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Abstract

Digital health is the appropriate application of technology to enhance the health sector. With Universal Health Coverage (UHC), insufficient money is not a major hindrance to receiving the full range of high-quality healthcare services if and when needed. Strategies, models, and frameworks continue to be formulated to guide operations, as well as in the regulation of healthcare. This study provides a thorough analysis of digital health models for equitable access to UHC by highlighting key factors of these models while identifying and analyzing knowledge gaps. Considering UHC and the aspect of inclusivity as espoused in the Sustainable Development Goal 3 (SDG3), which speaks of health for all in a population, this study explores models that cover a general population and were designed with equity as a key component. The study methodology is a scoping review that uses a manual search of digital libraries and repositories, employing tailored search terms. From the results, though models exist that address equity, more work is required to formulate generalizable digital health models for equitable access to UHC, and majorly for developing economies. Moreover, it is a call to consistently adapt models that meet the target needs of a population at any given time.

Keywords: Digital health, digital health framework, digital health model, healthcare, landscape, digital health strategies, universal health coverage

Introduction

Over the years, digital health has seen unprecedented expansion, bringing huge opportunities for positive transformation of the economy, healthcare, and society. Moreover, developments have been growing to support the health ecosystem, including Universal Health Coverage (UHC). Target 3.8 of the Sustainable Development Goals was added in 2015 to address UHC and guide that healthcare, which covers the entire range of vital, high-quality healthcare services, should be available to all people in a population without suffering financial hardship (Muthuuri, 2020). On the other hand, technological advancements resulted in healthcare systems integrating technology to address disparities (Ahmed et al., 2020). Consequently, this informs digital health, which is at the nexus of the two sectors: health and Information and Communication Technologies (ICT) (Olu et al., 2019).

Healthcare, and in this case digital health, is continuing to transform as research on health inequalities develops and the profession of technology and health advances. Furthermore, the negative consequences of COVID-19 also led to an increase in technologically assisted healthcare solutions. With digital health and UHC garnering significant attention in the
global stage, among the emergent concerns, is equitable access, whose concerns continue to affect the quality of care, utilization, and expenditures of households (Okech & Lelegwe, 2015; Chattu et al., 2021; Adepoju, 2022). Further, millions of people continue to suffer digital health inequalities from having digital health opportunities and platforms that are not equitably distributed and accessible (Nsaghurwe et al., 2021; Chen et al., 2021; Dixon & Holmes, 2022; Yao et al., 2022; Hadjiat, 2023). Digital health opportunities are also not usable by the proportion of people in the general population (Ghorbanian Zolbin et al., 2022).

Research over the years has shown health disparities based on one or more health outcomes that negatively impact several defined populations. These disparities are drawn along the lines of those living in rural areas, those with low incomes, people of colour, and members of sexual and gender minorities, among others. Previous research highlighted the differences and disparities (Chen et al., 2021; Yao et al., 2022). Progressively, researchers worked to uncover the root causes of the disparities and a dedication to finding workable solutions. However, recent studies still point to a need for further research in promoting equitable access to healthcare (Kristjánsdóttir et al., 2023).

Models for digital health equality and equitable access to UHC are becoming increasingly important (Puradiredja et al., 2022). Advances in digital health are strategically significant in support of the work of business leaders, information systems developers, and health systems operations, as well as in research and academics. Among the proposals to promote equitable access is having guiding system models (Puradiredja et al., 2022) and inclusive co-design approaches in systems implementation (Latulippe et al., 2020; Darley & Carroll, 2022; Miller et al., 2023; Wambua, 2023). Leveraging digital health to reduce societal obstacles and increase access to high-quality and reasonably priced healthcare is also a strategy (Olubiyi et al., 2019). This study, therefore, presents a review of digital health models for equitable access to UHC.

