open internet models to rule-based models, to authoritarian ones). Countries differ substantially in their reaction to such new business models and their implications on work standards, consumer safety, market concentration risks, and levels of societal trust. Emerging digital and data standards, which usually follow geopolitical alliances, are also often negotiated and developed under the guise of trade policy.[68,69]

Health data as the open frontier of digital transformations[70]

> **The dynamics of data extraction are a defining factor of digital transformations. The transformations themselves, as well as their impacts on health and digital futures, cannot be understood and effectively governed without targeting such dynamics.**

Emerging technologies and innovations (not only in the field of digital health) are critically reliant on the availability of massive quantities of health and health-related data, as well as on the growing computing capacities required to process them. Such data, which is continuously collected, used, and managed by individuals, healthcare providers, and other actors in the digital health ecosystem, thus constitutes the critical premise, enabler, and profit centre, of digital transformations of health.[71,72]

In particular, data is increasingly seen as a powerful commodity and a major driver of change as a result of the growing economic importance of secondary use of data.[73] While quantifying the total value of data is impossible, most estimates and methodologies agree on its enormous economic significance, whether by looking at national value chains,[74] at the economic value generated by government data and open data,[75] or at the market capitalisation and revenue streams of data-intensive companies.[76,77]

The health sector, with its increasingly Big Data-driven dynamics, represents a case in point. Already in 2009, a survey of healthcare executives had revealed that a large percentage of them expected that the information contained in their electronic health records would become their most valuable asset in the space of five years.[78]

The data that is relevant in this digital health economy can increasingly be collected from three key types of sources, namely (i) data stemming from electronic health records; (ii) data from real-life digital trails (that include signals produced by people's everyday actions, recorded digitally through devices and sensors measuring individuals' movements and behaviours); and (iii) data from virtual digital trails (information and usage patterns recorded by and derived from virtual digital media – these include social media and search engine data, digital data entry and self-reported health-related attitudes and behaviours).

In turn, this data can be divided between:

> (a) health data properly defined, which are those relating directly to the health and well-being status of an individual (e.g. causes of death, historical healthcare background, reproductive outcomes, quality of life), or to the services that the individual receives (e.g. personal choice about selecting a treatment, treatment reports), whether collected by healthcare providers or by patients themselves;
>
> (b) 'data for health', a notion that includes those data that are not immediately related to the health and well-being of an individual but may be used to support health decisions, such as demographic data, telecommunications data, and weather data. Importantly, these data may also include personal data that are only indirectly health-related, such as location data, customer shopping data or social data collected through smartphones or self-tracking devices, but which can also potentially be used by healthcare providers, insurers, or decision-makers.

Such data is inherently relational and heterogeneous, and thus uniquely characterised by the need to manage a range of competing interests. These include: (i) the interest held by individual towards improved therapies, higher quality of healthcare services, and protection from human rights infringements; (ii) the interest held by governments towards creating and learning health systems and promoting efficiency in healthcare delivery, scientific discovery and innovation, and evidence-based decision-making for public health; and (iii) the interest of other health system actors, including the private sector, towards achieving cost savings and reaping returns to discovery, innovation, and service delivery. Health data, in other words, does not only generate private economic value, but also produces a range of social and economic benefits to the health system.[79] The need to bring these two forms of value together to ensure that data is harnessed for the public good is explored in this report through the concept of 'data solidarity', which is discussed in sections 6 and 7.

Digital transformations and the COVID-19 pandemic

With COVID-19, we have witnessed a further major shift. Several of the digital technologies that gained prominence during the pandemic were imagined, researched, validated, and commercially developed years ago. However, due to lack of incentives and funding, as well as the entrenched practices of both professionals and patients, the pace of their uptake within health systems had previously been slow.[80] COVID-19 increased the pressure to adopt digital solutions, influencing

patient behaviour and pushing the health sector to seek out tools that had often been met with resistance before the pandemic, for example online consultations. While digital health experts had long called for such changes, it is still difficult to say how sticky these shifts will be once the pandemic is over. If taken further, these transformations could radically change our understanding of health and health systems, and the way public health is practised.

On the biomedical side, current capacities for data generation, sharing, analysis and coordinated use have underpinned COVID-19 research efforts, as illustrated by the fact that it took only a week for Chinese researchers make the genetic code of the virus openly available to all scientists across the globe.[81] In turn, this permitted the development of diagnostic tools in record times. Large-scale digital data collection and globally coordinated trials have since led to a good understanding of viral spread dynamics, risk factors, and the varying effectiveness of drugs and vaccines.

Beyond biomedical aspects, the pandemic has also boosted the demand for using digital technologies as instruments to support broader public health goals. In doing so, it led to the deployment of a myriad of new digital tools (e.g. digital survey apps for symptom reporting, mobile contact tracing applications, real-time monitoring for ensuring compliance with quarantine measures), but also accelerated the adoption of existing digital technologies such as telemedicine, data exchange collaborations, and mobile health payments. The adoption of these tools has been uneven, and it has arguably intensified pre-existing social inequalities.[82] Moreover, the vast amount of personal data required by these tools brought to the fore the question of how to ensure compatibility between a democratic understanding of data privacy and the public health requirement of disease control, and in doing so further stimulated research in this field.[83]

More specifically, the COVID-19 pandemic highlighted the ethical, human rights, and societal trust risks that exist at the blurred line between the public and private value of health and personal data[84]. First, these tensions have been evident in the use of 'proximity tracing' (or 'contact tracing') applications to monitor disease spread, some of which faced significant criticism because of attempts to centralise data storage.[85] The use of personal cell phone location data, facial recognition, and other technologies has posed risks to personal privacy, and yet may have benefited public health responses and opened up a window of opportunity to foster solidaristic practices in digital health.'[86] At the same time, aggregated mobility data has been used to identify disease hotspots through 'people flows', a possibility that presents more limited privacy concerns but also suggests the need for transparent and community-based approaches to data stewardship.[87] Secondly, health or health-related data derived from online interactions or mobile apps has sometimes been used not to trace contracts, but more directly to restrict people's movements and monitor their compliance with rules.[88]

The pandemic has influenced the dynamics of governance and collaboration between actors in the digital ecosystem, raising important questions about the role of technology companies as gatekeepers of public health decisions.[32] A case in point is the Bluetooth-based exposure notification-technology for COVID-19 contact tracing applications, which was only possible after the technology companies Google and Apple collaborated to ensure interoperability.[89] Another example is the reaction to the so-called 'infodemic' - that is "an overabundance of information and

the rapid spread of misleading or fabricated news, images, and videos" that spread through online social media like a virus[90] - which saw the WHO develop several collaborations with social media platforms to reduce misinformation.

Digital transformations as determinants of health

Within the boundaries that influence and shape the global ecosystem of digital transformations, the integration of digital technologies into people's lives drives health transformations both (a) directly, through its application in health systems, healthcare, and self-monitoring of health status and behaviours[91] and (b) indirectly, through its influence (both positive and negative) on the social,[92] commercial,[93] and environmental determinants of health.[94] Moreover, we can consider the digital ecosystem itself (including the variable dynamics of digital and data access and literacy) as an increasingly important determinant of health.

As digital technologies get integrated into people's lives, the very understanding of health and well-being changes. For example, ever since the rise of the Internet and social media, questions surrounding the positive and negative implications of the increased time spent online for social connectedness and mental health have moved to the fore of many research agendas.[52,95] In turn, as mentioned above, digital transformations themselves evolve whenever health and other societal considerations emerge as a leading accelerator of certain digital trends over others.[96]

In the next section, we explicitly focus on digital transformations of public health and UHC. Here, we suggest that even when not directly relating to healthcare or health systems, digital technologies interact with the social, political, commercial, and environmental determinants of health in significant ways (figure 3).

First, the social determinants of health – including factors such as age, race/ethnicity or socio-economic status - play an important role in influencing how digital technologies are used for health and well-being purposes.[97] In addition, it is well-documented that the relevance and usefulness of digital health technologies are heavily dependent on digital literacy, that is, the varying ability of both children and adults to use such technologies and understand their risks,[98,99,100] as well as on health literacy, that is, people's ability to assess and make use of health information to maintain or improve their health and well-being.[101,102] For children and young people, social support networks (e.g. parents and teachers) play an important role in helping them navigate the digital world.[103] In the near future, the resulting disparities in the use of digital health technologies may then mediate or even reinforce existing inequities in income, social status, or access to health services.[92]

The interconnection between digital transformations of health and social determinants becomes particularly evident with the proliferation of algorithms in the healthcare sector which may reproduce and embed into technical solutions the inequities that exist in the analogue world.[104] Beyond this paradigmatic example, however, in the future digital technologies will also have a profound effect on educational environments[105] and the future of work,[106,107] influence whether social determinants such as the remoteness of the place of living are still as important as they used

to be, and even affect the wider societal values that are currently institutionalized through social contracts stemming from another age.[108]

Secondly, digital technologies are reshaping dynamics of social environments and affecting trust in health systems, leading authors to suggest the digital infosphere as another 'social' determinant for health.[109]. For example, research on anti-vaccination movements has long shown that the spread of mis- and disinformation can have real-world effects on health,[110] and a growing number of controversies suggests that lack of patient trust in the safety of their health data can undermine medical research and uptake of digital health tools.[111] At the same time, the potential of social media and digital marketing can significantly be leveraged by the public (health) sector to boost health promotion and disease prevention, as demonstrated by the efforts undertaken by the WHO and many national governments to convey health messages through social media platforms during the COVID-19 pandemic.[90]

Third, and more generally, digital technologies, governance and literacy underpin the functioning of modern democracies through their positive (or negative) influence on people's exposure to marketing and political messaging, and their consequent effects on the ability of individuals to make informed decisions, both online and offline.[112] In doing so, digital transformations thus impinge on the political and commercial determinants of health.

Finally, digital technologies lie at the core of both negative and positive trends in the environmental determinants of health. AI and Big Data play a role in accelerating human pressures on the biosphere and climate systems, from supporting global production chains and allowing automatised commodity trading[113] to facilitating the spread of climate denialism and misinformation online.[114] However, the same technologies can be associated to environmental governance efforts. For example, Earth Observations techniques and so-called environmental Big Data are proving relevant in the context of surveillance and early warning systems in areas ranging from disaster risk reduction to air pollution, and they will be increasingly used to monitor trends in other environmental determinants of health, including land-use change and ecosystem degradation.

Figure 3: Conceptualising the interface between digital technologies and the determinants of health. Source: the authors.

[Insert Figure 3 here]

Section 4 – Digital transformations of public health and UHC

Digital transformations call for a new understanding of public health and UHC

Traditional notions of UHC do not sufficiently capture the extent to which digital transformations are affecting our understanding of health and well-being, and the means through which public health goals can be achieved. A new understanding of public health and UHC is necessary to harness the novel opportunities and dynamics offered by digital technologies, while simultaneously mitigating potential harms through strengthened health governance.

According to the 2019 high-level political declaration on UHC adopted by the UN General Assembly, UHC implies that "all people have access, without discrimination, to nationally determined sets of the needed promotive, preventive, curative, rehabilitative and palliative essential health services, and essential, safe, affordable, effective and quality medicines and vaccines, while ensuring that the use of these services does not expose the users to financial hardship, with a special emphasis on the poor, vulnerable, and marginalized segments of the population." When this definition is considered in the context of digital transformations and their multi-faceted impacts on health and well-being (section 3), it becomes clear that achieving UHC in a digital world will inevitably require more than the adoption of new technologies in health and healthcare as a means of simply increasing efficiency or cutting costs.

The first key question will be whether digital technologies help increase the availability, accessibility, acceptability and quality of health services as we know them.[115] The second (and related) question concerns the changing nature and direction of healthcare, and the possibility of making it more preventive, personalised and mobile through the use of such technologies (e.g. wearables and AI applications to improve self-care and prevention, Big Data and genomic technologies to enable both precision medicine and precision public health, smartphones to support telemedicine and online consultations with health professionals). Finally, the third question relates to the extent to which digital transformations will enfranchise patients and communities (and particularly vulnerable groups including children and young people) and evolve their relationship with health professionals and providers, thus helping shape the health system according to the needs of the former (figure 4).

Figure 4: Three key dimensions of a digitally-transformed UHC. Source: the authors.

[Insert Figure 4 here]

From a practical perspective, developing a new understanding of the interface between digital transformations and UHC will thus require two synergistic efforts. First, it will require a mission-oriented approach to digital health innovations that draws on new technologies and knowledge "to attain specific goals",[116(p 804)] underlining the argument that digital transformations of healthcare could provide medicine with the opportunity to be more 'human' and more 'humane'.[117] Translating these 'missions' into a portfolio of policies and initiatives that help diffuse the benefits of digital health technologies equitably, make their deployment economically feasible, and

decentralise and democratise their control, will inevitably be context-specific, and informed by the unique characteristics of different health systems and digital health maturity levels.

Secondly, digital transformations also call for a re-imagining of conventional understandings of public health and UHC, to account for the new dynamics that such transformations introduce in the health ecosystem. For example, this means that the breadth of health services that are offered in health systems and included in the publicly financed UHC package will have to expand to include those new dimensions of health and well-being that are directly dependent on digital technologies and their role as new determinants of health.

In this section, we identify a series of emerging public health dimensions that are being shaped by digital transformations and preliminarily outline their implications for governance, which will be discussed more in detail in section 7.

Health systems of the future: precision medicine and precision public health

At the macro level, digital transformations can be used to improve population health through data-driven public health interventions and policies. At the micro level, they constitute the basis of emerging applications in genomics and precision medicine. A problem-solving approach must orient innovation in these areas and promote the development of working designs that create public value.

The emerging applications of Big Data, AI, genomics, robotics, and other digital technologies in health and healthcare are vast,[118] and there is no doubt that in the future they may lead to the creation of entirely new health paradigms, while also strengthening existing health systems. The term 'frontier technologies' is frequently used when referring to these developments, aiming to capture the rapid pace of their emergence, the difficulties faced by policy-makers and regulators in responding to them, and their large-scale potential impacts on economies and societies.[119] Among the technologies that do stand on the verge of mass adoption are those that enable new forms 'precision' medicine and 'precision' public health – both of which have recently been described as potentially complementing conventional public health approaches in the context of the COVID-19 pandemic.[120]

'Personalised' or 'precision' medicine approaches, which rely on a wide range of biomarkers and other patient data (i.e. behavioural data, socio-markers), have been long associated with a promise of targeted diagnosing and treatment, and more patient-centred healthcare.[121,122] As precision medicine builds on genomic technologies, molecular pathways, and real-time monitoring of conditions by patients, it is also fundamentally driven by digital transformations, because it relies on the availability of advanced computational and statistical methods.

When precision medicine involves making personalised care decisions, massive amounts of data from individuals may need to be shared. Increased opportunities for patients to become more proactive in the generation and sharing of their own data[123] might lead to more enfranchised patients. However, questions about health and data literacy, data security, equity, and human

rights gain even more importance. For example, it is unclear how the incidental discovery of genetic mutations predicted to confer high-risk of cancer should be handled within an otherwise healthy child. The implications of therapies that could remove undesired genetic traits or introduce desirable ones is even more unclear, with obvious dual use concerns.[124]

It has been argued that health systems need precision medicine to be able to keep up with constrained health staff situations, the rise in demand for health services, technology costs, and patient expectations towards these services.[125] For the clinical reality, however, there are challenges arising from personalised predictive models: the tools need to be in sync with workflows of practicing clinicians; the models need to be transparent enough for clinicians to understand their method and implications; the tools should not be used beyond their ability to classify people based on their risk; and they should not automatically be expected to be prescriptive (i.e. able to predict the most favourable impact among several treatment options).[126]

For its part, precision public health is understood as a means of improving population health through the use of new technologies - particularly genomics, geospatial modelling and predictive analytics - which may enable frontline health organisations, policy-makers and wider health systems to guide public health practice by generating more individually- or community-tailored interventions and policies.[127] The COVID-19 pandemic has highlighted the immense need for public health surveillance, health intelligence, and whole-of-society responses, even beyond a specific public health crisis.

