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Digital Health Companies - Efforts to Innovate for Health Equity

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Digital Health Companies - Efforts to Innovate for Health Equity

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Abstract

INTRODUCTION: To achieve greater health equity, we should look to the ways in which digital technology can positively impact healthcare service and delivery. While there is an incredible opportunity to improve healthcare with digital technology, the potential to exacerbate existing health inequities also must be considered. One important and influential player in the healthcare ecosystem is the digital health innovator. These are companies looking to improve how healthcare is performed and delivered. It is imperative that while they respond to the market forces driving change, they also work to deliver products that can benefit everyone.

METHODS: A literature review was conducted to understand the scope and impact of digital health tools on health equity. Novel quantitative and qualitative data were used to describe current efforts by digital health companies to design and deliver products in an equitable way. Recommendations are provided to help digital health companies incorporate important elements in the design and delivery of their products. First, companies ought to prioritize diverse teams and utilize community-based participatory research principles to yield greater equity. By ensuring consideration for people in oppressed groups as well as those with disabilities, companies can further widen the range of possible users. An increasing number of digital health technologies incorporates machine learning technologies. As such, it is important to test and de-bias datasets and algorithms. The accessibility of these digital health tools can be increased by offering them in multiple languages, complying with the American with Disability Act (ADA) guidelines, offering them in multiple platforms and interfaces, prioritizing text messaging features, and providing support for low health and low digital literacy users.

OBJECTIVES: Digital health companies have an opportunity, incentive, and moral imperative to help close the health inequity gap. This research paper will heighten awareness about the

importance of digital health innovation that utilizes a framework of principles to work toward health equity.

KEYWORDS: health equity, digital health, health tools, digital health companies

Introduction

The promise of digital technology to improve the lives of individuals and society has been a remarkable revolution to bear witness. Every major industry, from manufacturing to finance to education, has been transformed due to digital technology. Digital technology touches nearly every aspect of our lives in the United States along with much of the world. The accelerated and steep trajectory of technological growth, unyielding to any criticism or concern, dares to innovate and push the limits of what is possible. Indeed, the growth of these digital technologies has not all been for the absolute betterment of individuals and society. Health care delivery in particular, warrants attention and scrutiny, as the growing impact of digital technologies is at once fantastic and somewhat alarming.

Recently, the COVID-19 global pandemic served as a catalyst for digital innovation in health care. Remarkable efforts were made to share research knowledge, develop vaccines, tests, and treat patients using digital technology. The volume of electronic health visits, for example, skyrocketed during periods of mandatory lockdowns and sheltering-in-place (Koonin et al., 2020). However, the pandemic also laid bare the enormous gap that exists in society with regards to access and quality of care (Thakur et al., 2020). It is incumbent upon us to address this gap and work to ensure that we utilize digital technology to improve healthcare for everyone.

There are two parts of this research paper. First, a literature review was conducted to better understand the scope of the problem of health inequity as it relates to digital health and help identify key areas to address. Second, novel quantitative and qualitative data will be shared to help understand how digital health companies are considering issues around health equity as they innovate, build, and deliver their products.

Background and Literature Review

Health inequity

The fundamental right to health means that every person has the right to attain their full health potential (World Health Organization. 2017). But the reality is that there are barriers to achieving this potential. These barriers are social, environmental, economic, and structural (Penman-Aguilar et al., 2016). They are systemic, unjust, and preventable. And they result in health inequities. These health inequities can be observed globally between high-, middle-, and low-income countries and within countries as well (Barreto, 2017). Here in the United States, studies have repeatedly found inequities in healthcare access, utilization, and outcomes resulting in differences in morbidities, mortality, and general well-being across specific population groups (Communities in Action: Pathways to Health Equity2017). "Systematic differences in health based on race/ethnicity, sex, gender identity and sexual orientation, SES, age, disability status, geography, and primary language (among other characteristics) persist in the United States to the current day" (Penman-Aguilar et al., 2016).

Research has shown that there is a socioeconomic gradient of health whereby disadvantaged groups experience a disproportionate burden of poor health (Petrovic et al., 2018) When saddled with poor health, families enter into a health-poverty trap, whereby the experienced health inequities can reinforce gaps in income as well (Bor et al., 2017). These families are more likely to suffer from loss of income and rising medical costs resulting in debt which may set the course for their future generations.