**Literature Review**

Equitable access within the health ecosystem spans across sub-sectors in health, such as a focus on educational access and experiences, a focus on population, and especially for the underrepresented populations, which ultimately influence access, service quality, and cost. Developed models address varied digital health issues. To solve unequal educational access and experiences for marginalized communities in health education, Macdonald et al. (2023) prioritized EDIA (equity, diversity, inclusivity, and access) capability. According to Macdonald et al. (2023), EDIA's capability to reach out to the community offered sustainable growth routes with strong transferability to other health initiatives.

Considering digital health and healthcare in general, innovations that advance UHC and numerous comparable models have been developed (Audi et al., 2020). The following is a review of the various models.

**Healthcare Information and Management Systems Society (HIMSS) digital maturity models:** Faced with the problem of not having a defined way of measuring digital transformation progress, the Healthcare Information and Management Systems Society (HIMSS) developed various models. The following are digital maturity models by HIMSS:

i. **Electronic Medical Record Adoption Model (EMRAM):** This model focuses on using medical records (Cresswell et al., 2019). Faced with the problem of not having a defined way of measuring digital transformation progress, this model mapped out stages, from
0 to 7, for the adoption and utilization of electronic medical records functions and would measure levels of computerization.

ii. HIMSS Analytics Infrastructure Adoption Model (INFRAM): This model focused on infrastructural adoption and utilization, in the health ecosystem (Cresswell et al., 2019).

iii. Continuity of Care Maturity Model (CCMM): This model focused on continuity of care (Cresswell et al., 2019). With this model, healthcare executives would evaluate, execute, and scale the smooth coordination of patient care across a continuum of care locations and providers (Cresswell et al., 2019).

iv. Adoption Model for Analytics Maturity (AMAM): Beyond clinical decision assistance, analytics enhance a healthcare company's operational and financial elements, among other areas. This model, therefore, enhances the workforce, governance, and predictive analytics aspects of digital health (Healthcare Information and Management Systems Society, 2024a).

v. Community Care Outcomes Maturity Model (C-COMM): Considering that digital systems were essential to community care, this model linked all non-acute care facilities and assessed the value of the digital solutions. In this manner, it allowed for patients to be met where they were, get supported, and provide person-centered treatment. Measurement of digital maturity of care delivery, in this case, was done using an eight-stage (0–7) scale, which helped to guide and explain the specific needs and characteristics of a community organization that offered non-acute care (Healthcare Information and Management Systems Society, 2024b).

vi. Digital Imaging Adoption Model (DIAM): To enhance patient safety, organizational effectiveness, and care quality in hospitals and diagnostic centers, this model assisted healthcare organizations in measuring their capabilities linked to the secure delivery of medical imaging and related procedures. All facets of the health system would benefit from enterprise imaging made possible by DIAM, which made it possible to manage multimedia material and digital imaging in an organized, comprehensive, effective, and efficient way (Healthcare Information and Management Systems Society, 2024c).

The various models developed by HIMSS were a great addition to the healthcare ecosystem in that digital transformation would be reviewed over time to ascertain growth or the lack of it. Each deployed model was specific to a defined function, which meant that a facility would require procuring and deploying the various models to measure the various functions. For example, to obtain analytics over time, a facility looking at using the HIMSS models would require DIAM and not the rest of the models. This would be limited to a facility that desired a single digital health model encompassing its core functions.

On the other hand, these models were not fully inclusive in line with UHC. For instance, EMRAM focused greatly on technological capabilities, neglecting service delivery and social inclusion. In this case, this model excluded human and organizational factors, considered enablers of transformation. Consequently, adapting this model required more tasks to be done. For instance, a case like of NHS England, whereby EMRAM created a Digital Maturity Index to assess hospitals’ digital capabilities, required adding other dimensions. In this case, the adaptation added the dimension of interoperability, technological readiness, and infrastructure components (Cresswell et al., 2019).

The “Evolve in Context” model was a digital excellence model in healthcare that borrowed greatly from the HIMSS measurement models: EMRAM, INFRAM, and CCMM. This model examined how to evaluate digital maturity in fluctuating objectives and goals scenarios. The flexibility of the model allowed for changes to be made along the journey of any intervention.
Additionally, by leveraging the institutional and technological infrastructures already in place, this approach allowed for measuring digital excellence in areas where digital maturity could be customized to meet the demands of the local populace (Cresswell et al., 2019).