For decades, public health authorities have provided population-based health situation analyses, surveillance and annual population health reports, trend analyses of health determinants and outcomes. Increasingly, these efforts imply collection and monitoring of real time data from many sources, requiring new types of data sharing agreements – for example on mobility data – and to bring together diverse data sets.[128] AI-based methods such as multi-level modelling can support this process in new ways by extracting health and non-health data at different levels of granularity, harmonise and integrate information about populations and communities with epidemiological evidence as well as socio-markers or behavioural data.[120,129] In turn, this is also expected to reduce health inequities by tailoring public health guidance to communities who are most at risk.

Like precision medicine, however, precision public health can also bring a range of non-intended consequences as the volume of data that is potentially relevant for public health analysis increases and the risks for individuals or groups are defined, with little scope remaining for individual or community agency. For example, the uses and misuses of personal data in precision public health might undermine fundamental rights, beyond rights to privacy and self-determination, by leading to discrimination in access to services or participation in political life. At the same time, if not properly contextualised and complemented by broader public health measures, granular data about risk factors or broader social determinants may reinforce existing place-based stigma and reduce social solidarity.[120]

Developing national digital infrastructures for Health for All

> **As access to quality health information and services becomes increasingly reliant upon digital technologies and data, ensuring equitable and affordable access to connectivity becomes a precondition for achieving UHC while addressing the risk of compounding existing inequalities.[130]**

Creating a robust national digital infrastructure and closing the digital divide are both necessary steps for the transmission, processing, and storage of the data that fuels health information systems. Technologies such as machine learning and virtual reality depend on fast connectivity and use high volumes of data. Access to the internet is critical for health workers working within and outside of facilities to access and share health information. It is also increasingly important for individuals to manage their health and well-being through online platforms and devices, and to communicate with health workers. The COVID-19 pandemic highlighted the importance of universal connectivity[131] not only for tackling health challenges but also for staying in touch with loved ones, keeping young people learning, and keeping parts of the economy running.

Figure 5a: Under-five mortality and access to internet. Source: under-five mortality data via World Development Indicators, based on data from IGME.[132] Data on internet penetration via World Development Indicators, based on data by ITU.[133] Population data based on UN DESA, Population Division.[134] Authors' analysis.

[Insert Figure 5a here]

Figures on internet connectivity serve as a proxy for measuring the technical context of digital transformations and indicate which parts of the world are at a disadvantage for harnessing the power of data and technology for health. Between 2006 and 2018, the proportion of the world's population using the internet increased from 20% to more than 50%.[133] While progress has been made, the disparities between Internet users continue to be significant.

The geographical 'connectivity divide' is particularly visible among young people (figure 5b). While almost all young people in developed countries, and most young people in developing countries, are online (69% of 15-24-year-olds), only 38% of youth in countries defined as 'least developed' are using the internet.[133] To be young and offline (as 2.2 billion of youth aged 25 years or less are) is to miss out on important forms of communication and opportunities to receive and share information, including health information and education.[135] It also means being excluded from online activities and communities, which contribute to young people's sense of identity and well-being.[136] There is also a digital gender divide illustrated by higher rates of computer, mobile, and internet use among men compared to women, especially in LMICs[137].

While only half of people worldwide use the internet, almost the entire world population now lives within reach of some form of mobile broadband or internet service.[138(p 8)] This demonstrates that there are multiple barriers to meaningful access that need to be addressed, including quality of coverage, cost of connectivity and devices, lack of science, technology, engineering, and mathematics (STEM) education, digital skills and literacy, and lack of relevant online content.

Figure 5b: Percentage of children and young people with internet access at home, by region. Source: figure adapted from UNICEF and ITU.[135(p 5)]

[Insert Figure 5b here]

Moreover, national digital infrastructures can only be fully harnessed for health if individuals have a legal and secure digital identity. The right to identity is recognised as an established human right under the UN Convention on the Rights of the Child (UNCRC), and SDG Target 16.9 aims to provide legal identity for all, including birth registration, by 2030. In this context, not only can digital technologies be a key vehicle to establish functioning civil registration and vital statistics (CRVS) systems, they can also be used as the basic building blocks for improving access to health services and collect reliable health data - for example through electronic health records.[139] In turn, especially in countries where immunisation coverage exceeds birth registration rates, the digitalisation of health documents such as child health cards could be linked to such CRVS systems, thus providing all children with a unique digital identity early in life.[140] For countries that have tried to use mobile technology tools to increase birth registration rates, such as in the case of Ghana's m-Birth project,[141] lack of interoperability with other national CRVS systems has indeed been described as an important obstacle to the development of integrated digital identity ecosystems.[142(p 54)]

Creating digitally-enabled health systems

> **Digital health technologies are an essential part of transforming UHC, but they must be aligned with the actual needs of health systems, the health workforce and users in order to do so.[143] The analogue and digital components of future health systems need to be integrated in a strategic and coherent way,[144] including with children and young people's expectations in mind.**

The World Health Assembly Resolution on Digital Health, unanimously approved by WHO Member States in 2018, demonstrates a clear recognition of the potential of digital technologies to support health systems in health promotion and disease prevention, and to accelerate accessibility, quality and affordability of health services – especially for those in hard to reach areas.[145] As a result, the WHO has also developed a taxonomy for the use of more than 80 digital health interventions by identifying health system bottlenecks and how digital tools can help to address those constraints.[146] For example, the move away from paper-based and fragmented data collection and surveillance systems towards electronic health records and national health information systems (e.g. on birth and death registration, tracking of health status and services, medical commodities' management, citizen-based reporting) is an important and foundational step being taken by many countries in their digital transformation process.

If properly governed, this increased availability and use of health data could enable more timely and transparent decision-making and communication by health system managers and policy-

makers. For example, the population-based predictive models that underpin precision public health are suggested to present great promise in areas ranging from public health surveillance to the definition of proactive prevention strategies and effectiveness evaluation.[147] More generally, for more than a decade authors have argued for learning health systems which harness the potential of electronic health records and Big Data analytics to improve diagnoses, treatment decisions, and healthcare processes.[148]

In addition, digital transformations carry great potential to enhance the effectiveness, efficiency, and coverage of health services in contexts where health systems are weak (e.g. through client-to-provider telemedicine, health worker training and decision support, easier commodity and stock management) and where large populations of children and young people have no access to health workers, even if connectivity is not consistently available.

At the same time, the WHO also highlights how digital health can be characterised by "implementations rolled out in the absence of a careful examination of the evidence base on benefits and harms," leading to the potential "proliferation of short-lived implementations" and to "an overwhelming diversity of digital tools, with a limited understanding of their impact on health systems and people's well-being" (for example, the possible diversion of resources from alternative, non-digital approaches that might be more effective).[144]

Digital technologies, in other words, can expand the reach and impact of fundamental health systems dimensions - such as the need for adequate financing, leadership and governance, health workforce, and access to essential medicines - but they cannot ultimately replace them. Moreover, they should not preclude the provision of quality non-digital services, whenever these would be more affordable, acceptable in target communities, or simply more responsive to the challenges that policy-makers are trying to solve. Third, their adoption should be based on an assessment of the health system's ability to absorb such digital interventions, in order to avoid implementation failures caused by inadequate training, infrastructural or financial limitations, and poor access to equipment and supplies. Lastly, their rollout should consider (and mitigate) the potential risks and harms facing those who are most vulnerable to potential abuses, for example displaced individuals and other children and adults in humanitarian settings (panel 3).

Panel 3: Vulnerable groups at highest risk - data in humanitarian settings

The number of current and emerging digital health applications in humanitarian settings is vast. For example, aid providers are communicating by SMS with disaster-affected communities to provide rapid, targeted healthcare advice, or to collect data on local health risks from community members. Drones are being deployed for the delivery of life-saving materials, including vaccines, to populations that are hard to reach by land. Satellites, radars, and machine-learning technologies are forecasting catastrophes, allowing for prompt resource mobilisation, community preparedness, and early action, in turn minimising health consequences. Cloud-based electronic health systems and digital identities are facilitating access to medical records of forcibly displaced populations. Connectivity is also allowing displaced populations to gather information on a new location, access educational resources, and communicate with support services and family members.[149]

Even when the intention is to provide humanitarian aid and healthcare,[150] however, personal data may also be used in efforts by state and non-state agents to identify, target, and exclude children and adults from support opportunities. The most vulnerable children and adults worldwide, such as those living in low-resource conditions or displaced from their homes due to forced migration or natural disasters, are also often the groups who are exposed to the greatest lack of control over how their biometric information and other personal details are collected and used.[151]

Digitised wearable devices tend to simplify calculations of health status, but go even further in generating digitised data that may not be well protected from third-party use or secondary use by those who collected data which have not been consented to. Young children and adolescents in humanitarian settings are at risk of violence, exploitation, and sexual assault, and technologies that reveal their identities or activities involving data sharing can be used to facilitate such abuse.[171]

Further, such devices can be used to demonstrate that help is being provided (by their symbolic provision) in the absence of solutions to problems such as displacement and emergencies. Simply monitoring children's needs does not entail meeting those needs.[152] Despite the funds invested in establishing the infrastructures required to generate datasets from digital technology use, these data are not always readily available or open to analysis, becoming ends in themselves rather than solutions to health and humanitarian problems.[151,153]

Finally, there is the risk that 'tech-dumping' will occur,[154] involving directing untested or insecure digital health technologies at low-resource populations, including children and young people, with little regard for their safety or efficacy.[155,156] This raises the question of the ethics of using such technologies and how the 'do no harm' position can be protected.[152]

Calls for expanding the evidence base around digitally-enabled health systems and developing common frameworks for assessment has already been voiced in the literature.[157] In line with what has been suggested by the WHO, we also argue that digital health solutions can contribute to UHC only if they are characterised by health information that is aligned with recommended health practices; supported by ICT systems and communication channels that facilitate delivery and maintain cybersecurity;[158] embedded in value-based business and operational models; and integrated in a coherent, interoperable digital health architecture.[144]

Promoting digital health readiness

To achieve UHC, an equity and rights-centred approach to digital health that prioritises those with the least power - such as children, youth, women, people with disabilities, minority groups, and marginalised communities - is required from the onset. The readiness of a country to harness digital transformations in support of UHC and better health futures should therefore be assessed through an equity and rights-based lens.

Digital health readiness refers to the variable extent to which individuals and countries have the capacity to use digital technology and data for improving their own, or their population's, health and well-being.

High digital health readiness at individual and societal levels are a prerequisite for harnessing the benefits of digital transformations in support of UHC and putting patients first, including through democratic and digital literacy, informed citizenry, and participatory and community-led approaches to the design and deployment of digital tools. An individual's ability to benefit from digital transformations thus requires that they have the knowledge, skills, access, and agency needed to make free and informed choices and act independently in relation to the digital technology and data that is evolving around them and how it interacts with, and influences, their health and well-being.

One well acknowledged aspect of digital health readiness by governments is a country's overall level of digital development. Several initiatives, such as those led by Cisco,[159] GSMA,[160] ITU,[161] Portulans Institute and WITSA,[162] OECD,[163] and UNCTAD,[164] have resulted in tools to measure digital readiness across countries. Common indicators used include internet usage, mobile network coverage, and the number of fixed and mobile broadband connections. In all these indices, a clear digital divide is visible, with countries defined as 'least developed' – with high mortality rates and the largest shares of young people – ranking lowest, reflecting the ability of countries with higher incomes to invest more in the foundational infrastructure and technology required for digital health.

A growing number of tools are being developed to assess digital health readiness more specifically, many of which are based upon the WHO and ITU's eHealth strategy toolkit and its seven eHealth building blocks (namely leadership and governance, strategy and investment, services and applications, standards and interoperability, infrastructure, legislation, policy and compliance, and workforce).[165] The most promising tool for measuring digital health readiness is the Global Digital Health Index (GDHI), which allows countries to self-assess their level of digital health maturity.[166] In an effort to extend the GDHI to more countries, Digital Square has identified proxy indicators based on the World Economic Forum's Networked Readiness Index.[167]

Whilst existing digital readiness and digital health readiness tools provide important insights into the maturity of digital infrastructure and digitally-enabled health systems, they are insufficient for assessing the extent to which a country's approach to digital transformations will support the achievement of UHC for all. Some tools do include indicators to measure equity outcomes, but very few indicators are disaggregated. Overall, existing tools for assessing a country's digital health readiness are not adequately people-centred and do not consider established Health for All values such as democracy, equity, solidarity, inclusion, and human rights. Furthermore, current approaches to assessing readiness do not consider young people's perspectives or how approaches to digitalisation might specifically impact young people's health, well-being, and rights – now and in the future (section 5).

A more comprehensive and ambitious way of assessing digital health readiness is needed that encourages all actors in a digital health ecosystem to align their approach to digital transformations

with their UHC and SDG goals. Digital health readiness should only be seen as achieved therefore when *all* people and their communities, the health ecosystems they interact with, and the countries they live in are prepared, equipped, and empowered to use digital technology and data to meet personal health and well-being needs and to improve the health and well-being of the whole population. This interpretation of readiness necessitates analysis of the intersecting forms of discrimination and inequalities that undermine the agency of people as holders of rights in relation to digital health. It also requires prioritisation of those people who are most left behind at all stages of design, implementation, and monitoring of digital approaches, and greater consideration of how future generations will be affected by decisions made today.

The Commission worked with a group of young people to develop an overarching conceptual framework that sets out 10 main enablers of digital health futures readiness (see table 1). This framework could be used by policymakers and other stakeholders to assess their level of readiness to harness digital transformations in support of UHC and equitable health futures. The framework puts an emphasis on *futures* since policymakers and practitioners must be encouraged to think about the potential impacts of digital technology and data on health and well-being outcomes for future generations as well as those alive today.

Table 1: A potential assessment framework for digital health readiness. Source: the authors.[168]

Enabler	Description
1. Embedding health and well-being in all (digital) policies	The potential benefits and risks for health systems, determinants of health, and health equity are considered in all digital and data-related policies and programmes.
2. Engineering inclusive decision-making processes	The participation of all groups – including children, youth, and marginalised communities – is a regular practice in digital health decision-making and their participation is fully resourced by relevant ministries and other digital health actors.
3. Prioritising all people in the design	Digital technologies, initiatives, and services are designed with and for all groups that may directly use or be indirectly affected by them.
4. Increasing digital health literacy	Governments and their partners invest in multiple forms of literacy and skills (i.e. health, digital and civic) so all people can fully benefit from digital transformations.
5. Promoting human rights on- and offline	Policies and programmes related to digital technology and data are assessed from a human rights and child rights perspective to ensure that all rights, including the right to heath, are promoted and protected.
6. Investing in equitable, digitally-enabled healthcare	Governments, donors, and private investors target and prioritise their investments in digitally-enabled health systems and healthcare towards the realisation of UHC and reduced health inequities.