Health inequities have forever been a global challenge. In recognition of this, the United Nations has adopted good health and well-being as one of its 17 Sustainable Development Goals (SDGs) for 2030. Specifically, the goal is to "Ensure healthy lives and promote well-being for all

at all ages." To help answer this challenge in the United States, the Healthy People 2030 (https://health.gov/healthypeople) vision is "A society in which all people can achieve their full potential for health and well-being across the lifespan."

Healthcare and its delivery

While there are a multitude of factors ranging from social determinants of health to structural disparities which bring about health inequity, an important and obvious place to focus attention is on health care itself and its delivery to the people. Since the advent of modern medicine, people's health has vastly improved, with more people living longer, healthier lives. And while the rise of longevity can be hailed as a great achievement, the gains have slowed more recently (Olshansky, 2016) and have been unequal. Life expectancy has stagnated or even declined in some demographic groups (Bor et al., 2017). There is a growing field of healthcare inequities research which has begun to identify areas for improving healthcare delivery for all, along with those working in implementation science to help determine best processes and strategies (Baumann & Cabassa, 2020). Ultimately, it is critically important that an equity lens be used when creating and delivering systems of care.

Digital health tools

An important tool in realizing the Healthy People 2030 vision, is digital technology. Beginning in the late 20th century, a steady and gradual increase in digital technology utilization could be seen in many corners of health care. From electronic health records (EHRs) to diagnostic instruments to remote monitoring, the power of technology was harnessed to streamline and make health care delivery more effective and efficient. Around the world,

examples abound, highlighting the ways in which digital health can be used to reach more people, with better services and with less financial stress (Wilson et al., 2021). However, in many areas of healthcare, uptake of digital tools is slow and riddled with obstacles. Since the arrival of the COVID-19 pandemic, innovation and adoption has increased with remarkable speed and volume (Peek et al., 2020). The healthcare sector had to make quick adjustments and innovate to solve a multitude of problems using digital technology (Peek et al., 2020). Nevertheless, the COVID-19 pandemic has further compounded existing health inequities as certain populations struggled with access to healthcare, suffering from higher rates of morbidity and mortality (Crawford & Serhal, 2020). With COVID-19 as the catalyst, it became obvious that there was also an imperative to consider the ways in which digital health tools could be used to make gains in terms of population health. How could health care leverage digital technology to make health better for all?

Digital health inequity

A large, persistent gap in the access and quality of healthcare exists between socioeconomic groups. As digital technologies are developed in health care, this gap has the potential to widen, and existing inequities will become even larger. Studies have shown that in addition to broadband and device access, there are also measurable differences in digital literacy (Rodriguez et al., 2020). It is critical that we work to address the issue of health inequity as it relates to digital health before the problem becomes exacerbated by the explosive growth of the digital health industry. Without proper consideration of the power and impact as well as the efficacy and limitations of such technologies, our ability to meet sustainable development goals

(SDGs) and Healthy People goals will be stymied and more people will be left behind with poorer health outcomes and enter into the health-poverty trap.

While the world has begun to take notice of the major growing problem of health inequity as it relates specifically to digital technology, there is much research still needed to better understand how this inequity plays out in the digital space. As Katharine Lawrence (2022) states, "More research is needed to develop validated processes and measures to identify, prevent, and mitigate inequity in digital health." What are the mechanisms by which this digital divide is growing? How should these issues be addressed?

We can evaluate the barriers of digital health equity at each level of the social ecological framework—individual, interpersonal, organizational, community, and policy. Rodriguez et al. (2020) recommends a multi-faceted approach to promote health equity in digital health tools ranging from increasing broadband access to diverse and inclusive design of technological tools to federal equity mandates.

Digital health industry

To date, there is very little formal guidance or strategy regarding the growth of the digital health industry. It is, in many respects, like the days of the Wild West where the lack of order and regulations creates a landscape where anything is possible. However, in March 2020, the Office of the National Coordinator for Health Information Technology's (ONC) released its final rules for the Cures Act in an effort to make it easier for patients to access their health data. The ONC also hopes that the rules encourage a faster pace of innovation and investment of patient-facing tools to help transform the way patients access care (Office of the National Coordinator for Health Information Technology. n.d.). The rules set forth do not however, go far enough as

they do not address well-known disparities such as user-centered design or literacy in digital health tools.