![Figure 1: The "Evolve in Context" model: Source: Cresswell et al. (2019)](image)

This model was advanced from the various HIMSS models. The model factored in the continuity of patient care and patient medical records, key components of any medical facility. Moreover, facility infrastructure components were also included, enabling a better evaluation of technological impact over time. Though this model may not be fully inclusive as guided in UHC, it addresses key UHC dimensions through its continuous cycles of reassessments; it provides an opportunity for healthcare review, which may impact the quality of service, population coverage and even cost elements in offering healthcare.

**Tanahashi model:** This model covers access and coverage of health services through five key dimensions: availability coverage, accessibility coverage, acceptability coverage, contact coverage, and effective coverage (Ojo, 2022). These five dimensions were presented as a series of cascades where problems at one level impacted the next, leading to gaps in the healthcare system's quality, coverage, and cost (Tanahashi, 1978; Ojo, 2022). This model aligned with the UHC service quality dimensions, population coverage, and cost. The model was not aligned to digital health despite the dimensions and applicability considered. However, the projected dimensions rightly informed a digital health model for equitable access to health, including UHC.

**The Mehl's and Labrique’s cascading model:** This model, updated from the Tanahashi model, prioritized mHealth strategies for attaining UHC and factored accountability, availability of commodities and equipment, availability of human resources, and financial and continuous coverage as key measures. This model also informed the digital health interventions adopted by WHO for healthcare systems (Labrique et al., 2018; Ojo, 2022).
In addition to the Tanahashi model dimensions of availability coverage, accessibility coverage, acceptability coverage, contact coverage, and effective coverage (Ojo, 2022), this model's added dimensions gave it greater coverage. The cost element and resource adaptation, coupled with a focus on digital health, made this model a good benchmark for digital health models for equitable access to health, including UHC.

**A Four-Component Framework toward Patient-Centered, Integrated Mental Healthcare**

This framework focused on mental healthcare in Kenya and comprised four components: sensitization of providers, continuous supervision, continuous professional training, and empowerment of leaders, as key steps. Though not fully integrated within the health ecosystem, this proposed framework reviewed UHC as one of the key policy developments to guide the implementation of the framework (Kumar et al., 2021).

![Four-Component framework](image)

*Figure 2: Four-Component framework. Source: Kumar et al. (2021)*

This model informed UHC in the considered dimensions and in its focus on mental healthcare, which would be intentionally considered in healthcare. However, this model did not emphasize technological inclusion, which informed digital health. Moreover, the model’s focus was not all-inclusive for UHC in that it addressed only mental healthcare.
EDIA capacity model

EDIA concentrated on removing structural prejudices and obstacles that limited fair chances and kept people from reaching their full potential. The four ideas that made up EDIA included a shared commitment to equally honoring, appreciating, and supporting each person's unique life experiences and viewpoints, regardless of how they identified with themselves (Macdonald et al., 2023). Six dominant factors that affected EDIA capacity were identified by a study by Macdonald et al. (2023), such as interfaculty communication, institutional messaging, and knowledge of the EDIA language, which were found to be weaknesses. On the other hand, informal community-building activities for EDIA growth were found to be innovative assets that needed to be prioritized. Faculty members' overall motivation to participate in EDIA was shown to be correlated with emotionally charged events (Macdonald et al., 2023).

Although not fully aligned to digital health for equitable access to UHC, this model proposed factors that impacted a population. Understanding the used language and communicating as guided by EDIA capacity was paramount to any system, including digital health.