7. Governing for equitable health futures	Approaches to governance of digital technology and data are grounded in equity and human rights so that the benefits of digital transformation can be realised, and the risks mitigated, for all. Civil society groups led by youth and marginalised communities are able to independently assess whether governance frameworks reflect their needs.
8. Doing no harm to the planet	Industry and governments harness digital technology and data to protect the health of our planet. Proactive measures are taken at local, national, and global levels to mitigate any negative environmental impacts of digital transformations of health.
9. Connecting every household	The backbone infrastructure, hardware, and services required for reliable internet access are available, accessible, and affordable to all.
10. Connecting every health worker and health facility	Health facilities at all levels – from national hospitals to community clinics – are connected through reliable digital infrastructure that is regularly maintained. All health workers, including community health workers, have the tools, skills, and support to effectively use digital technologies.

Children and young people at the centre of a digitally-transformed UHC

The health needs of children and young people are different from those of older adults, and they also vary at different stages of life. At the same time, putting the concerns and expectations of children and young people who are growing up in a digital world at the centre of a new understanding of UHC is arguably critical to ensuring that everyone benefits from digital transformations of health and healthcare.

First, this depends on the fact that, in keeping with the notion of lifelong health, "health in the earliest years lays the groundwork for a lifetime of well-being".[169(p 2)] Ensuring that digital tools support the health and well-being needs of children and young people, and addressing the role of digital technologies as determinants of health already in early childhood, has the potential to improve indicators of population health, and reduce the social and economic burdens of disease later in life.[170] Secondly, children and young people are usually among the most vulnerable groups in a population, and their health and well-being outcomes are thus likely to be a litmus test for the whole of society's capacity to harness digital transformations in support of UHC. Third, children and young people are already those with the highest exposure to digital technologies, with youth aged 15-24 representing the most connected age group.[171] As such, they are both particularly exposed to potential harms that may derive from them and uniquely equipped to shape a new UHC that includes the evolving understanding of health and well-being in a digital world.

The main implication of putting children and young people at the centre of a digitally-transformed UHC is that the type of health services offered in digitally-enabled health systems and included in the publicly-financed UHC package must be adapted to the changing needs and expectations of these demographics. For example, the youth consultations held by the Commission (panel 6) revealed that young people aged 14-29 expect a mix of digital and in-person health services – and

that their top concerns include physical fitness, mental health, sexual and reproductive health, NCDs (especially as they get older), and the ability to access reliable health information. Young adults also point to several key qualities they expect from all in-person and online health services, including their affordability, respect of privacy and confidentiality, quality, and their responsiveness to feedbacks and inputs. These demands must inevitably be integrated into the digital transformation of UHC. At earlier time points, such as during infancy and childhood, digital systems may instead be seen as enablers for parents or other caregivers, ensuring a better assessment of infants and children's mental and physical development and supporting health education. Such applications would have to be differently tuned to different communities and levels of digital literacy, but may be most important for those groups who face challenges in accessing traditional health systems and sources of health information. Finally, because adolescents and young adults have both an understanding of their needs and the ability to devise solutions, future health systems should by necessity be participatory, and enfranchise such groups as co-producers and co-designers in the development of digital health tools.

In the next section, we will specifically focus on this interface between digital transformations, UHC, and the health and well-being of children and young people.

Section 5 - Youth futures: children and youth are central to digital transformations of health

No universal experience of growing up in a digital world

All children and young people are growing up in a digital world but their lived experiences of that world, and its opportunities and risks, vary dramatically depending on where they live. How young people use digital technologies to learn about and manage their health and well-being is also determined by a range of intersecting economic, social, and political factors.

The multi-faceted intersections of digital and health transformations clearly impinge upon the transformation of health and well-being for children, young people, and future generations. Existing bodies of evidence, predominantly focused on HICs in Europe and North America, already offered insights into the experiences and views of young people in relation to digital health.[172] The Commission, in collaboration with the International Federation of the Red Cross and Red Crescent Societies (IFRC) and the United Nations Children's Fund (UNICEF), consulted with young people from LMICs to capture a broader range of voices and perspectives (panel 6).

These consultations confirm that as with digital transformations, there is no single youth transformation, but rather multiple transformations depending on different societal and geographical contexts, and no universal experience of growing up in a digital world (see also panel 4). We propose to categorise young people's experiences into six broad profiles, ranging from 'digitally excluded' children and youth who are currently disconnected (from both the online environment and formal health systems) to 'digitally immersed' children and youth who have access to a wide range of digital tools and services and can use them effectively to support their health and well-being. Young people at highest risk of disease and with the lowest access to a health worker and essential health services are usually the least connected (see figure 5a).

Our conceptual typology of digital childhood profiles tries to capture how across the world, children and young people's use of digital technologies, and access to health-related information, can be mediated by several, intersecting factors including their age, gender, location, and socio-economic status (section 3). Within countries there are stark divides between those young people who can leverage digital technologies to support their health needs and those who cannot. Factors such as household rules set by caregivers, curricula and availability of technology in education settings, levels of digital literacy, gender, and government regulation of online content can also represent significant enablers or barriers to independent technology use.[98,173] Moreover, in a context characterised by the rapid emergence (and decline) of digital trends, age difference can itself create significantly different online experiences.[174]

Panel 4: Digital childhood profiles

Digitally excluded - Young person has never experienced a digital environment. Lives in an extremely poor household that cannot afford digital devices and is not served by the basic infrastructure required to get online. Local health systems are weak, so most health information

and care are provided by the community. Households may have limited access to community health workers equipped with basic smartphones.

Digitally limited - Young person has very limited experience of digital environments. Lives in a household with a single, shared device that can connect to the internet, but the young person's access is severely limited due demand for the device, irregular power or connectivity, and the financial costs of data and charging the device. Digital technology may play a role in communicating with health providers and acquiring health information.

Digitally intermittent - Young person's experiences of digital environments are increasingly frequent but irregular. Their household can afford digital devices and connectivity, but access is restricted due to distance from mobile networks and overall weak infrastructure. Digital literacy is generally low meaning that young person receives limited guidance on how to navigate the digital environment in ways that support their health and well-being.

Digitally cautious - Young person has regular access to digital environments with minimal infrastructure or cost-related barriers. Personal anxieties and caregiver concerns about online risks limit the young person's use of digital technologies and services in support of their health and other interests.

Digitally consumed - Young person spends excessive amounts of time in digital environments leading to significant exposure to commercial marketing and potentially harmful content and interactions. Young person receives little support or guidance from caregivers to help them moderate their technology use or deal with any negative impacts to their health and well-being.

Digitally immersed - Young person is able to transition seamlessly between online and offline environments and effectively use digital tools to support their health and well-being. Whilst continuing to be exposed to online risks, adequate levels of digital literacy and a supportive environment allow the young person to understand and mitigate any risks they encounter.

Figure 6: Visualisation of the Commission's Digital Childhood Profiles. Source: the authors.

[Insert Figure 6 here]

Datafication of children and young people

Despite the varying experiences of growing up in a digital world, the datafication of children and young people will represent a defining feature of health futures. A trend is already evident across all age groups and countries in high-income settings, and increasingly in the low- and middle-income settings: people's use of digital technologies leaves behind data traces and trails of their personal information.

Digital health technologies include search engines, websites, online discussion forums, telemedicine and telehealth systems, electronic patient record software, mobile devices and apps, wearable devices, and elements of 'smart homes' such as digital home assistants and security systems. People's movements in public spaces or institutions are also recorded by an expanding

array of sensor-equipped 'smart' technologies, including digital video cameras, movement sensors, and facial recognition systems.[175]

This datafication[51] of people's bodies and activities, can begin for children and young people even before they are born. This generates the phenomenon of 'the datafied child'[176] and resulting in 'datafied childhoods'[177] lived in 'datafied environments'[178] which include:

- pregnancy and parenting apps;[179,]
- digital technologies and wearable devices used to track health status, behaviours, and development;[180,181]
- smart toys;[182]
- digital learning technologies and apps for managing classroom behaviour;[183,184] and
- surveillance software and devices used to monitor their attendance, progress, and safety in schools.[185]

Across the world, young people who are connected also use a range of digital technologies to seek health information and advice and to improve their well-being, from, more traditional forms of digital media such as search engines and websites to messaging platforms and social media. Young people also increasingly use devices and software designed to promote their health and fitness,[186,187] making them one of the largest consumer groups of 'wearables' and other activity tracking devices.[188] At a more fundamental level, we are also moving towards an era of social genomics:[189] While mostly limited to HICs for now, an increasing number of children and young people will grow up with availability of information about their digital genetic selves.[190] Taken together, emerging technologies and digital and data standards will therefore create new paradigms of datafication and possibilities of social self-definition via a lens of data and algorithms.

The exposure of children and young people to digital technologies is already higher than for the rest of the population, as they are among the users spending the most time online.[191] Moreover, for younger children and adolescents, the family environment itself can be conducive to higher exposure to devices, software, and datafication.[177,192] However, children and young people's understanding of the digital- and data-driven world has gaps that can result in harm to them, for example in the context of their ability to manage interpersonal and commercial privacy in online environments.[98,193] The continued use of digital technologies implies that more aspects of children and young people's lives will be measured, coded, and stored than ever before; those who own and control these technologies may influence their decisions and behaviours, and put them at risk of online privacy infringement, manipulation, and commodification.

(Mis)information that could be harmful to health also reaches young people through multiple digital devices, often without their knowledge.[194] Half of all global advertising spending is now spent online, making digital media platforms increasingly important spaces for commercial marketing.[195] Digital channels may thus expose young people to unhealthy and harmful products and messages and are also major sources of data extraction.[196] For example, concerns have been raised about security breaches of smart toys and young users' personal information, as well as the commercial exploitation of these data.[197].

In addition, social media often enable abuses that affect the online experiences of children and young people.[198] These abuses, which include harassment, cyber-bulling by peers, threats of sexual violence and body shaming, and which are often motivated by race/ethnicity, gender, or sexual identity, are estimated to have increased during the COVID-19 pandemic.[199,200] Although there is evidence of overlaps between 'traditional' and online forms of abuse,[201,202] as well as of potentially higher prevalence of the former,[203] researchers have pointed out that there are qualitatively unique aspects to phenomena such as cyberbullying (for example, the perceived anonymity and number of perpetrators),[204] and that increased time spent online will significantly correlates with higher risks of being exposed to such phenomena.[205] As highlighted by the Commission's Youth Statement and Call for Action,[15] forms of online abuse thus raise serious well-being concerns, including in terms of their influence on self-harming behaviours,[206] and in turn prompt calls for greater accountability of governments and social media companies.[207]

In parallel, the relationship between the time spent in online environments and dimensions such as social connectedness and mental health continues to be debated, with studies evidencing both the positive and negative impacts of increased Internet and social media use.[52,208,209] Moreover, researchers have started to investigate the potential effects of digital technology use on the cognitive development and physical, mental and behavioural health outcomes of both children and adolescents,[210,211] albeit with a greater focus on negative impacts and a limited exploration of positive outcomes and opportunities.[212]

Importantly, the process of datafication does not only refer to those who are alive. Today's societal preferences and institutions are already reconfiguring the world that future generations will inherit. Digital and data-driven innovations, but also the rules that will govern the implementation of such innovations, are likely to shape the health and well-being dynamics of the world they grow up in. However, significant gaps remain in our understanding of how such impacts will unfold over time (see panel 5).

Panel 5: How digital technologies may impact children and young people's health and well-being over time. The need for a longitudinal multi-country study?

Digital technologies are increasingly pervasive in the lives of children and young people. While several initiatives have explored the positive[213] and negative impacts of these technologies,[214] significant evidence gaps persist, particularly with respect to longer-term health effects or the impacts on the lives of children and young people who have limited access to digital technologies and the skills to use them. Research challenges such as capturing diverse perspectives (acknowledging demographic variables such as age, ethnicity, race, gender and sexual identity, religion, national origin, location, skill and educational level, and/or socioeconomic status), contextual nuances, and cross-country comparability compound the difficulty of measuring significant impacts over time.

To address some of these gaps, as the recent WHO report on *Youth-centred Digital Health Interventions*[13] suggests, both a landscape analysis and a needs assessment can help highlight young people's experiences and contextual realities in different regions of the world. More broadly, there have been increasing calls to understand different challenges (e.g., issues

connected to screen time, problematic media use) and opportunities (e.g., use of wearables to measure and encourage physical activity, and access to knowledge, information, and technologies (e.g., health bots) around sensitive or stigmatised health issues). There have also been increasing calls to include children's and young people's perspectives in the design, development, implementation, and evaluation of digital health technologies and policies, under the assumption that this will lead to a more robust data and evidence base for policy-makers.[318,215]

Among the possible forms that research activities can take in this domain, longitudinal (multi-country) research with young people can offer several benefits over other types of study design (e.g. cross-sectional). First, longitudinal studies can assess how digital technologies may impact young people's health and well-being over time. Such technologies may not have an immediate negative or positive impact on youth but, instead, cumulative effects that can only be measured by long-term research.[216] Relatedly, longitudinal design can better demonstrate the effects of different determinants of health, such as socioeconomic status, education, and access to and quality of healthcare. Longitudinal research can also help demonstrate causal effects by collecting detailed information on the sequence of different practices and events.[217] Further, research in multiple countries can allow for a degree of cross-country comparability, as demonstrated by the Health Behaviour in School Age Children Study, a WHO collaborative cross-national survey that now includes 50 countries and regions.[218]

Although conducting a longitudinal multi-country study comes with challenges,[219] there is great promise in this research approach. Looking ahead, it will be essential to determine the study's main emphasis, further define the methodology, and convene relevant partners. It will be critical to build partnerships with children and young people themselves to ensure that we can, together, shape evidence-based digital health innovations, policies, and programmes that amplify and value young people's voices and promote their health and well-being.

Children and young people as drivers of positive health futures

An important, underlying dimension of the datafication of children and young people consists in the fact that they are treated - and encouraged to view themselves - as inert, calculable data subjects.[176] Such an approach denudes children and young people of agency and autonomy, including towards their caregivers,[220,221] instead of promoting the role of families, schools, and peer mediation in helping children and young people develop forms of digital resilience against online risks and harms,[5(p 33-38)] For example, child safety and protection issues are often used as selling points by surveillance technology developers, positioning children as risky subjects requiring high levels of monitoring and unable to take responsibility for their own safety. As a consequence, children and young people often have little choice in engaging with these technologies[222]: for example, when they are expected to use digital learning platforms, biometric systems, or self-tracking devices at school and there is little or no option to opt out.[176] The COVID-19 experience has highlighted many of these issues.[223]

In a similar vein, in many parts of the world, young people already contribute to digital health ecosystems through healthcare start-ups, advocacy, and non-profit initiatives.[224] However, investments in, and decision-making on, digital health technologies and ICT systems are rarely oriented around their skills, needs and views. In fact, both marketing strategies and policy debates are more likely to consider younger age groups as consumers of technologies and centres of data extraction, not only raising concerns for their health and well-being[2] but also potentially undermining their participatory rights.[225,226]

If digital transformations are to be aligned with health and well-being across the range of potential health futures, the perspectives and agency of the generation(s) who will inhabit such futures must become foundational pillars of any attempt to govern it. The UNCRC argues that the right to be heard applies to children of all ages and in all contexts, including health.[227] Such a need for greater intergenerational leadership and participation has been recently voiced in the context of planetary health but is also emerging in the context of digital health and well-being.[228]

At the same time, many social movements and democratic processes driven by young people could not be envisaged without them using digital tools extensively and creatively.[229] In the last two decades, more and more young people around the world have found and deployed their voices online, showcasing the potential use of digital media and technologies as a critical tools for civic and political engagement and participatory research.[53,54] With respect to health and well-being, the role of online testimonials and social media has also become an important tool to create interest and appeal to a wider audience.[230]

The consultations held by the Commission reveal several ways in which children and young people's perspectives would be critical drivers of digital and health transformations, while reinforcing the necessity of seeing digital tools as integrated with broader efforts to ensure UHC and strengthen health systems.