In our market-driven country, the most powerful solution just may lie with industry. They have the financial resources, tools, and the drive to innovate. In 2016, the American College of Cardiology convened a think tank to address the promise and challenges of digital health. It was pronounced that "Digital health technologies have significant potential to revolutionize healthcare delivery, transform clinical trials, and improve health outcomes" (Sharma et al., 2018). Collaboration between stakeholders including researchers, industry, regulators, and patients, are vital to ensure that digital health works to improve healthcare for all. However, in a recent study of top-funded digital health companies, there is little data to show substantial impact on disease burden or cost in the US health system (Safavi et al., 2019). The recommendation is to build an environment via policy and market conditions whereby digital health companies are encouraged to build evidence-based, high-impact products. Ideally, strategies should be implemented to direct, encourage, and incentivize companies to innovate better digital products with health equity in mind. But first, we must understand how digital health companies are even thinking about health equity and learn about their ideas on how to go about solving the problem.

Methods

An extensive literature review was conducted to identify and describe the scope of the problem of health inequity as it relates to digital health. Multiple searches were conducted within PubMed and Google Scholar using the following keywords and terms: digital health equity, digital health companies, digital health tools, mhealth, ehealth, health disparities, and the digital divide. Due to limited published research in this relatively new field, resources from technology companies, non-profits, and opinion articles from thought leaders in this area were also reviewed.

A small-scale mixed methods research study was conducted under the umbrella of UCSF's Accelerated Digital Clinical Ecosystem (ADviCE) program. The ADviCE program is a recent initiative to create a collaborative marketplace for digital health tools. To ascertain the attitudes and actions of digital health companies in regard to health equity, two survey questions were devised based on literature findings along with consultations from the ADviCE core team and other leaders in the digital health space. Upon an accepted invitation to join the ADviCE program, over 30 digital health companies were surveyed and 3 of those companies were selected for follow up with a 30-60 minute qualitative semi-structured interview. The survey questions were embedded in a longer survey form called the Digital Health Common Application which was sent and collected via Research Electronic Data Capture (REDCap). Study data were collected and managed using REDCap electronic data capture tools hosted at UCSF. REDCap is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data

downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources (Harris et al., 2009; Harris et al., 2019). The qualitative interviews were conducted over Zoom.

Survey answers were tabulated and arranged into a data table and graph. Quotes were highlighted from the interviews to provide a deeper, nuanced understanding of how these companies were considering the issue of digital health equity as they innovate their products.

Results

Literature review

While the topic of health equity has been longstanding, and the topic of digital health, though relatively new, has generated much research and discussion, when these two search terms are combined, the relatively modest results confirm the fact that this is a burgeoning new area of study and focus. And so, a number of viewpoints and editorials are adding to the published research studies to describe the promise as well as the challenges of digital technology.

A collection of papers describing digital health research in low- and middle-income countries evaluated by (Sinha & Schryer-Roy, 2018) determined three important themes regarding digital health equity. First, that digital health can positively influence health equity. Second, that gender and power analyses are essential. And third, that digital health strengthens upward and downward accountability. Their findings provided recommendations on how to design, implement, and evaluate digital health interventions with an eye towards the SDGs.

A synthesis of Healthy People data spanning two decades, "highlights the digital health and health literacy trends and disparities that persist and proposes remedies to ensure that health literacy and digital health issues receive the attention they deserve in the next decade" (Jackson et al., 2021). One paper focused more specifically on the topic of digital health literacy and presented an 18-point "Digital Universal Precautions" mandate for health care organizations (Smith & Magnani, 2019).

There are also a number of research studies supporting the use of digital technology to address specific areas of health. One study showed that text messaging can help improve breastfeeding rates (Harari et al., 2018). Another study examined how a technology enabled treatment protocol could ensure digital health equity in an outpatient mental health clinic

(Rauseo-Ricupero & Torous, 2021). Digital access issues were addressed in one study describing a program where cell phones were provided to those experiencing poverty or homelessness as a point-of-care intervention (Kazevman et al., 2021)

A number of articles explored telemedicine access differences across population groups during the COVID-19 pandemic and urged practices to promote telemedicine equity (Rodriguez et al., 2021) (Chunara et al., 2021). While editorials are noting the way in which the COVID-19 pandemic has led to extraordinary transformation of healthcare (Peek et al., 2020) and are also calling for the use of digital technologies to deliver health benefits for all (The Lancet, 2021).

Published viewpoints are calling out for more community-engaged research to address health inequities that are being exacerbated by digital technology (Brewer et al., 2020). A review concluded that the same social determinants that affect health outcomes similarly affects the use implementation of digital health technology (Saeed & Masters, 2021). While one published commentary argued that "a sense of urgency cannot be an excuse or substitute for a critical assessment of the tools employed" and that we must think through the use of digital technologies in public health (Gómez-Ramírez et al., 2021).