National Institute on Aging (NIA) disparities model

Concerning inequalities research, this model described four primary levels of analysis: environmental, sociocultural, behavioral, and biological, with priority emphasis areas identified within each category (Hill et al., 2015). To support efforts to address health disparities in the ageing population, the NIA Health Disparities Research Framework highlighted critical components for health disparities research related to ageing, offered an organizing framework for tracking progress, stimulated opportunities to better establish linked pathways, and broadened the scope for adaptable targets for intervention (Hill et al., 2015).
While the NIA disparities model was not essentially a digital health model for equitable access to UHC, it depicted key necessary factors. This model considered demographic variables as fundamental factors, making it a model that advanced population coverage, which was a key dimension of UHC. Further, despite the model's focus on disparities related to the aging population, its levels of analysis were adaptable to models for other population groups (Hill et al., 2015).

National Institute on Minority Health and Health Disparities (NIMHD) Research Framework

This model was an adaptation of the National Institute on Aging (NIA) disparities model, with the addition of the healthcare system domain due to its particular importance to health (Richardson et al., 2022). The framework made it easier to evaluate the possibilities, gaps, and advancements in minority health and health disparities research. The model incorporated a life course perspective component highlighting the significance of considering lifetime-extending factors in determining health inequalities. It specified that health outcomes spanned numerous levels (National Institute on Minority Health and Health Disparities, 2018).
The adaptation of this model enhanced its initial focus from fundamental demographic factors to include the health care system. This adaptation, when aligned to the levels of influence, allowed for advanced evaluation of health outcomes related to population coverage, service quality and cost. Hence, an adapted model that was well aligned with the UHC dimensions. On the other hand, though this model was not exclusively aligned to digital health, it presented factors adaptable to digital health for equitable access to UHC.

**Framework for Digital Health Equity**

This framework expanded the NIMHD research framework by including a digital environment domain (Richardson et al., 2022). The model was published in 2019, incorporating the digital environment domain because of its critical role in the health ecosystem (Richardson et al., 2022). The model was divided into domains: biological, behavioral, physical/built environment, sociocultural environment, and the healthcare system. The model grouped determinant domains based on the socio-ecological model's levels, whereby the physical/built environment, the sociocultural environment, and the healthcare system domains were where Social Determinants of Health (SdoH) were mostly featured (Richardson et al., 2022).

The digital environmental domains highlighted key Digital Determinants of health (DDoH). The DDoH referred to digital environment conditions that impacted a broad spectrum of risks and consequences related to health, its function, and the general quality of life at the individual, interpersonal, communal, and societal levels. These conditions comprised access to digital literacy, technology tools, and community infrastructure like broadband internet, which impacted equitable access to healthcare and harmed digital health equity (Richardson et al., 2022).
Figure 5: Framework for Digital Health Equity. Source: Richardson et al. (2022)

Relating this model to the NIA disparities model and the NIMHD research framework, from which it was enhanced, it directly informed digital health. The added digital environment domain presented technological considerations across the levels of influence, which spanned from individual to society levels. This way, presented in a health ecosystem, this model factored in the technological interventions and, therefore, gave a better evaluation of disparities related to digital health.

**Dover and Belon’s model**

This model was a health equity measurement framework that measured social inequalities in health. In this model, the hierarchical distribution and unequal allocation of power, prestige, and resources within economic and cultural social contexts was referred to as social stratification (Dover & Belon, 2019). This process placed people in a social location determined by various intersectional factors, including age, income, location, gender, ability, occupation, and other social factors. Dover and Belon’s model informed the Digital Health Equity Framework (DHEF) (Dover & Belon, 2019).
This model used social stratification and factors in demographic variables to measure health equity. As much as this was a health equity model, it did not appear to speak exclusively to digital health, where technology consideration was a key factor. However, social factors were considered to impact digital health as well.

**Digital Health Equity Framework (DHEF)**

To start with, DHEF considered that, in addition to person-centred care, health providers got training on digital health equity, which would be promoted on a personal, institutional, and societal level (Crawford & Serhal, 2020). This model was used to consider health equity factors. Similar to Dover and Belon’s model, DHEF digital determinants of health interacted with the individual's present demands and state of health as well as other intermediate health variables such psychological stresses, prior medical problems, attitudes and actions connected to health, and the environment (Crawford & Serhal, 2020).