First, children and young people signal that their perception of health and well-being goes beyond a narrow understanding of healthcare, to include day-to-day concerns about fitness, nutrition, sexual and reproductive health, and self-care. For example, young people consider being online and connected to other people – connectivity - as an increasingly critical part of health and well-being, and want services and tools, including digital ones, that promote well-being and support mental health to be included in the essential package of services available to all young people.

Secondly, young people expect a mix of digital and in-person health services that are easily accessible, responsive, and friendly towards their evolving needs and capacities. Young people consulted by the Commission expressed their preference for getting health information online or from their family and friends, over getting it directly from health professionals. However, access to health facilities remains important for accessing treatment and care, as well as seeking advice on more serious health conditions.

Third, children and young people demand to be given the knowledge and skills to manage their health and well-being in the digital world, including:

- digital, health, and civil literacy and skills to navigate digital environments and exert greater informed control of their personal data;
- health education around physical activity, dietary habits, relationships and products such as drugs, alcohol and tobacco;
- quality education and skills that can enable them to be part of the future workforce, so that they can build future health and digital economies that meet the needs of young people.

Fourth, young people want to be enfranchised, including through new models of participatory governance, co-design and research.[231,232] This means, among other things, that they must be able to play a part in decision-making processes that impact their health futures, including the design and governance of digital health approaches and other digital and data-driven services; to be given spaces to express their views and share their experiences about health and well-being; to shape and implement accountability mechanisms for governments and private actors; to have access to an enabling environment for youth-led innovation that can allow them to design their own health futures; and finally, to be able to rely on affordable and universal internet connectivity in order to be able to play an active role in governance and innovation.

Finally, as discussed in the Commission's Youth Statement, children and young people want to be protected from commercial exploitation and harmful content when they are online, to know how their health data is being collected and used, to give informed consent to the sharing their data, and to be able to use online platforms that help them distinguish reliable health information from disinformation and misinformation.

Panel 6: Young people's views on digital health

In October and November 2020, UNICEF conducted a U-Report survey on behalf of the *Governing Health Futures 2030* Commission to better understand the expectations, demands, and concerns of young people in relation to the use of digital technology and data for improving their health and well-being. The survey comprised six questions: four multiple choice questions about young people's use and views of digital technologies for health, and two open questions to capture their opinions on what governments and technology companies should do to govern digital health, as well as what they imagine digital health will look like in 2030.

The survey was distributed through seven national U-Report channels (Argentina, Brazil, France, Guatemala, Myanmar, Serbia and Zambia) and through the U-Report global channel. Poll results were analysed by the Commission Secretariat to identify key themes and trends. A total of 23,435 children and youth from 176 countries participated. The majority of respondents (86%) were aged 14-29 years. Ninety-five percent came from LMICs.

Summary of survey findings[233]

- Eighty-eight percent of respondents use some form of digital technology for health-related purposes.
- Smartphone apps and websites are the most common technologies used.

- Improving fitness is the most popular health-related purpose for users of digital technologies. Smartphone apps are the most popular form of technology used for supporting fitness, whereas websites and social media are more widely used by young people concerned about other health issues such as infectious diseases, nutrition, mental health and reproductive health.
- Half of respondents said that accessing health information was the biggest way that digital technologies can help young people manage their health and well-being.
- Inaccurate health information is the biggest worry for young people using digital technologies, followed by concerns about their privacy, and use of digital technologies making them less physically active.

What should governments and technology companies do to ensure that digital technologies improve the health and well-being of young people?

Young people's recommendations focused on improving internet access and the quality of healthcare rather than on digital tools. Many respondents urged governments and technology companies to mitigate harms associated with the digital environment such as misinformation and harmful content. Overall, respondents believe stronger governance of digital technologies is required but they expressed a high degree of cynicism about governments' commitment to act on young people's recommendations.

When asked to imagine a world in 2030, young people aren't sure how they will use digital technologies to get health information and advice in the future. There is a high level of uncertainty with a large number of open-ended responses as 'I don't know'. Young people tended to be polarised between highly dystopic and utopic imaginaries: with predictions for 2030 ranging from a "robotised" future where "everyone can access the internet" to "it will be chaos!". Youth imaginaries on what digital health will look like by 2030 revealed a number of themes that are relevant for governing health futures including: building young people's trust in health knowledge and governments; increasing health and digital literacy; building basic digital infrastructures; ensuring digital tools complement and do not undermine the importance of face-to-face interactions with health professionals; increasing the quality of internet access and health services; discouraging excessive time online; and shifting towards more personalised models of medicine.

Responses to the survey suggest that many young people had not previously thought about the role that digital technologies do – and could – play in supporting their health and well-being. Further opportunities should therefore be created for young people to critically examine the potential opportunities and risks associated with digital transformations of health, and to relay their ideas and concerns to policy-makers and technology companies, including opportunities to consult young people who cannot participate in online surveys such as U-Report due to insufficient connectivity and other barriers.

Section 6 – Creating a value-based framework for governing health futures

'Health for All' Values

It is imperative that any tension between health and digital transformations be resolved in favour of the core values of health. We argue that the governance of health futures should rely on the values set by the WHO in its Health for All approach,[234] namely democracy, equity, solidarity, inclusion, and human rights, while also updating these values to reflect their new meanings in a digital world.

The previous sections have emphasised the fundamental interconnection of health and digital transformations, and preliminarily outlined a series of significant challenges and opportunities for governance. But what are the values that should guide decision-makers and other public and private stakeholders as they seek to harness the potential of digital technologies in support of UHC?

We argue that any approach to shape health futures through digital transformations should be grounded in the same set of universal values[235] that are articulated in the 2030 Agenda for Sustainable Development[16] and the high-level political declaration on UHC[19] - both of which have been adopted by all UN Member States. Core to these agendas are the principles of democracy, equity, solidarity, inclusion, and human rights, which are required to achieve *all* dimensions of health futures, including those not immediately dependent on digital technologies. They also encourage a progressive universalism approach, which means proactively reaching populations at greatest risk of being left behind first in order to reduce equity gaps.

Upholding Health for All values serves to ensure that digital technologies enable health benefits including a positive transformation of UHC, improved access to and quality of health services, as well as more effective prevention and management of public health crises. In turn, this will result in digital transformations of health creating public value and actively advancing social justice, rather than promoting a siloed and ungoverned adoption of new technologies as they emerge (figure 7). If Health for All values are to play a central role in shaping health futures, however, they themselves must be strengthened and updated to reflect their specific relevance for, and intersection with, digital transformations. In this section, we build on such values to identify a series of foundational entry points for the governance of digital transformations of health, which provide a critical framing through which to understand the action areas presented in section 7.

Figure 7: Conceptualising the public value of digital transformations of health. Source: authors' illustration.

[Insert Figure 7 here]

Human rights and ethical principles

Digital and data-led transformations of health pose a set of novel ethical and human rights challenges. Letting digital spaces, platforms, and technologies go ungoverned risks creating "human rights black holes."[236] Digital technologies will only advance social justice and reduce health inequalities if they are designed and implemented with ethical principles and human rights-based approaches in mind.

Without a new digital ethics, based on integrative approaches between 'offline' and digital rights, and centred around the protection of principles and collective values such as privacy, equity, fairness, patient safety, and human autonomy over healthcare decisions,[237,238,239] health could become an entry point to the use of digital technologies in support of new forms of 'surveillance capitalism',[240] data colonialism[241] or digital welfare dystopias characterised by a wide range of approaches to control citizens.[45] We are already witnessing such developments in a number of countries, as a consequence of the COVID-19 pandemic.[242,243]

Despite the long-standing adoption of broad strategies and declaration of principles to guide digital transformations,[244] in practice many countries still lack effective approaches to digital health that have democracy, equity, solidarity, inclusion, and human rights at the centre. Compounding pre-existing failures of many health systems to put patients and their human rights first, digital health ecosystems themselves are often developing without adequately considering the unequal distribution of power and resources that affect an individual's or community's access to, engagement with, and ability to benefit from digital health technologies.[4,92] For their part, health professionals who are challenged to respond to the new ethical issues arising from digital health transformations, from differences in access to digital health technologies to algorithmic biases,[245,246] are not necessarily prepared or trained for this purpose.

Established public health concepts grounded in the Health for All approach are critical to ensure that digital transformations advance social justice and promote health equity. Similarly, the realisation of human rights including the right to health, privacy, equality, and non-discrimination constitutes an unavoidable normative framework to orient such transformations. While they were adopted long before many of today's digital technologies were conceived, universal human rights instruments such as the UNCRC apply online as they do offline and have to be respected in full. More recent efforts, such as the EU Strategy on the Rights of the Child[247] and the OECD Recommendation on Children in the Digital Environment,[248] reinforce this need.

By contrast, the absence of a strong ethical and human rights-based analysis when designing, implementing, and evaluating digital health solutions for welfare policies and programmes can lead to ignoring or exacerbating existing health inequities and other forms of discrimination, or even creating new ones. Such analysis, which is especially relevant for populations who are already at risk, such as young people, women and girls, migrants, and displaced people in humanitarian settings, must consider the specific outcomes of data-extractive processes (panel 3 in section 4). For example, controversial data-sharing schemes have enabled governments to start accessing medical records as part of a welfare system's assessment processes, a development that "might

deter vulnerable people from seeking medical assistance when they need it"[249] and thus interfere with their rights to health and privacy.[250]

These challenges do not apply equally to all countries (or even to everyone within the same country) and they of course find different expressions in different political systems. First, they arise in the context of, and interact with, the emerging geopolitics of digital governance. As such, they manifest themselves with different nuances, based on the specific governance approaches chosen to regulate (or not regulate) the power and agency of the actors of the digital health ecosystem, be they governments or the private sector.

Secondly, they are met with vastly divergent responses across different societal contexts, given that ethical principles and human rights in the digital space are, much like their 'offline' versions, subjected to different political systems, socio-cultural understandings, preferences, and governance contexts. This has become abundantly clear during the COVID-19 pandemic. For example, consent for digital health applications to track the location of every individual to make contact tracing easier in the event of an epidemic might be given in one country but fiercely fought against in another, as might the broader consent for sharing personal information for healthcare purposes.[251]

Third, they are compounded by pre-existing inequalities, such as those represented by the growing digital divide. For example, the better off, urban, and educated are often the best placed to fully capitalise on digital health technologies. Digital solutions may exclude those who likely need it the most, such as those living in rural areas with limited internet connectivity, women, the less educated, the impoverished, and the elderly. This has also been debated in the context of COVID-19, as countries started to set up online registration systems for administering vaccinations.[252] Even in countries deeply invested in digital transformations of health, such as China, the divide remains evident.[253]

Fourth, the full ethical and human rights ramifications of emerging and future technologies, are simply unknown.[254] For example, de-identified shared genomes have been successfully used to re-identify individuals or their families and such information can be used adversely.[255] Moreover, while legislation may prohibit discrimination based on genetic data, the intersection of AI and health data has previously led to unintended racially discriminatory consequences that would need to be guarded against even more when genomic data gets added to algorithmic 'black boxes'.[256]

A solidarity-based approach to health data

The way in which we collect and use health data must reflect the ways in which the social contract in health and healthcare is articulated in different cultural and societal contexts. Governing digital health through the prism of UHC means an approach to health and health-related data that is centred on a social contract that also applies to the digital sphere and is built on the notion of data solidarity.

Among all Health for All values, we believe that the notion of solidarity is particularly important for understanding the opportunities and challenges brought about by digital transformations of health. The concept of UHC itself is an expression of a social contract[257] based on solidarity, which we understand as an enacted commitment to carry the 'costs' (financial, social, emotional, and other contributions) of assisting others with whom a person or persons recognise similarity in a relevant respect".[258] Social contracts built on a similar, solidarity-based approach "emphasize the simultaneous importance of personal and collective needs, interests and responsibilities, and focus action on the space where the two overlap."[259]

From a UHC and public health perspective, digital health tools can provide decision makers with reliable data to deliver comprehensive health services for all in terms of planning for such services and providing care in communities.[260] There must therefore be a conscious effort to bring together individual health agendas – which for digital applications are more focused on aspects such as behavioural monitoring, precision medicine, and disease prediction through genomic approaches – and the more structural efforts towards broader population-based impact that have long characterised public health action.[261]

In this context, the importance of a solidarity-based approach, and of adopting a public health perspective more generally, is often not considered or is discounted. The ethical and human rights challenges that come from digital- and data-driven transformations of health are often confined to questions of autonomy, data ownership and control or (on the other end of the spectrum) to public health surveillance, forcibly pinning notions of privacy and public health surveillance one against the other. The misleading nature of this framing, which has already been discussed in the context of the relationship between the social solidarity basis of public health and the individual right to health,[262] is also illustrated by the debates surrounding the deployment of contact tracing technologies during the COVID-19 pandemic. On the one hand, the use of privacy-related arguments to promote an individualised understanding of health and health-related data overemphasises the idea of individual data ownership[263] neglects the social and relational nature of (health) data,[264] and ignores the heterogeneity of data coming from a variety of different sources. On the other hand, the COVID-19 response has highlighted the real risks that problematic approaches to data collection, integration, sharing, and storage could bring for privacy and other human rights, especially if applied beyond emergency measures or made available to law enforcement agencies.[265]

The notion of solidarity, as applied to health data and data for health, can be a way of rebalancing this debate by safeguarding non-extractive and trustworthy approaches to data collection, use and sharing, building a culture of data justice and equity, and ensuring that the value of data is harnessed for public good. Its articulation, however, requires a new understanding of how the approaches that have emerged to govern data in our societies can be updated to reflect existing, shared goals for health and well-being.[266]

Inclusion and enfranchisement

AI and other digital technologies raise important issues about the way in which we imagine and represent sexuality, race/ethnicity, gender, class, geography, age, and ability. A new understanding of inclusion and enfranchisement in the context of digital health will entail forms of context-aware technical development and innovative, local and community-led approaches to the co-design and deployment of digital tools.

Biases in public health and administration are not exclusive of digital systems. On the contrary, studies in humanities and social sciences have increasingly documented how algorithmic processes, AI, and machine learning may reproduce social patterns of bias,[267,268] and be affected by them. In this sense, the ethical and human rights dilemmas that arise from digital transformations of health must address the challenge of promoting inclusiveness and enfranchisement of marginalised actors and vulnerable groups in broader governance systems.

A critical obstacle to increasing the inclusiveness of digital health interventions is what some scholars call digital (or data) colonialism.[241] This concept indicates all digital practices through which individuals are marginalised or dispossessed by more powerful actors (both private and public), usually based in higher-income and technologically advanced countries, through the extraction, control and use of their data. Beyond economic consequences, such loss of control over digital health futures is troubling, because health interventions that are not anchored to local contexts and understandings around health (for example, because they do not involve local developers) may be ineffective or even harmful.[269] More broadly, the massive increase in health data flows, both within and across countries, presents significant risks of social externalities, from those linked to data storage, transfer, and anonymisation to the wider implications for power relationships and societal dynamics.