Mixed-methods pilot study

Over the course of nearly six months, over 50 digital health companies were invited to participate in the UCSF ADviCE program. The first step involved completing a Digital Health Common Application which included two questions specific to the issue of health equity.
32 companies answered the first question (Table 1 & Figure 1) which asked about elements considered in designing and developing their product(s). Over half replied that their solutions were co-created with the intended community utilizing a community-based participatory design.

31% cited 'other' elements were used to design and develop their application. 28% replied that their application was tested for bias in their datasets as well as their algorithms. 25% replied that their application was tested in oppressed groups. And 25% tested their application for use by people with physical disabilities.

Table 1. Designing for health equity		
No. of respondents	32	
		%
Community-based participatory design	17	53.10%
Other	10	31.30%
Application tested for bias in datasets and algorithms	9	28.10%
Application tested in oppressed groups	8	25%
Application tested for use by people with physical disabilities	8	25%

Table 1. Designing for health equity- responses from the Digital Health Common Application

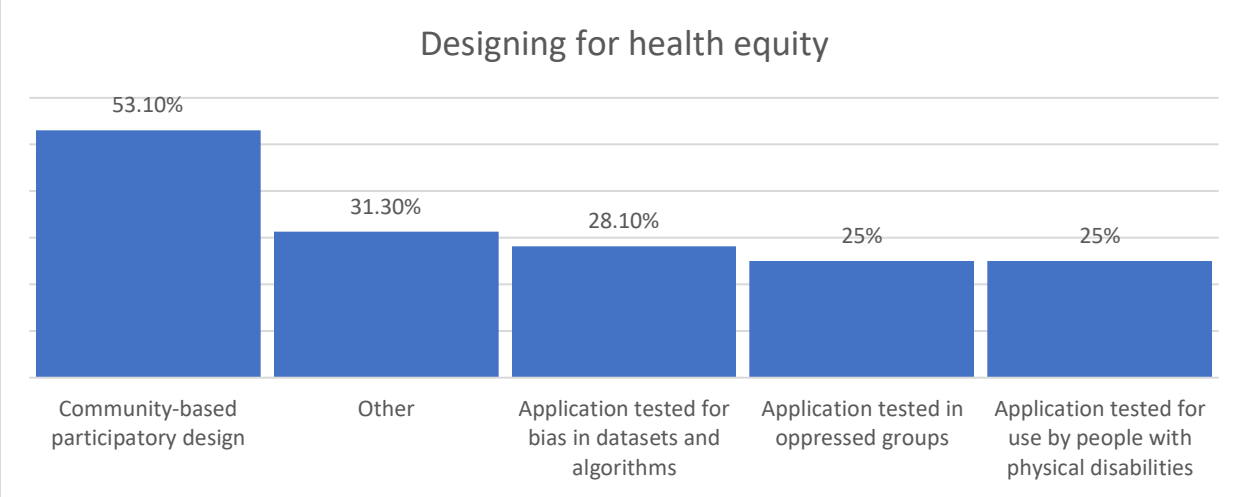

Figure 1. Designing for health equity- responses from the Digital Health Common Application

The second question received 38 responses regarding accessibility of their product (Table 2 & Figure 2). Almost 74% replied that their application was accessible by more than one digital

platform. Nearly 61% replied that their product provides support in languages other than English. Half of the companies who responded offers support for low digital literacy. 47% offers support for low health literacy. Almost 37% of responding companies reported utilizing text messages. 32% of respondents checked the "other" box to indicate other mechanisms are used to make their product more accessible. About 11% reported that their application complied with ADA guidelines.

Table 2. Accessibility strategies		
No. of respondents	38	
		%
Support for languages other than English	23	60.5
Support for low health literacy	18	47.4
Support for low digital literacy	19	50
Compliant with ADA guidelines	4	10.5
Accessible by more than one platform	28	73.7
Utilization of text messaging	14	36.8
Other	12	31.6

Table 2. Accessibility strategies- responses from the Digital Health Common Application