Unlike the framework for Digital Health Equity, which expanded the NIMHD research framework by including a digital environment, this model (DHEF) considered digital determinants of health. Therefore, it informed digital health for equitable access to UHC.
Methodology

As guided by Munn et al. (2018), a scoping review methodology was employed to provide a review of digital health models for equitable access to UHC. The core search terms included in this study were “digital health”, “equity”, “equitable access”, “universal health coverage”, “healthcare”, “model”, “strategy”, “framework”, and “ehealth”. Digital copies of the relevant documents were downloaded from the search results. The inclusion criteria for the review were all documents that addressed digital health models for equitable access to healthcare and universal health coverage.

To ensure a thorough and organized search process, searches were conducted on the various digital libraries and repositories. The process involved using the identified search terms, including manual searches to ensure completeness (Townsend et al., 2023).

While we provide a thorough analysis of digital health models for equitable access to UHC, we do not claim to have included all the provisions that may be important for equitable access to UHC in technology and digital health research. Moreover, the field of digital health encompasses a wide range of study domains. To maintain the relevance of this study, the review was limited to digital health models for equitable access to UHC.
Discussion

Given the technological advances and the changes within the health ecosystem and beyond, model developments, adaptations, and enhancements are required to inform progress and to support and guide operations with changing goals and targets (Cresswell et al., 2019). Considering UHC, which advocates for inclusivity across its main dimensions of population coverage, service quality, and cost, designed models, regardless of their focus, should reach out to the communities and remain people-centred (Macdonald et al., 2023).

The various models reviewed offered guidelines for key aspects that impact health outcomes. To start with, the models by HIMSS (EMRAM, INFRAM, CCMM, AMAM, DIAM, and C-COMM) (Cresswell et al., 2019), guided on healthcare measurements (Cresswell et al., 2019), whereas the four component framework that suggested sensitisation of providers, continuous supervision, continuous professional training, and empowerment of leaders, as key steps to mental healthcare, through in the issue of routine health practices (Kumar et al., 2021). Additionally, the Tanahashi model covered access and coverage of health services (Ojo, 2022) and was adopted by Mehl’s and Labrique’s cascading model, which prioritised mHealth strategies for attaining UHC (Labrique et al., 2018). Further, the NIMHD Research Framework, an adaptation of the NIA disparities model, added the healthcare system domain as a key factor to health. NIMHD was further expanded by the Digital Health Equity framework to include a digital environment domain (Richardson et al., 2022). Hence, all reviewed models existed to address a key element in health.

Three reviewed models stood out in line with digital health for equitable access to UHC. The digital health framework (DHEF) by Crawford and Serhal (2020) presented a model for considering digital health factors. The framework for digital health equity introduced a digital environment domain that allowed for the consideration of digital health interventions in healthcare (Richardson et al., 2022). Moreover, Mehl’s and Labrique’s cascading model considered digital health in adapting the Tanahashi model (Labrique et al., 2018; Ojo, 2022).

Conclusion

Digital technology advancements continue to influence the digital health ecosystem. The inclusion of digital health tools and technologies like Artificial Intelligence (AI) and the Internet of Things (IoT), among other technologies, impact health to the extent of the kinds of services offered, information systems deployed, and even the digital health programs available. Further, a more receptive political environment and a rising body of digital health data demonstrate the effectiveness of digital health tools and technologies, which ultimately pave the way for digital health to become a crucial component of healthcare delivery.

On the other hand, when access to face-to-face treatment is not an option, like was the case during COVID-19, health systems, in particular, become aggressive in developing measures to assist patients in accessing digital health services and programs. Therefore, these systems must consider the appropriate and people-centred factors for effectiveness. Moreover, models that consider varied digital health tools and technologies, digital health services, digital health programs, and digital health information systems and are adaptable to changes within the digital health ecosystem and beyond should be explored.
References


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