Beside the potential application of digital technologies for health to new colonialist practices, the tumultuous invention, application, and scale-up of these technologies also raises important questions about the way in which they imagine and represent sexuality, race/ethnicity, gender, class, geography, age, and ability. Experts have raised concerns that digital technologies may reproduce, and often exacerbate, historical patterns of bias, unequal distribution of power, and discrimination. These concerns, which become particularly relevant in the context of machine learning, have been raised in all social domains, including healthcare – and have led to calls for the adoption of decolonial[270] and feminist[271] approaches to AI and data science more broadly. In health, they are being raised by advocacy groups as well as scholars in the humanities, social sciences, and health sciences.[272,273]

This growing body of research, which addresses biases at the level of gender,[274] race/ethnicity,[275] disability,[276] and indigenous populations,[277] among others, suggests that software developers and researchers alike must consider the legacy of these social biases, in order to advance medical knowledge and improve healthcare delivery. For example, existing efforts to harness advances in genomic sequencing in support of precision medicine are hindered by a lack of diversity in genomic datasets, with genomic variants coming from areas of high genetic diversity (such as the African continent or India) significantly underrepresented when compared to European populations.[278,279]

Digital, health, and civic literacy

To create public value and contribute to UHC, digital health must be underpinned by high levels of digital, health, and civic literacy. These are essential to achieve health equity, strengthen democratic participation, and enable better individual and collective choices.

Robust democracies characterised by greater freedom of expression, free and fair elections, higher levels of trust and respect of the rule of law have consistently been shown to yield better outcomes in confronting health challenges, making progress towards UHC, and enabling more inclusive and transparent debates around health interventions.[280] These fundamentals arguably become even more relevant in the context of digital transformations of health. On the one hand, strong civic tech ecosystems can play an important role in ensuring the democratic governance of digital health, and digital technologies more broadly are providing young people with critical tools for civic participation and activism (section 5).

On the other hand, private individuals (and children and young people in particular) often have little control over their data and limited opportunities to shape, design, or monitor digital technology to ensure it meets their health and well-being needs. Moreover, the power asymmetries of the new digital ecosystem have undermined the agency of many national governments and their ability to exercise ownership over digital transformations' processes in the best interest of their people's health and well-being, as new actors hold increasing power.[281]

At the core of this democratic dilemma lies the critical need to ensure that people have digital skills and literacy, and that governments can represent the perspectives that people express in the health domain. Ensuring equal access for boys and girls to STEM education, as well as providing every young person with the basic digital skills which are required to make use of digital devices and online applications, is an increasingly important democratic requirement in the digital era. In addition, the demand for more advanced digital skills is rising across all economic sectors and quickly becoming a critical determinant of young people's work readiness,[282] including in the fields of health and healthcare.

At the same time, digital literacy refers not only to the applied technical skills necessary to use and access the Internet, but also to the capacity to critically and confidently engage with the online environment, including its political economy and geopolitics.[283] More broadly, as a determinant of health in its own right, it has been emphasised that digital literacy significantly interacts with other intermediate health factors and social determinants, to influence both access to digital health resources and wider health equity outcomes.[284]

For example, digital literacy is not only intertwined with 'conventional' health literacy, but also strictly interconnected with broader democratic and civic literacy skills, in the sense that neither of these skill sets can be expressed effectively without the other in a digital age. On the one hand, the digital ecosystem offers new spaces for political participation and civic debate, including on health matters, but only to the extent that informed citizens are able to engage critically with it

and protect themselves and others from misinformation and abuse such as discrimination and cyber-mobbing.[285] In turn, digital and health literacy can only thrive:

- in equitable health systems that strive to reduce health disparities and improve access to care for all social groups;
- in societal contexts characterised by high levels of trust, respect for others, good governance, respect of the rule of law, independent journalism, and information stewardship;
- within wider geopolitical contexts in which the perspectives of those societies can be heard within the wider governance of health and data technologies.

Section 7 – Shaping health futures

Introduction

An approach to governing health futures in a digital world must be purposeful in the challenges it sets. All levels of governance, from multilateral fora to country governments, regions, and cities, should ensure that digital transformations create public value, advance democracy, and uphold health and digital rights, equity, and solidarity.

The breadth and complexity of digital transformations of health suggest the necessity of governance transformations that can effectively address the multiple interweaving dimensions of health futures.[286]

First, where the Internet was once primarily associated with decentralising and democratic attributes, the ecosystem of digital transformations is now one of concentrations of data, computational capacity, and power. Digital transformations are compounding or influencing power relationships between public and private actors. They are becoming embedded in broader geopolitical developments, potentially concentrating decision-making (including on health matters), and expanding the power of those who control the access to, and leveraging of, health data and technologies.

Secondly, digital tools, platforms and services developed by the private sector represent new objects of regulation, with different digital governance models being adopted in different societal contexts and a growing attention to their implications for health and well-being. Despite the many initiatives that are being taken by governments, civil society, and private sector actors themselves, a global consensus or international instrument on digital governance seems less likely. Yet, it will be critical to explore how political systems can reach agreement within the United Nations system and shape an inclusive digital agenda, despite their major differences.

Finally, digital transformations are providing policy-makers and bureaucracies with an unprecedented set of tools for governance in areas ranging from public health surveillance to welfare systems – a dynamic that has been laid bare during the COVID-19 pandemic. Translating such tools into working designs that contribute to digitally-enabled health systems and create public value will require the development of mission-oriented frameworks through which to steer innovation,[287] in order to ensure that digital technologies, data and algorithms (including those adopted in health and healthcare) are not developed or repurposed in ways that threaten human rights, enable digital surveillance and mass monitoring, exert undue political influence, and reinforce discrimination.[288]

Taken together, these digital transformation trends have major implications for health and well-being, which have been explored in the previous sections. In this section, we propose four interacting action areas that may help address power asymmetries and rebalance trust in digital transformations of health – or 'digital health trust'. First, we suggest that decision-makers, health professionals and researchers should consider digital technologies as increasingly important determinants of health, and address their interactions with the other determinants. Secondly, we emphasise the need to build a governance architecture that creates trust in digital health and

enfranchises actors at all relevant scales. Third, we call for a new approach to the collection and use of health data based on the concept of data solidarity, with the aim of simultaneously promoting individual rights and public value. Finally, we urge decision-makers to invest in the enablers of digitally-transformed health systems. The Commission considers the four areas to be critical game-changers for shaping health futures and achieving a public value-driven governance of public health and UHC in a digital world.

Addressing the digital determinants of health

Digital transformations are in themselves a determinant of health, but they also interact with the many other determinants that define the health futures of children and young people. Investing in health, education, the future of work and climate action as part of the 2030 Agenda is a necessary baseline for ensuring sustainable health futures.

Investing in universal broadband access must also have the highest priority at national and global level. The digital potential for UHC can only be achieved if the glaring gaps in connectivity are addressed with urgency.

Investing in the Sustainable Development Goals

Many policy-makers put great hope in the contribution of digital technologies and ICTs to bolster sustainable development and accelerate the implementation of the 2030 Agenda – thus harnessing the positive role of digital transformations as a social determinant of health. But, for this to happen, governments and other public sector actors must invest in critical areas such as health, education, and decent work as well as the digital connectivity, capacities and infrastructures that allow for their digital transformations. This will require both public and private investments, as well as public-private partnerships.[37(Ch 5)]

For example, thriving education systems, incorporating both analogue and digital components, will define the future well-being of children and young people. They are critical for addressing priority challenges such as the cognitive development of children and their emotional and mental well-being. They must ensure health and digital literacy, and address concerns such as the mental health implications of online harms, competitive educational environments, and datafied childhoods.[289]

Similarly, ensuring decent work and preparing for workforce transition in a digital age will require labour laws that offer protection and significant investments in equipping children and young people with STEM education and digital skills, promoting re-training programs and lifelong learning, and mitigating the impacts of emerging technologies on unemployment.[290] These investments should also seek to bridge the gender divide in STEM and digital technologies, with girls and women still representing a small minority of digital professionals, researchers and developers.[291] We know very little today about the exact workforce needs of the future but we do know that the digital skills of today will be the basic work skills of tomorrow – also in health and healthcare.

Addressing the digital and health divide – within and between countries

Digitally-enabled socio-economic development is a high priority for developing countries and many countries wish to prioritize and accelerate digital transformations. Yet we see that the countries with the largest youth populations are often those where investments in connectivity infrastructure are underdeveloped, correlating with poor health outcomes and limiting the potential for children and young people to benefit from digital transformations and contribute to sustainable development. While recent analyses reveal a growing Internet uptake and mobile-broadband subscriptions across the world, they also emphasise that an estimated 3.6. billion people remain offline, that the digital gender divide is widening, and that affordability remains a challenge for many countries, especially those defined as 'least developed'.[133]

Digital transformation strategies are essential for health too. From this perspective, the UHC mission of health and well-being must shape public investment and ICT markets, and regulation should be used to spur responsible innovation, rather than to create barriers. The present political economy of ICTs represents a major obstacle to the growth of a digital communications network for health. However, market-failure frameworks are not sufficient – demand-side stimulus and innovation are needed to enhance supply in LMICs and drive bottom-up innovation.

In this context, it is also important to stress that global access to information technology does not have to mean access to the latest technologies, as foundational investments are the most transformative in many contexts. For example, in the context of the COVID-19 response, WHO, ITU, and UNICEF proposed all telecommunications companies to help reach every person on the planet with vital health messages, whatever their connectivity level, by building on existing efforts to deliver health messages to mobile telephones as part of the BeHealthy BeMobile initiative.[292] Similarly, building on the One Million Community Health Workers campaign and its 'Phones for Health' project, a new global initiative could be launched to connect every primary healthcare centre and community health worker to the Internet using foundational technologies such as smartphones.[293]

Regulating powerful players and adopting mission-oriented innovation policies

As tech giants increasingly drive digital health and the wider health economy, proper checks and balances are needed to avoid health systems being affected by digital development pathways guided merely by economic gains, while also integrating private investment and resources in country-led efforts to strengthen health systems. From this perspective, solidarity-inspired initiatives at both international and country levels can play a vital role along several dimensions.

First, governments and regional organisations should adopt mission-oriented innovation policies that '*pick the willing*' to stimulate investment and innovation towards the challenges of health transformation and UHC.[116(p 804)] This would entail, inter alia, the use of public policies to shape new markets in digital health (rather than just fix existing market failures); to create a sense of ownership among public authorities, private actors, researchers, and communities around a vision of health futures; to provide patient public finance to digital health innovation beyond basic

research; and to share risks and rewards with private sector innovators through return-generating mechanisms for its investments (e.g. retaining equity or royalties, or capping prices of final products.

Secondly, while governance pathways for health futures should take into account the need to leverage the skills of all actors, it is also clear that a new phase of regulatory action is required to fight the trends towards the increasing concentration of power and agency in the hands of digital superpowers and private tech giants. If left unchecked, for example by encouraging self-regulation by large technology companies, these trends may lead to governance systems that simply reinforce power imbalances and codify forms of data colonialism and data opportunism, with the health sector representing an ideal 'Trojan horse'.[85] Governments should ensure the widespread application of good governance principles to digital health applications and services,[294] anchoring their own practices to strong rules and practices around accountability, transparency, respect of the rule of law, and equity.[295] At the same time, they should limit the massive data extraction practices of powerful private sector actors through stronger competition and data protection policies, capacity-building of independent regulators, and greater participation of the public (including young people) in regulatory bodies, building on initial efforts such as the EU GDPR, the recent European Commission proposals on a Digital Services Act and a Digital Markets Act,[296] and the California Consumer Privacy Act, which enables California residents to demand information collected about them from companies that profit from consumer data[297].

Moreover, they should accelerate international efforts towards a fair taxation of the Internet economy, seeking to address the disconnect that digitalisation has progressively created between the physical presence of technology companies and the markets in which such companies create value by interacting with users through digital channels.[298(p 79-82)] The OECD released a report on its digital tax plans in October 2020,[299] while the European Commission has also proposed new rules to ensure that digital business activities are taxed in a fair and growth-friendly way.[300] A multilateral approach to the taxation of the digital economy has been described as the only approach capable of avoiding a fragmentation of the Internet and addressing the equity and justice concerns of many LMICs, particularly at a time in which significant fiscal space must be created to fund COVID-19 response and recovery.[301] For example, the African Union has drawn attention to the rapid growth of the digital economy during COVID-19, which has seen Big Tech companies be among those experiencing the greatest market capitalisation gains in 2020,[302] and its implications for fair taxation.[303] As a result, a growing number of proposals for COVID-19 recovery plans focus on the possibility of using revenues from digital taxes to support health systems.[304,305]

Building a public trust architecture for digital transformations of health

To protect individuals – especially children and young people - from negative health and well-being implications of digital technologies, governments must go beyond issues of data privacy, freedom of expression and harmful online content. They must ensure responsible and ethical technology development through robust and participatory regulatory and accountability frameworks. An inclusive governance architecture that

aims to build trust among all stakeholders of the digital health ecosystem is a prerequisite for digital technologies to benefit public health and UHC goals.

Ensuring health and digital rights

First and foremost, governing digital transformations inevitably means identifying new ways of protecting individuals from emerging threats to their health and well-being, with a focus on vulnerable groups such as women, children, young people, and future generations (panel 7). These threats may range from so-called online harms (which include the exposure to illegal content and activities, online abuse, gender bias and discrimination, cyberbullying, and the impact of excessive screen time) to the broader influence of digital technologies on the social and commercial determinants of health.[176,197]

Panel 7: Legal, governance and technical tools to protect and promote the health of future generations

While laws and public policies are often primarily designed to benefit the health and well-being of people living today, there is increasing attention towards their potential to influence systemic, and enduring change in the interests of health across the life course and also across generations. Crucially, laws can also hold institutions and other actors formally accountable for decisions and actions that could impact on health, sustainable development, equity, and human rights.

Legal and governance tools

Laws and regulations for protecting and promoting population health have long been in place in most countries,[306] those that establish public health norms and standards, modify known structural risk factors for disease and injury and enhance key protective factors such as food, housing, education, income, employment, sanitation, social connectedness, and healthcare. More recent laws concern protections related to digital health, such as regulation of emerging technologies, use and sharing of data (privacy), and intellectual property. Where these laws moderate exposure *before conception* to environmental factors that increase disease risks through epigenetic adaptations, they reduce transgenerational transmission of disease risks[307] and in this way, contribute to healthier futures.

While such issue-specific laws are vital, attempts to promote intergenerational well-being in an integrated way are also being explored. For example, Wales' *Well-being of Future Generations (Wales) Act (2015)*[308] has a cohesive, overarching goal requiring "public bodies to do things in pursuit of the economic, social, environmental and cultural well-being of Wales in a way that accords with the sustainable development principle".[308(p 1)] The Act has changed how business is done and is enhancing a foresight-oriented culture. The Secretary of State and the 44 public bodies report formally on well-being indicators; a Commissioner for Future Generations is a visible change agent; and local-level public services boards advance action on well-being. 'A Healthier Wales' is one of seven core goals. Public bodies are required to undertake horizon scanning exercises involving public, private, voluntary sectors, and members of their community to conceptualise and plan for the long-term (25 years). Financial assets are being created to benefit future generations, such as a GBP 50 million Digital Priorities Investment Fund to

transform digital services for patients, public and professionals, invest in data and intelligent information, adopt the latest cloud technology, and facilitate cyber-security and resilience.