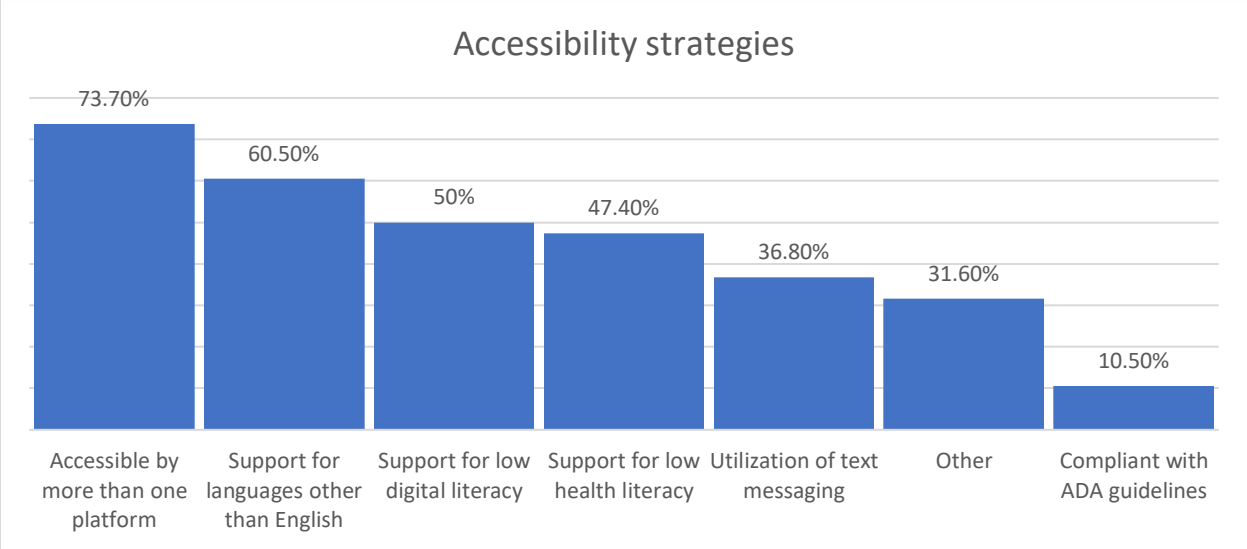

Figure 2. Accessibility strategies- responses from the Digital Health Common Application

Three companies, referred to as company A, B, and C, whose technology is driven by artificial intelligence (AI) were chosen to follow up with a qualitative interview. These interviews ranged in duration from 30 to 50 minutes.

Company A strives to empower patients and physicians with information to help them make decisions around cancer treatment. During the interview with the Chief Product Officer for company A, several notable remarks were made regarding the company's efforts around health equity and accessibility:

> "We're really trying to accelerate and learn from every patient…I basically interviewed these patients and asked 'what would have made it easier, what would you have wanted?'"
>
> "We did a lot of patient interviews before we actually built the portal."
>
> "I think the underlying issue is, so most patients are being seen in the community setting, right, not everyone can go to Stanford, not everyone can go to Memorial Sloan Kettering, so the issue is how do you actually ensure that every patient, no matter where they are getting seen has the right amount of care? And in order to do that, you need a shared a shared learning system that we're building right? And everybody has equal access to it."
>
> "It's just English. …in the future, we will. I think as we launch more to different health systems. That's what we want to get to."
>
> "We can ensure that it's very easy for them. From a UI perspective. So that's definitely something that we are constantly improving on."
>
> "You need to service the entire US population in order for your product/service to grow."
>
> "I do see that gap getting smaller due to the awareness now. This is also important for anyone that [is] developing AI algorithms. You can't really launch a great product if it's only useful for Caucasians, for example."

Company B works to provide a scalable AI platform for data collection and analysis in clinical trials. During an interview with the director of Strategic Partnerships, many noteworthy remarks were made:

> "They found that they actually had created an algorithm that was based on bias, right? Especially when it comes to things like digital biomarkers […] They actually had a decision to make, because it had gotten to be like the end of the building period. And a lot of companies wouldn't have trashed that work right? […] because of the amount of money that they put in. They started it all over again and they actually expanded […] to retrain and reprogram and rebuild out the software completely."

> "Health equity, diversity, inclusion and really inclusive excellence […] is something that our investors and our board is really, really interested in. They support our initiatives […]."

> "We're also taking a look at how to bring in groups that we've historically not worked with, you know, nursing groups, health advocates and really, that kind of collaborative-care shared decision-making approach."

> "We do provision devices and this becomes really important for those communities that have […] issues not only with maintaining the monthly bills, if they have the Wi-Fi issues, it really helps us to be able to deploy in places like Africa that might have an infrastructure issue, and so our devices are able and really the platform is able to collect about a week's worth of information just on the phone to be able to be upload whenever it is able to connect to Wi-Fi."