Across a range of countries, 'foresight architectures'[309] including commissioners and parliamentary councils for future generations have been established, including in Hungary, Tunisia, Malta, United Kingdom, Canada, Germany, Finland and Wales. Finland's Committee for the Future is a well-established model - a 17- member parliamentary standing committee introduced in 1993. It functions as an advanced think tank, particularly on science and technology policy futures cutting across governmental portfolios. It publishes a parliamentary response to the government's *Report on the Future*. Its analytical reports have agenda-setting potential and include *Societal Transformation 2018–2037. 100 anticipated radical technologies (ART).*[310]

Technical and policy tools

Finally, technical tools enabling long-range thinking about future generations and health are being refined and developed, and include foresight methods and impact assessments. Foresight methods are being used more widely and systematically for long-term thinking about health, healthcare and digital health in government and other institutions and organisations. Methods include futures literacy labs, horizon scanning, trend projections and trend (impact) analysis, participatory scenario development, back-casting, causal layered analysis, and Delphi surveys. Big Data analytics capabilities are strengthening predictive capability. In 2020, the WHO Western Pacific Regional Office used a multi-method approach in a sequence of intensive, multi-country workshops to examine possible post-pandemic futures.[311] New knowledge, perspectives, insights, and social relationships were constructed with value for national policy re-sets around issues including digital health and, potentially, ways of governing and working.

The quality and reliability of several types of impact assessments - health, health technology, intergenerational fairness,[312] health equity,[313] privacy, environmental – are improving with use. It may be expected that these tools will be increasingly used by decision makers tasked to act and invest in the interests of the health and well-being of future generations as well as the present. Impact assessments of digital health innovations will be vital to ensure risks are identified and mitigated while maximum benefits are derived. In a project in Kenya, for example, an equity assessment for mobile personal health records undertaken[314] which highlighted concerning implications for some community groups of using digital record, as well as acceptable measures for maximising benefits and mitigating risks.

By advocating for a new Optional Protocol to the UNCRC, the report of the WHO-UNICEF-*Lancet* Commission emphasised the need to limit the commercial marketing of products that are harmful to children, including through social media, as well the inappropriate use of children's personal data.[2] More broadly, as mentioned in section 6, the same rights that people have offline must also be respected in the digital environment,[315] and the recently-adopted General Comment 25 emphasises that the articles of the UNCRC remain relevant to children's health and well-being in an increasingly digital world (panel 8).[321]

Panel 8: Applying existing guidance on children's rights to digital health[316]

Children recognise the important role of different actors and governance mechanisms for protecting their rights and helping them derive the physical and mental health benefits that digital transformations can offer. However, children feel that, collectively, diverse stakeholders are currently failing to prioritise their rights in relation to digital transformations.[317]

Existing guidance and mechanisms for digital health governance rarely situate issues within a human rights framework, let alone a child rights framework. The specific needs, rights and aspirations of children are therefore frequently overlooked.[318] Furthermore, digital initiatives often reproduce problematic assumptions about children and their needs, framing them in deficit terms as either disproportionately 'at risk' or as a source of risk to others and themselves.[319]

Efforts to build more robust, child-rights responsive digital health ecosystems can draw from the UNCRC, the most widely ratified treaty in the history of human rights.[320] The UNCRC, along with its accompanying Optional Protocols and general comments, provides a ready-made framework to support ethical and effective digital health decision-making that supports the rights of children everywhere.

General Comment 25, adopted in March 2021, provides governments and other actors with specific guidance on fulfilling their obligations under the UNCRC in relation to the digital environment.[321] It encourages governments to:

- Use digital technologies to promote healthy lifestyles by facilitating children's access to health services and information;
- Prevent the spread of misinformation, materials, and services that may damage children's mental or physical health;
- Prioritise the best interests of every child in the provision, regulation, design, management and use of digital health technologies and services;
- Invoke legislative and regulatory powers that tackle known digital harms (such as unhealthy engagement in social media and the marketing of unhealthy products);
- Ensure that children's rights are respected and protected by all organisations that collect or process their data.

In line with the UNCRC's guidance, approaches to digital health must help to progressively realise children's rights, balancing individual rights and collective benefit. The global digital health community must acknowledge the indivisibility of all children's rights, and the impossibility of considering children's right to health in isolation.

Realising the aspirations of the UNCRC in the domain of digital health will require action in three areas. First, digital health governance must create space and opportunity for ongoing, meaningful engagement of children themselves to help build children's trust in digital health systems. Second, states, businesses, and other digital health actors must commit to children's rights and routinely account for children's needs, desires, and aspirations in their approaches to digital health and the capture, storage, and usage of children's digital health data. Third, regulation, legislation, and processes of remedy for children in relation to digital health must be strengthened to account for children's rights.

A child rights-focused ethical framework to specifically guide the design, implementation and evaluation of digital health initiatives that impact children would constitute a significant advance in the quest to protect, respect and remedy children's rights within the digital health ecosystem. However, such a framework will need accompanying internationally-agreed standards put in place and periodically conducted child rights impact assessments. Moreover, it must be urgently and systematically activated across the field of practice internationally, "before systems, processes and industry practices [further] sediment."[322]

From the point of view of accountability, the urgency to regulate digital technologies through adequate legal frameworks and 'algorithmic impact assessments' that seek to identify the broader harms that may be caused by machine learning and other data-driven tools has been suggested by several authors.[323] Such efforts go far beyond data protection, even though certain features of data protection laws remain themselves relevant, especially if health-related harms are explicitly included in such laws (for example, the requirement of consent for the use of any health-related information, the limitation of purposes for which health data may be used (or re-used), the possibility of data protection impact assessments, the need to conduct regular privacy, algorithm and security audits, and the obligation of notifying data breaches without delay).

In particular, it might be important for governments and development partners to invest in the capacity and training of offline intermediaries (e.g. civil society organisations, bureaucracies, health workforce and local government officials), in order to help them understand and navigate the potential harms and risks arising from the use and sharing of health data. These offline intermediaries could act as data stewards, coordinating data sharing and management and supporting the implementation of data solidarity approaches. In addition, intermediaries could also become reliable points of contact for communities that have been marginalised by technology because of lack of access and resources, privacy risks, and algorithmic exclusions. For example, intermediaries that already exist in communities could help people negotiate better on questions of digital technologies, including by supporting greater public sector transparency, acting as watchdogs in case health data is used for other purposes (e.g. surveillance), and facilitating access to redress mechanisms.

Taking a more anticipatory perspective, it is also important to recognise the need for action in relation to the governance of technology development, with a focus on strengthening transparency and accountability requirements around explainability,[324] fairness, patient safety, and the validation of use applications of emerging AI and machine learning tools. At present, the main multilateral attempt to develop a standard-setting instrument is UNESCO's work on a Recommendation on the ethics of AI,[325] but a 2019 review article identified 84 documents containing ethical principles or guidelines for AI – 88% of which were released after 2016.[326] In health, the WHO recently published its own guidance on the ethics and governance of AI applications, which endorses six ethical principles aimed at governments, developers, and users.[327] While they largely restate concepts that are contained in existing documents,[328,329] the principles are specifically formulated from a health and healthcare perspective, and could thus serve as the basis upon which value-based governance frameworks for digital health are built at national and subnational levels.

Enfranchising communities and advancing public participation

Beyond the protection of health and digital rights, there is also a need for forms of inclusive governance that enable individuals and groups to actively participate in and co-create the design and implementation of digital health policy and technology, as well as to feed back to decision-makers, development agencies, and private companies. Civic technology (henceforth, civic tech) models, which broadly refer to the co-creation and use of digital technologies (e.g. online dialogues and citizen consultations, open government data and open source software, participatory design tools and processes) to improve public participation in democratic and decision-making processes, are increasingly seen as enablers of improved public policy and service delivery, including in health.[330] In particular, civic tech models can help counteract interdependent burdens of health and digital divides and address the risk of exacerbating existing inequalities through digital applications.[331] Participatory design solutions, open-source models, open data sets and solidarity-based approaches to data management for the common good must be an integral component of such efforts. For example, civic tech approaches based on open data, such as the data visualisation tools deployed in Taiwan during the COVID-19 pandemic,[332(p 9)] may be used to complement top-down decision-making[333] and therefore increase trust in public health responses. Similarly, the role of local public health observatories[334] could be leveraged to harness the active contribution of civil society to the collection of data needed for precision public health, as well as ensure that such data is managed transparently and used to solve local problems.

Children, young people, women, and other marginalised communities must be at the forefront of these governance transformations. The involvement of these groups is critical in strengthening trust, promoting context-aware solutions to public health challenges, reducing built-in biases and inequalities in digital applications (including by advocating for equity frameworks for technology development and digital spaces, such as decolonial and feminist approaches),[335] and building community resilience to future changes.

Civic tech models that are focused on communities and user needs, however, are not possible without governments taking an active role in shaping collaborative ecosystems that enable data reuse and accessibility and are designed with public good goals in mind – what some authors have referred to as 'digital public infrastructures' or 'digital public spaces'.[336] This challenge is also captured by the concept of 'government as a platform', which has been adopted by the OECD to support a culture of digital governance built on principles of 'transparency, integrity, accountability and stakeholder participation'.[337,330(ch 4-5)] In the context of health, the 6th OECD Expert Group Meeting on Open Government Data has recently emphasised the importance (and challenges) of governments acting as publishers of open data to support enhanced collaboration in the COVID-19 response.[338] The urgency of such collaboration is emphasised by the many experiments in participatory design that have already arisen during the pandemic, helping governments reach communities while supporting government accountability, helping debunk misinformation and disinformation, and enabling quick citizen feedback on public service delivery. For these experiments, open government data has been necessary, and it has provided opportunities for transparency and bottom-up accountability.[339]

Similar approaches could also more directly involve patients and community groups in the development of digital health applications,[340] as user-led design has increasingly been shown as a critical means to increase their effectiveness, usability and relevance.[341,342] This might entail new forms of patient engagement through crowd-sourcing, involvement of patient organisations, or the integration of stronger qualitative components in product trials.[343]

Governing digital transformations of health with regions and cities

A democratic and distributed governance model for digital transformations of health will inevitably have to leverage the role of local communities and sub-national authorities, including cities. Essential entry points to governing health futures, including participation and enfranchisement of individuals, young people, respect of ethics and human rights, and high levels of digital trust and solidarity, are only achievable through community-based strategies built upon local needs, ownership, and priorities.[344] Regions, cities and other local authorities can thus play an important role in governing digital transformations of health to create public value for their inhabitants.

Cities around the world have increasingly promoted open government practices and civic tech models as part of a broader push towards city-level technological and data sovereignty, which could be seen a form of data solidarity that simultaneously seeks to ensure the individual control over creation, access and use of data and the rights of a community to manage such data for common purposes and data-driven city policies. For example, the 2017-2020 Digital Barcelona Plan focuses on an open and efficient government that uses technology to transform and digitally innovate the public sector based on the use of free software, the adoption of free data standards, and open, interoperable public data infrastructure.[345] More broadly, initiatives such as Cities for Digital Rights and the Digital Cities Toolkit, supported by UN-Habitat, have started to articulate overarching frameworks for similar city-level data strategies, which should be based on (i) data re-use and open-source licenses; (ii) the maximisation of the quality, integrity and security of data; (iii) data management that promotes care throughout the data's life cycle; (iv) the respect of privacy and ethical considerations 'by design'; (v) the promotion of open data and civic participation; (vi) city residents' control over data through data commons or other forms of data stewardship; and (vii) the development of an interoperable data infrastructure. [346]

From this perspective, COVID-19 has highlighted the relevance of city-level use of digital technologies for health purposes,[347] but also exposed a series of critical challenges, and particularly the need to develop better coordination between central and local governments. Absence of clear leadership and responsibilities, lack of skills, resources, and common standards for data management, as well as long-standing problems of data quality and interoperability, have all been described as hindering the timely release and use of public health data.[348]

Informing patients – enfranchising citizens

At a broader societal level, there must be active engagement in the digital health domain to ensure that patients, consumers, and citizens can make informed choices. This means that public sector actors should target technical and literacy skills in digital health to avoid the risk of widening the

gap in health between different societal groups, thereby further hindering levels of societal trust and increasing social and health inequities. The importance of digital health skills for transforming UHC stretches beyond the health workforce. As outlined in this report, civic and digital (health) literacy is also a fundamental enabler of public participation and informed citizenry, which can contribute to advancing social justice and health equity.

Individual initiatives seeking to improve digital heath literacy among patients have progressively emerged.[349,350] What is missing, however, is a strong link between these efforts and broader health system strengthening objectives. To contribute to a transformed UHC, digital skills and literacy programmes should also be actively deployed to bridge health inequalities (for example, by helping individuals living in remote areas and elderly citizens to access telemedicine solutions) and lead to increased participation in design and implementation.

In the age of misinformation fuelled by social media, building digital health literacy among patients also means having a strong public communication policy in all health subjects, including in the use of digital health technology. In the context of the COVID-19 pandemic, this was illustrated by the multiple examples of collaboration between the WHO, the health ministries of several countries and social media platforms such as Instagram, Twitter, and Facebook, which were aimed at fighting misinformation campaigns and promoting reliable health information.[351]

Beyond specific campaigns and public-private partnerships, however, governments and international organisations should also consider more institutionalised and coordinated approaches to protect democratic processes that enable citizens' agency and readiness, including the fight against online disinformation, the upholding of an informed public debate, and the protection of free and fair elections from cyber threats.[352].

Enacting data solidarity as part of a new social contract

A solidarity-based approach to health data must urgently emerge as a new public health dimension. At the global level, enacting health data solidarity depends on the effective regulation of power asymmetries through digital cooperation.

At the level of national governments, research institutions, and the private sector, health data solidarity also requires a clear statement of the public health goals to be achieved through data collection, and full transparency on how data sharing will lead to better health of individuals and the community in which they live. It also requires establishing data institutions governing the exchange and storage of the respective data, as well as institutions to which people who claim to have been harmed by data use can appeal.

Meeting global challenges through digital cooperation

Many optimistic visions of digital transformations fail to recognise how countries may follow different pathways to realise the affordances of digital technologies, based both on a lack of

common underlying values and on the use of technology for economic and (geo)political purposes,[353] and to acknowledge how similar dynamics may lead to further fragmentation of governance approaches and erosion of multilateralism.[354]

Digital transformations that run counter to the 'global good' potential of digital health, - including supporting higher concentrations of market power and unfettered access to, and control of, data,[355] - fundamentally collide with the vision of UHC futures. The world must thus act urgently to address global power asymmetries through a digital commons architecture that addresses data extraction. Digital cooperation should support a greater shift towards a vision of health data and data for health that is based on data solidarity.

The governance choice must be to advance a digital cooperation architecture that harnesses the potential of digital technologies for the global good. A high-level panel appointed by the United Nations Secretary General has proposed a 'digital commons architecture' as one of three potential architectures to support such cooperation, together with the so-called Internet Governance Forum Plus, and a distributed co-governance architecture.[400] These options have been recently reiterated in the UN Secretary-General's Roadmap on Digital Cooperation, with the Internet Governance Forum Plus gaining the most traction in international negotiations.[356]

In the context of health, a digital cooperation architecture could level the playing field for all stakeholders, allowing for cross-cutting participation, promoting data trust architectures between individuals, health providers and policy-makers, and providing some 'regulation guard rails' through guidance on human rights, data protection, and interoperability. A distributed co-governance model or digital commons architecture (as opposed to the Internet Governance Forum Plus) would bring a greater shift towards a vision of data that are pooled in local contexts for local use-cases, before extending outward for broader access. These types of models would also require a greater private sector mindset shift, whereby value would be not in hoarding data but in data imagination (e.g. new use-cases, algorithms, and user interfaces that are tailored to healthcare workers or patients in specific contexts), and would rely on existing governance initiatives rather than support the development of new regulations and contracts, where there is risk of time wasted on building consensus.

Defining health data and principles based on data solidarity

While certain principles for data governance in healthcare have been advanced by international institutions such as the OECD,[357] it remains difficult to unpack health data governance frameworks from the broader data governance models that have emerged in different societal contexts, ranging from the European Union's General Data Protection Regulation (GDPR)[358] to the Cybersecurity Law adopted in China in 2017.[359] Different types of health and health-related data might be defined differently across different pieces of legislation and subjected to different regulatory requirements, due to the absence of a widely-agreed notion of what health data actually consists of.

A first step to build health data solidarity must thus be an attempt to distinguish public interest from private interest in data use. For example, the EU's GDPR provisions on health data foresaw the special 'public' significance of this type of data in public health emergencies, long before COVID-19. Although criticised for its lack of clarity,[360] the GDPR opened the possibility of permitting the processing for reasons of public health of "certain categories of personal data without the consent of the data subject" (recital 54) but also recognised the right of EU Member States to pass additional protective legislation relating to "the processing of genetic data, biometric data, or data concerning health" (recital 53).

A second, resulting step consists in the development of a clear international taxonomy of health data that can be used to diversify the levels of protection and the rules governing their use and sharing while mediating among existing national approaches. These range from the privacy-oriented one adopted by GDPR and in legislatures around the world (including India, Japan, Australia, Canada, the United Kingdom and the US state of California) to the one defined by the 2017 Chinese Cybersecurity Law, which affords the government greater powers in monopolising and centralising data flows.[361] Under a similar taxonomy, health and health-related data could be diversified either according to their health purpose (e.g. health data proper vis-à-vis data for health) or to their official, collective or 'privy' (e.g. related to people but not collective and not in need of being authenticated) nature, mirroring a proposal by Snower, Twomey and Farrell.[362]

Third, a clear taxonomy of health data and related regulatory proposals could underpin attempts to establish international standards for health data interoperability, whose absence has been described for years as a major roadblock to the development of learning health systems.[363] Such standards could build on existing efforts to create health information sharing architectures through an open and collaborative approach, such as the one adopted by the OpenHIE community of practice.[364] In turn, they could also support emerging efforts to establish interoperable cross-country infrastructures for data access, such as the one envisioned by the European Commission in anticipation of its 2021 proposal for a European Health Data Space.[365]

Lastly, globally-agreed rules on the sharing of health and health-related data would also be important for realising another cross-border dimension of data solidarity, namely the transparent sharing of data during public health emergencies and pandemics. From this perspective, COVID-19 has laid bare the limitations of the International Health Regulations' provisions on information sharing,[366] and prompted urgent calls for the inclusion of data sharing issues in the fledging negotiations on a potential pandemic treaty under the WHO.[367]

Building data institutions for data solidarity in health

Solidarity-based approaches to health data can only emerge if people and organisations trust that shared data is not misused or stolen during the time it remains available for those who need it. Moreover, such approaches need to overcome existing challenges hindering the transparent and timely sharing and oversight of health data for medical and public health research. These challenges, which have become particularly visible during the COVID-19 pandemic, include

compliance with data protection requirements but also extend to broader cultural and economic incentives for monetising data.[368]

Governance proposals have thus started to emerge on the need for new data institutions (within and beyond the health sector) that could take over this data stewardship role to build trust, protect data security, rebalance power in the data economy, and address the dualism that exists between the individual right to privacy and the increasing need for data-solidarity approaches.

Innovative data stewardship models are being tested in different contexts,[369] and although the evidence base is still poor, the first indications are that they can be effective in enabling people to better control and manage their data and deploy it for personal and common purposes, also in health.[370] Data trusts, for example, have been defined as "legal structures that provide independent stewardship of data", aggregating data from multiple sources and deciding who has access, under what conditions and to whose benefit.[371(p 2-4)] By contrast, data cooperatives allow data subjects to "voluntary pool their data together,"[372(p 204)] retaining control over how such data is managed for mutual benefits and how these benefits are shared.[373]

In the health sector, the different models that have been explored involve public data trust approaches (e.g. Sweden's electronic health records model, which allows citizens to view their medical data and see who accessed it on a national electronic health record),[374] public benefit data trusts that manage data provided voluntarily for a public purpose (e.g. local public health observatories using neighbourhood data on environmental quality gathered through citizen science initiatives) and various forms of data research trusts in which health data coming from different organisations is made available securely to health professionals, researchers, or the private sector for research purposes (e.g. the Health Data Research UK).[375] At the international level, one such example is I-DAIR, a new initiative that is currently being incubated as a neutral, trusted and multi-stakeholder platform for a distributed and collaborative approach to data use in global research collaborations, with the aim of bringing focus to emerging digital health capabilities and networks in LMICs.[376]

More broadly, several think tanks and NGOs have suggested similar attempts to address imbalances in the data economy and underline the collective and community dimensions of data rights. These proposals start from the premise that (i) privacy-related harms (including gender bias and discrimination) are often community harms which impact on broader groups of people; (ii) at the same time, community-based solutions to data stewardship might increase trust in, and acceptability of, certain secondary uses of personal data for public purposes; and (iii) pooling data rights might ensure better bargaining with technology companies and generate value for communities. Therefore, they suggest the need for community-based data trusts, whereby the trustee would consist of a representative body for that community or, according to some, of local or central governments themselves.[377]

Finally, the emphasis put on increased individual control and risk minimisation in many current health data governance systems, as useful as this approach has been to date, is likely to also engender problematic expectations for data subjects, especially given uneven levels of digital literacy globally and between generations. As a result, it might become important for healthcare

and research organisations to establish bodies with health data stewardship responsibilities, including harm mitigation functions such as the capacity to provide redress to individuals who can plausibly make a case that they suffered significant and undue harm by data use, and that of monitoring harms reported as being caused by Big Data practices.[378]

Investing in the enablers of a digitally-transformed UHC

Governing data-driven transformations of health must ultimately aim to strengthen UHC. In order to do so, country governments must capture the potential of digital approaches to increase connectivity between actors (patients, providers, payers and policy-makers) and health system components (drugs and commodities, workforce, information, financing, leadership) in the national digital health ecosystem, with the objective of shaping a digitally-enabled UHC.

Increasing country ownership of digital health strategies

Countries are at different stages in their journey to digital health maturity. Guides including the WHO-ITU eHealth Strategy Toolkit and the Digital Implementation Investment Guide (DIIG) have highlighted how considerations relating to leadership, strategic planning and governance are among the critical building blocks for the success and sustainability of such a journey. As more LMICs progress to higher levels of digital health maturity, they should thus take steps to drive their own digital transformations. As illustrated by the case of countries like Tanzania, particularly important is the development of a coherent health enterprise architecture and of a digital health investment roadmap, both of which can help the government, donors and the private sector align their investment decisions with health system needs.[379]

At the same time, many national digital health strategies, including some of those discussed in panel 9, are often written and conceived by external consultants, highlighting the urgency of more neutral guidance and capacity-building activities. To succeed, these activities must address the expressed needs of the officials and professionals that they target, for example by tailoring content to local contexts, including case studies and applied projects in the training curricula, incorporating advocacy and communication skills, and broadening their scope to include government and non-governmental actors beyond Ministries of Health.[380]

Panel 9: Approaches to digital health in the world's youngest countries

The Commission gathered information about approaches to digital health taken in different parts of the world, particularly in countries where young people under 25 make up a substantial proportion of the population. Africa is a region of particular interest to the Commission because it is home to the countries with the largest proportions of young people aged 25 and under. Furthermore, it is estimated that, in 2030, almost one-third of children under 15 will live in this continent and it will be the only region of the world where the population of children under five is greater than the population of people over the age of 65.

Reviewing the content of a national digital health strategy provides a helpful overview of a country's vision and priorities for digitally transforming their health system. The Commission reviewed the latest available digital health strategies for ten African countries with high youth populations: Cameroon, Democratic Republic of the Congo (DRC), Ethiopia, Liberia, Malawi, Mali, Niger, Nigeria, Tanzania, and Uganda. Through an analysis of each strategy's content, we sought to understand which level of digital transformation countries are focused on, and what kinds of governance challenges they have identified. We also assessed the extent to which children and young people are considered in approaches to digital health and whether the Commission's foundational entry points are being considered.

Nine out of the ten countries had current strategies focused on some aspect of digital transformations of the health system at the time of our review. The latest available strategy of Mali was published in 2013 and is therefore due for update. All ten strategies reflect their respective government's aspiration to use digital technologies and data to improve the performance of health systems and achieve better health outcomes for the population. The situation analysis within each strategy describes both significant health challenges and relatively low levels of digital maturity. All strategies therefore place strong emphasis on building the foundations required for the effective use of digital technologies and data. With the exception of Mali, all strategies draw heavily on the WHO-ITU's 2013 National eHealth Strategy Toolkit and many strategies are structured according to the Toolkit's seven building blocks.

Each strategy has a strong emphasis on strengthening integrated health information systems to improve data collection and use for decision-making. In the cases of Ethiopia, Liberia and Malawi, health information systems are the primary focus of the strategy. In all countries, increasing the availability of high-quality data, and the capacity of the health workforce to use that data, are recognised as essential for optimising the efficiency and effectiveness of health services. In addition to strengthening health information systems, all strategies outline plans to use telemedicine, mHealth and/or eHealth tools to improve quality and increase service coverage, especially for underserved populations. Tanzania is unique in having a strategy that includes a reference and commitment to explore and research emerging technologies such as AI.

Whilst the national health strategies of all ten countries prioritise new-born, child and adolescent health, none of the digital health strategies reviewed included any specific consideration of children and youth in the development and application of digital technologies or management of health data. The context sections of several strategies did reinforce that improved child and adolescent health are intended outcomes of digital health. Some also noted their country's young population and opportunities presented by so many young people entering the workforce to support the transformation agenda. None of the strategies referenced the involvement of children and youth in the development or monitoring of the strategy. Neither did any of the strategies allude to the potential risks to young people's health and well-being as a result of digital transformations.

Alignment with the Commission's foundational entry points varied across the ten strategies. Nine out of ten strategies are aligned to the SDGs and the realisation of UHC. The exception is

Mali's strategy which predates the adoption of the SDGs and high-level political commitments to UHC. Eight out of ten strategies explicitly reference equity as a core principle and the remaining two (Cameroon and DRC) indirectly support using digital health to reduce health inequities through their alignment with an equity-focused national health strategy. Five strategies explicitly talk about the need for an ethical approach to digital health; one references the need for users of health information systems to be trained in ethics (Liberia); and the remaining four do not mention ethics. Only two strategies (Malawi and Uganda) outline a human-rights based approach. Two strategies (Mali and Niger) note that the Right to Health is enshrined in the country's constitution and one (Nigeria) references the Right to Privacy. Three strategies (Ethiopia, Liberia, and Tanzania) do not use rights language but indirectly talk about the need to protect individual privacy and confidentiality.

Only four strategies refer to the inclusion of communities. Two (Ethiopia and Uganda) are explicit about the importance of involving communities in planning, implementation, and monitoring. Niger commits to civil society involvement in creating a legal framework for digital health. Whilst none of the strategies applied solidarity as a framework, Cameroon and Uganda's strategies both recognise the need for approaches to data governance that balance individual and public health needs.

All ten strategies recognise the need for stronger governance of digital health and data. The legal and regulatory environment for digital health is acknowledged to be weak in all countries, particularly in relation to protecting data security and confidentiality. Several strategies (Cameroon, Mali, Niger, Nigeria, and Uganda) note the existence of data protection laws but state that they are insufficient for governing health data. None of the strategies makes any reference to governing other aspects of digital transformations (such as the internet or digital health technologies) or the growing number of digital health actors that may have an impact on the achievement of health goals, particularly for children and youth.

Donors, development partners and global investors should encourage these efforts towards greater country ownership of digital transformations and implementation of national digital health strategies, including by ensuring that their investments are aligned with broadly-agreed principles such as the Digital Investment Principles.[381] Among other things, the Principles call upon donors to prioritise investments in national plans that incorporate digital public goods, invest in sustainable country capacity for digital health governance and leadership, and support countries at a level that is appropriate to their level of digital health maturity. A digital health readiness assessment framework like the one presented in this report (section 4) could be particularly suited for this purpose.

The development of national frameworks for health data governance represents another critical component of broader efforts to increase country ownership of digital health strategies,[382] especially as country-level definitions for health data and health data standards are still missing in many countries,[383] and even electronic health records are not always part of integrated health information exchange systems.[384] Recently, the WHO has tried to develop a shared understanding about health data, with both Resolution 71.7 on Digital Health[145] and the WHO Draft Global

Strategy on Digital Health 2020-2025[8] emphasising the importance of digital health ecosystems in which such data is simultaneously protected by high safety and security standards and seamlessly exchanged and shared for public interest purposes with the consent of patients and individuals. A similar attempt to define adequate data approaches for use in country-level healthcare has been conducted by the OECD, which defines eight elements that must be in place for a good governance for 'personal health data', ranging from the presence of legal frameworks providing for adequate data protection safeguards to the use of best practices in data de-identification, as well as the periodic review of governance mechanisms to respond to the emergence of new data sources and technologies.[383]

At the same time, country champions that are accelerating digital transformations of their health systems through improved collection and use of data already exist. Finland has, for example, started to update its legislative framework to regulate the secondary use of health data for research, public decision-making, start-ups, and small and medium enterprises, creating a data permit authority.[385] Other OECD countries that have developed health data governance frameworks to support the use of data held in electronic health records for monitoring and research purposes include (but are not limited to) Norway, Poland, Iceland, Denmark and New Zealand.[383] Lastly, non-OECD countries such as Tanzania area also making significant steps to build on their existing work digitalising health data and move towards greater integration and use of such data, as part of their broader digital health strategies.[386]

Financing digitally-enabled health systems and identifying 'best buys'

Aligning health systems with digital transformations can create additional burdens on health systems, especially in resource-poor settings and in the absence of substantial multi-stakeholder collaboration and overall integration of digital health solutions in wider governance systems.[387] In order to address financing issues, it will be important to both solve the challenges facing commercial models of digital health innovation and identify context-specific best buys in digital health, which include digital public goods.

The sustainable financing of digital health innovation is a critical component of any effort to achieve UHC and ensure that the deployment of digital tools in fragile contexts and amongst vulnerable populations avoids placing additional burdens on the individuals who will be using them. There are numerous bottlenecks and market failures that prevent commercial models of digital health innovation from supporting UHC in LMICs, including lack of a 'visible' demand for ICT services in unconnected areas; the need to subsidise initial costs or de-risk private investments; and the fact that for many countries the most transformative digital tools are not 'frontier' technologies but 'foundational' solutions including smartphones, interoperability standards, workforce and supply chain information systems, and privacy and security policies and practices.