> "We do have multiple languages. I think we're up to like 45 [languages]. … everything is ADA compliant."

The co-founder and CEO was interviewed for company C, whose goal is to provide AI-based comprehensive risk assessment and treatment recommendations for cardiovascular patients. These were some notable comments:

> "[The] original study that we are working with was a 50,000 patient global study […] was diverse from the US, from Europe, from Africa, from Asia, so most people from all over the world, and this is where we developed our risk prediction."

> "In our algorithm, we make sure that we really provide objective information, objective risk assessment to the physician, because we know that there is a bias, to

think that women have lower incidence of cardiovascular disease, which is not true."

"Or […] that people of color have a higher [risk], however, if you asked me if we tested, you know, for that specific bias, we didn't test it. We know that there is a bias and we are addressing it, but we haven't tested it specifically."

"We are aiming to close the gap to bring everybody on the optimal level of care."

Discussion

The findings from this study are an important start in evaluating the potential gains that can be made with respect to health equity in the digital realm. Digital health is a relatively young field in the health care industry, and it has the potential to exacerbate existing disparities or it can be an opportunity for change and better health outcomes for many. The challenge is to identify areas of impact and create solutions in ways that improve upon health equity.

The effort to put equity at the center of digital health innovation can be guided by a framework put forth by RockHealth.org, a non-profit working to address inequities in healthcare by bridging a community of innovators, builders, and thinkers (2021). The first principle is to "center in the community". The design and efficacy of a product is more impactful if it is built with the trust, respect, and partnership of the community for which it is intended to serve. This is the essence of community-based participatory research, which has been well-established as an important research approach to equitably engage people to solve problems (Wallerstein et al., 2020).

The second principle is to "co-design the solution". This extends the CBPR theme of engaging those most affected by the issue. There are two aspects to this principle. One, companies that prioritize diverse teams allows for greater representation and better performance. Two, by soliciting input and feedback from their target population, companies are better poised to create products that will have better reach and impact. Well over half of the companies responding to the survey indicated using a CBPR approach to designing their product. And while it is unclear exactly how these companies utilized CBPR in their design process, it was encouraging to learn that companies are aware of the importance of CBPR and are making

efforts to work with the community for which their product is intended. During the qualitative interviews, company A noted that in an effort to learn from their patient population, they performed many interviews with patients prior to building their portal. Company B stressed their collaborative-care, shared decision-making approach to building their product.

Presuming that the companies surveyed were creating products meant to reach a broad population, it was somewhat disheartening to observe that only a quarter of respondents tested their application in oppressed groups. And again, only a quarter of respondents tested their application for usability by people who have physical disabilities. Over 30% of companies reported using some 'other' aspect to help design their application with equity in mind. While the survey had an option to define "other", most chose not to do so. One respondent defined it as testing within a multidisciplinary health care team while another respondent cited a different predefined set of guidelines -- CODIE for the deaf and hard of hearing community.

The third principle is to "develop the right tech". This means that the technology created should not perpetuate existing deficiencies and biases. While greater awareness about the potential for bias in datasets and algorithms is an important first step, innovators should do what they can to de-bias their tools. Over a quarter of the companies surveyed reported testing their application for bias in their datasets and algorithms. An important next step would be to understand how they do this testing and whether it is sufficient. It was interesting to learn that company B realized the perpetuation of bias in their dataset and algorithm when they were quite far along in their development and chose to scrap their work and begin again, mindful of the errors and choosing to reach far and wide to collect data that would be more diverse and inclusive. Company C noted that their risk prediction model was based on a large global study thus ensuring diversity.

"Make it accessible" is the fourth principle and should be a mantra for those wishing to reach a wider market for their product. Thoughtfully designed solutions are guided by Universal Design principles which push the "boundaries of 'mainstream' products, services, and environments to include as many people as possible" (Universal Design - The 7 principles.). Considerations include accommodating different languages, low health literacy skills, low digital literacy skills, ADA guidelines, and device diversity with an emphasis on texting modalities.

Almost three quarters of survey respondents checked the box to indicate that their product is accessible by more than one platform. It would be interesting to know the range of devices or platforms being accommodated. While the vast majority, nearly 97%, of Americans have a cell phone, approximately 15% of these are not smart phones (Mobile Fact Sheet. 2021). This is one reason why it is preferable to develop text features rather than an app. Additional benefits are that texting is often a preferred method of communication and can be easily distributed (Text Messaging in Healthcare. n.d.) Almost 37% of companies reported utilizing text messaging features for their application.