This is why, besides large private actors, governments and donor countries must be able to finance digital health innovation and a digitally-enabled UHC through smart, mission-oriented investments which strike a balance between supporting new solutions and connecting to (sometimes simpler) existing tools, thus contributing to bridging the digital divide. In other words, countries need to

consider the place of digital health investment as part of wider health system financing and national digital health strategies. A costed digital health investment roadmap, together with a strategy for planning, costing, and implementing digital health applications such as the DIIG developed by the WHO in 2020,[388] might help countries prioritise those 'best buys' that lead to actual improvements in productivity or cost savings, while allowing the possibility to reallocate the budget to other areas of needs.[388] This is especially true for those countries that are in the early stages of their digital health maturity, and often have a tremendous challenge moving from digital health interventions driven by external donors and partners towards domestic ownership of digital transformations of health (panel 10). Best buys in digital health, in this sense, are necessarily context-specific, require interoperability with the systems already in place, and must be preceded by basic building blocks such as ICT infrastructures, digital identification systems, skills development, and legal frameworks.

Panel 10: Development assistance for digital health

In contexts where development assistance constitutes a critical component of the health economy, the usefulness of digital technologies for improving public health and healthcare systems is increasingly highlighted by donor and partner countries alike. Many donor countries have developed strategic documents for how to utilise digital technologies in their work.[389,390,391] Specifically for health, however, the strategic backing is less structured, with the United States Agency for International Development (USAID) being the only development agency having published a strategy specifically for digital health in 2020 – called 'Vision for Action in Digital Health'.[392] The second largest donor country, Germany, mentions digital technologies in its 2020 Global Health strategy as a means of strengthening health systems, but a coordinated plan across the country's global health activities has not been formulated.[393]

To what extent these intentions are followed through with investments and project support in partner countries has not been analysed systematically to date. Building on data from the OECD Creditor Reporting System, a novel approach based on machine learning was used to understand the volume of bilateral development assistance projects of the G7 countries that use digital technologies in general, in health, and with youth as a beneficiary group in mind. The fundamental idea of this approach is to re-label each project according to the project descriptions that are self-reported by the donor countries and harmonised by the OECD Development Assistance Committee.

Figure 8a summarises the headline findings of the research and presents aggregates for the total bilateral G7 disbursements official development assistance (ODA) projects. In the period from 2016-18, the G7 disbursed annually on average around USD 95 billion for bilateral ODA projects. Only around 1.4%, or USD 1.31 billion, included digital technologies in one way or the other. A sizeable share of these projects were related to projects in the health sector (or had a health-related goal): Almost one third of the investment volume in digital technologies is health-related, i.e. USD 424 million. Within these projects are many that have children and young people as beneficiary group (37% or USD 157 million).

Figure 8a: Bilateral ODA from G7-countries with a focus on digital technology, digital technology, and health as well as digital technology and health and youth-related activities in relation to total ODA (average annual disbursements). The numbers are limited to projects falling under the categories 'ODA Loans', 'ODA Grants' and 'Equity Investment'. Source: authors' analysis, based on OECD CRS Bulk Data.[394]

[Insert Figure 8a here]

Looking at the results by donor country, large differences among the G7 countries become visible (figure 8b), with Canada and the USA retaining relatively high shares of investments with digital technologies (4.2 and 2.2%, respectively).

Figure 8b: Bilateral ODA with a digital technology focus by donor, 2016-18, in USD million per year (average annual disbursements). The numbers are limited to projects falling under the categories 'ODA Loans', 'ODA Grants' and 'Equity Investment'. Source: authors' analysis, based on OECD CRS Bulk Data.[394]

[Insert Figure 8b here]

A country-wise analysis is also insightful when it comes to the share of health-related projects that explicitly mention digital technologies (figure 8c). Particularly the UK stands out, with investments worth more than 8% of the bilateral ODA for health going into projects that use digital technology (about USD 62 million annually in the observed time window).

Figure 8c: Bilateral ODA with a digital technology and health focus by donor, 2016-18, in USD million per year (average annual disbursements). The numbers are limited to projects falling under the categories 'ODA Loans', 'ODA Grants' and 'Equity Investment'. Source: authors' analysis, based on OECD CRS Bulk Data.[394]

[Insert Figure 8c here]

While data limitations and the analytical approach imply that these numbers are likely to be lower estimates of the actual investment volumes, they provide a quite drastic difference in the donors' focus on digital health as part of their development assistance.

At present, the evidence base for 'best buys' in digital health is still small and must be expanded. At the most basic level, investing in public goods such as disease prevention and surveillance tools should be considered a priority over treatment, as the relevant software is usually low-cost and can support decision-making. Similarly, even when moving to next-level investments in treatment and diagnostics, which involve a greater involvement of the private sector, it might be more cost-

effective and impactful to direct public resources towards interventions that are supportive of UHC and can be made available to all – rather than necessarily on the most advanced technologies.

In this context, a vital role is already being played by digital public goods, which are defined as "open-source software, open data, open AI models, open standards and open content that adhere to privacy and other applicable laws and best practices, do no harm, and help attain the SDGs".[356(p 7)] The promotion of digital public goods, as complement to, and foundation for, commercial solutions, is increasingly considered a key enabler of a transformed UHC. Many of the first applications of the concept have indeed been in the context of health, such as the DHIS2 health information system,[395] the OpenMRS electronic medical records system,[396] and the iHRIS software for health workforce information.[397] Countries like Tanzania[398] and Rwanda[399] have already begun to roll out such tools as part of wider pushes to develop interoperable health information exchange systems. Scaling-up the contribution of digital public goods to UHC, however, will largely hinge on the extent to which existing platforms will be used to enable the development, financing, discovery, sharing, and adaptation of such technologies across multiple countries, as recently suggested by the report of the UN Secretary-General's High-Level Panel on Digital Cooperation.[400] The number and reach of initiatives in this field is rapidly expanding. WHO explicitly frames its Digital Health Atlas as a global public good that enables users to improve the planning, use, and coordination of digital health information systems through an open-source technology registry platform.[401] At the same time, multi-stakeholder collaborations such as the Digital Public Goods Alliance and the 2016-2026 Digital Square initiative aim to "facilitate the discovery, development, use of, and investment in digital public goods".[402] For example, the latter has supported 27 digital public goods for health, and released a 'Global Goods Guidebook' to showcase those that it has approved for investment.[403]

Preparing a new digitally-literate health workforce for digital transformations

There can be no UHC transformation and no digital transformations of health without policies that accelerate the education, training, and awareness-raising of current and future health professionals, policy-makers, and regulators. Building digital skills in the health workforce means creating many opportunities for youth employment at the intersection of health and digital transformations.

In order to achieve a digitally-enabled UHC, it will be crucial to harness and build the digital skills of young people, whose employment as health and social care workers has risen significantly in the last few decades and who are projected to fill most of the newly-created health and social care sector jobs.[404] Initiatives like the WHO Global Health Workforce Network's Youth Hub emphasise that the future workforce that will deliver UHC and achieve the SDGs will be a young and largely female workforce, but for this to happen, governments must significantly invest into the education, training, and employment of health workers – and particularly of women and girls.

Training curricula are key tools for building the digital health and data literacy of the health workforce, including social workers and care workers, but also of health policy-makers and regulators. Some examples of curriculum updates (or initiatives that promote such updates) already

exist, but they must be scaled up and integrated in broader educational frameworks for health professionals.[405] Life-long training programmes must include periodic updates on new technological developments and protocols, and more generally build the digital skills for health professionals by equipping them with the capabilities and tools they need to provide higher quality and more patient-focused care, especially in rural and remote areas. Even beyond health professionals, however, there is a need to build the common knowledge base of a new 'digital health workforce' that can scale and sustain digital transformations of health, for example in the areas of health information management and health informatics.[406]

Recommendations

Health futures are being decided now. Our world is being confronted with many overlapping threats and crises. Of particular concern is the limited progress on the achievement of the SDGs, which has been further pushed back by the COVID-19 pandemic - not only in relation to health but including issues such as access to clean water and sanitation, gender equality, education, poverty, inequality, environmental stewardship, and climate action. At the same time, health futures are also being shaped by digital transformations of information and communication, education, commerce, work, social relationships – and in health and healthcare. Business models based on increasing data extraction and concentrations of power, together with governments' use of digital tools for surveillance purposes and human rights infringements, are defining features of these transformations.

Digital transformations carry extraordinary potential to improve health, reduce health inequities within and between countries, close gender gaps, protect the most vulnerable, and strengthen democratic participation. To leverage these opportunities, however, all public and private stakeholders should contribute to the development of a governance architecture based on democracy, equity, solidarity, inclusion, and human rights. Innovative forms of stewardship, regulatory frameworks, and accountability can no longer be deferred "until we know more" – they need to be prioritised today, in the light of the significant risks involved.

In particular, the Commission urges action in four main areas that all stakeholders can contribute to by 2030 to ensure that digital transformations are harnessed for sustainable health futures. We use 2030 as the ultimate deadline for our recommendations, to coincide with the original vision of the Commission but also to highlight the tightly knit interface that exists between the governance of digital health and the achievement of global goals around UHC and the SDGs. Simultaneously, we recommend shorter deadlines for specific actions, which we believe are especially urgent, foundational, or achievable within a different timeframe.

Whenever possible, we suggest that our recommendations are taken forward and incorporated within existing monitoring and accountability frameworks, leveraging the role of multilateral fora such as the UN General Assembly, the World Health Assembly or the OECD. However, we also underline the urgency of developing new forms of participatory and bottom-up accountability, including by equipping transnational multi-stakeholder coalitions, civil society organisations, health workers associations, patients' networks, and local government officials to act as stewards and watchdogs for digital transformations of health.

Addressing the role of digital technologies as determinants of health

Digital transformations – or the exclusion from their affordances - are already affecting all peoples and all areas of life and health. It is therefore vital to consider the impact of digital technologies, platforms, and services as critical determinants of health, as well as address their influence on other determinants,

All public and private actors should urgently scale up their investments in health, education, the future of work, and climate action and strive to close the global financing gap for the achievement of the SDGs by 2030. This should be seen as a necessary baseline for ensuring sustainable health futures in the face of digital transformations.

Governments, in partnership with private sector and civil society, should also close all digital and health divides by 2030, including by achieving universal, affordable, safe, and meaningful connectivity as a human right and a public good, as it will substantially enable the provision of other public goods (including UHC) and will help countries progress more rapidly to higher levels of digital health maturity.

Public actors must stimulate investment and innovation towards health transformations and UHC. By 2023, all governments should have updated their programmes and policy frameworks in the area of research, technology and innovation to ensure that they reflect the twin priorities of shaping new markets in digital health while simultaneously fighting the trends towards the increasing concentration of power and agency in the hands of private tech giants.

Research institutions and youth organisations should expand the knowledge base on the impacts of technologies and algorithms on health and well-being, including by launching as soon as possible a multidisciplinary, longitudinal multi-country study on the impacts of digital transformations on children and young people.

Building a public trust architecture for digital transformations of health

Building digital trust among all stakeholders of the digital health ecosystem arguably represents the most urgent area of action for governing health futures, as its positive effects will cut across (and facilitate the uptake of) all other interventions recommended in this report. We urge a whole-of-society effort, which stretches from Ministries of Health and representatives of health professionals and patients to local governments and private companies.

By 2025, all governments should adopt country-wide strategies to safeguard health and digital rights, including regulatory measures to protect children and young people against online harms, training of offline intermediaries to act as health data stewards, and promotion of strong transparency and accountability requirements for emerging AI and machine learning applications in health.

All national and local governments should enfranchise communities and advance public participation in the co-design and implementation of digital health policy and technology, for example through public consultations, open data strategies, and forms of bottom-up accountability and oversight in relation to the use of health data by public and private actors.

By 2030, all national and local governments should co-develop strategies for a democratic and distributed governance model for digital transformations of health which leverages the role of regions and cities. This strategy should include policies and investments to improve data interoperability, clear allocation of responsibilities, common standards for data management, and the training of local government officials to act as health data stewards at the community level.

By 2030, all governments should also implement large-scale civic and digital health literacy efforts as part of national education, health, and digital strategies. These include platforms and initiatives that harness people's civic engagement and active participation in co-creating health data, digital tools, and health narratives that help fight health disinformation. Governments should also urgently develop new areas of public health legislation by regulating business practices and algorithms which contribute to mis- and disinformation in health and healthcare.

Enacting an approach to the governance of health data based on data solidarity

A solidarity-based approach to health data has three key components: giving people a greater control over their data as active decision-makers, ensuring that the value of data is harnessed for public good, and moving society towards equity and justice by counteracting dynamics of data extraction. There are several specific steps that stakeholders may take to strengthen health data solidarity, in addition to other actions highlighted in these recommendations that would also have a positive impact.

Building on ongoing multilateral discussions about the future of global digital cooperation, the UN General Assembly, the UN Secretary-General's Envoy on Technology and the Internet Governance Forum community should strive to advance a digital cooperation architecture based on the concept of digital commons, with the objective of addressing concerns around data extractive practices and promoting data trust architectures in health between individuals, health providers and policy-makers.

By 2023, under the aegis of the WHO and in collaboration with private sector stakeholders and civil society organisations, governments should develop a clear international taxonomy of health data, globally-agreed rules and processes for health data sharing, and international standards for health data interoperability. Of particular importance will be a commitment to increased transparency and compliance with health data sharing responsibilities during public health emergencies and pandemics.

By 2030, all countries should have in place data institutions, such as data trusts and cooperatives, that can help unlock the public value of health data while safeguarding rights; build trust in the process of health data sharing; provide opportunities for delivering redress from data misuse, and ensure that data users and intermediaries are held accountable. Healthcare and research organisations should also appoint health data stewards to ensure adherence to health data governance standards.

Investing in the enablers of a digital transformation of public health and UHC

Digital transformations can provide significant benefits for health promotion, public health, and healthcare. That is why investment in digitally-enabled health systems based on the Health for All values is a matter of great urgency for the achievement of UHC.

By 2025, al national governments should enhance the content and implementation of their digital health strategies, including by making use of a comprehensive digital health readiness assessment framework such as the one proposed in this report, increasing country ownership of digital health strategies through building capacity for digital health governance and leadership, and adopting health data governance frameworks and costed digital health investment roadmaps. Donor countries should incorporate these objectives in their ODA strategies, and together with other non-state development partners should ensure that all investments are aligned with the Digital Investment Principles.

National governments, in partnership with the WHO and non-governmental organisations, should also develop the evidence base around the identification of 'best buys' in digital health that are aligned with each country's levels of digital health maturity. These may include foundational solutions and open-source digital public goods which can - in many contexts - enhance interoperability, avoid vendor capture and provide the basis around which commercial models are built.

By 2030, all national governments, with assistance and coordination from relevant regional organisations, should have in place permanent programmes to support the life-long training of the current health workforce, as well as the training and education of young health professionals, to be well-prepared for digital transformations of health and data-driven health systems.

Conclusion

In this report, we have viewed digital transformations of health through the lenses of UHC and Health for All values. At the centre of our analysis is the redistribution of power and agency for the benefit of health. We require digital technologies that work for health, address its determinants. and build on broader efforts to overcome digital divides and achieve sustainable development. We also juxtapose a digital governance model based on data extraction with one based on data solidarity, digital trust, accountability, and public participation, which we believe holds the key to advancing health equity and reconciling privacy concerns and public value. If governments were to adopt such an approach to governing digital transformations, it would give us hope for an era of progress towards sustainable health futures.

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