Over 60% of survey respondents reported that their application was available in languages other than English. This is particularly important for users in the United States owing to the vast diversity of languages spoken and large number of non-native English learners. Company A acknowledged that offering languages other than English was a future goal. While company B offers their application in 45 different languages.

Half of survey respondents indicated that their application offers support for low digital literacy. Low digital literacy makes patients vulnerable in a similar manner to those with low health literacy whereby the ability to obtain important health information and make decisions becomes more challenging. Significantly older individuals and those with chronic health

conditions tend to have poor digital literacy skill as well (Smith & Magnani, 2019). Therefore, support becomes especially vital for applications intended for use in aging communities and those suffering chronic conditions.

Nearly half surveyed reported supporting low health literacy as well. There is a wide range of abilities that make up health literacy and enable patients to take charge of their health within the complex healthcare system. However, more than one-third of adults in the United States have limited health literacy putting them at a disadvantage leading to poorer health outcomes (Berkman et al., 2011). By writing at a fifth to sixth grade reading level, utilizing visual aids, avoiding medical jargon, and concretely presenting key points or steps, information can be made more understandable and accessible (Hersh et al., 2015).

A little over 31% of respondents checked the box for 'other', with one respondent indicating that their application was designed for color-blindness and can be read-aloud for the visually impaired. There may exist a multitude of creative ways that companies are trying to increase the accessibility of their applications. Whether this is accomplished by utilizing more readable fonts or including keyboard shortcuts or appropriate color contrast, by creating better designed applications, companies can always do more to increase the success of their products with greater accessibility. Company A can be quoted as saying "You need to service the entire US population in order for your product/service to grow".

A mere 10.5% reported that their application was compliant with ADA guidelines. While the American Disabilities Act was enacted prior to the invention of the internet, its forward-thinking provisions must also be considered for websites and technological innovation. The ADA web accessibility standards and compliance requirements consist of four basic principles (2022 ADA Website Requirements & WCAG Compliance Standards for Websites. 2021). First,

websites should be perceivable such that information be presented in ways that are perceptible using at least one modality. Second, any interface component must be operable. Third, the information and operation of the website should be understandable. And fourth, the content should be robust so that a wide variety of users will be able to access the content.

While this small pilot study is one of the first of its kind, yielding novel insight as to how digital health companies are approaching the issue of health equity, there are limitations. It was a very small sample of companies in a rapidly growing global digital health market which was valued at over 200 billion U.S. dollars in 2020 and is expected to exceed 500 billion dollars by 2024 (Statista, 2021).

Another limitation is that a wide range of digital health companies was surveyed. Their innovative products spanned a broad range of tools-- from clinical workflow enhancements to diagnostic tools, treatment recommendations, clinical decision support and more. Owing to this broad range of applications, not all of the attributes applied to each company or product. A company looking to streamline aspects of electronic health record keeping is not concerned with diverse data inputs in the same way that an AI-based diagnostic company would.

A re-design of the survey questions ought to include the option for companies to answer "none of the above". That way, it would be less ambiguous to know if an unanswered question was intentionally left blank because the company did not do those things rather than the possibility of them having simply missed the question.

A larger number of qualitative interviews would surely add more richness and depth to the findings. Each interview yielded interesting details and keen insight into a company's perspective on their process of innovating for health equity. It was helpful to learn about their challenges as well as their hopes for the future.

Recommendations

In response to the COVID-19 pandemic, digital health tools have rapidly become ubiquitous. From telehealth to mobile health apps to online health services and more, opportunities for innovation abound. And while there is great promise for the development and use of digital technologies to improve health beyond the pandemic, there is a potential for long-standing inequities to deepen, furthering the health divide. "Digital health technologies interact with social, cultural, and economic realities and with social determinants of health to indirectly contribute to health equity" (Crawford & Serhal, 2020). The World Economic Forum's Davos agenda recently declared that digital healthcare can be a catalyst for greater health equity (2022).

Digital health equity can be addressed at each socioecological level (Figure 3) (Lyles et al., 2021)). At the individual level, work can be done to increase digital literacy, interest, and usability. Within the family and home setting, better design for a variety of contexts along with supportive features could be beneficial. At the community level, CBPR principles would go a long way to increase trust and respect for digital health tools. Digital health companies play an important role at the services level where the development and implementation of innovative strategies could yield better health outcomes for all. The outermost level of consideration is that of policy, whereby accessibility standards and reimbursement would be mighty drivers of change.

Figure. Digital Health Equity Mapped to Socioecological Framework

Domains	Elements of digital health equity	Recommendations
Individual	• Digital literacy • Interest • Readiness	▸ Focus on usability and relevance
Family and home	• Caregiver and family support • Private and secure space	▸ Design for multiple contexts ▸ Blend digital and human support
Community	• Trusted partners (eg, community organizations) • Digital capacity and infrastructure needs	▸ Codesign with community ▸ Develop reciprocal relationships
Services (including health care)	• Digital training • Technical assistance • Linguistically and culturally concordant staff	▸ Implement and evaluate in clinical settings
Policy	• Broadband internet • Devices • Accessibility standards • Reimbursement	▸ Improve connectivity ▸ Improve accessibility ▸ Utilize value-based payment system

Figure 3 Source: (Lyles et al., 2021)

The study presented here examines just one part of the whole ecosystem—the digital health companies looking to innovate new ideas and products. In these early days of digital applications in healthcare, it is important to understand whether companies are prioritizing efforts to addressing health inequity. There might be recognition of the growing problem, but there might also be a lack of commitment in the battle against it. Sounding the public health alarm could motivate more companies to do better.

Providing digital health companies with guidance around best practices for designing and delivering their tools is of utmost importance. The Agency for Healthcare Research and Quality, a division of the Department of Health and Human Services is currently funding a project to "create a digital healthcare equity framework and guide that specify the aspects that need to be considered when creating and planning for equitable healthcare solutions that involve digital technologies" (Agency for Healthcare Research and Quality, n.d.). Led by Johns Hopkins University, the specific aims are to identify existing, related frameworks and best practices, determine consensus regarding the critical elements, and create a framework and guide for building equitable healthcare solutions involving digital technologies.

The working model put forth by Rock Health organizes important elements worthy of consideration when designing applications with health equity in mind (Rock Health, 2021). Companies ought to capitalize on the wisdom that can be drawn from people of myriad backgrounds and experiences by prioritizing diverse teams. These teams would be well-positioned to incorporate CBPR principles in their application design and solicit input and feedback from the communities they intend to serve. Companies would do well to intentionally consider the perspectives of and test their applications in groups of people who are oppressed or made vulnerable as well as those with disabilities. If datasets and algorithms are an important foundation for their applications, numerous toolkits and processes are available to mitigate, reduce, or clear the bias (Dilmegani, 2022).

Companies have a product or service to sell. Thus, it makes sense to try and appeal to as broad a market as possible by making a product or service as accessible as possible. Offering multiple language support not only makes sense in a county as diverse as the United States, but also allows the opportunity to expand into global markets. Complying with ADA guidelines

should be another imperative for companies to follow. While this law might not explicitly cover websites and other innovations, as the technological industry evolves, many of these products and services will be increasingly considered as places of public accommodation (Trichter, 2021). And places of public accommodation are subject to the ADA.

Spend time in any health care environment and it will quickly become evident that interoperability is a major challenge in need of solutions. The number and scope of systems required to communicate and deliver care is staggering. (Newman, 2018). As health systems work to create a more streamlined and efficient way to manage care, companies offering solutions to accommodate different user platforms and interfaces will be more attractive. With a focus on individual patient users in particular, incorporating text messaging features is preferable. Texting is considered to be informative, convenient, and effective for engaging people in their healthcare (Harari et al., 2018). Texting also does not discriminate against non-smart phones.

According to the American Academy of Family Physicians, health literacy is "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health care decisions" (Health Literacy. n.d.). More than 80 million adults in the United States are estimated as having limited health literacy skills which increases their likelihood for poorer health outcomes (Berkman et al., 2011). Companies should keep these consumers in mind as they design their applications. By using less medical jargon and keeping the reading level to that of 6th grade, they will make their product more accessible to the US population at large. By offering support services, companies can go further to ensure usability of their products by a wide range of consumers

Likewise, companies should also keep in mind the digital divide. The Pew Research Center identified five distinct groups of Americans along a spectrum of digital readiness ranging from relatively more prepared to relatively hesitant (Horrigan, 2016). Those falling into the relatively hesitant group tended to be older, from lower income households and with lower levels of education. Low digital literacy skills are particularly prevalent in the aging population who tend to use more health care services as they age. These older adults did not grow up in the digital age and often require some level of support to help navigate the rapidly evolving world of technology.

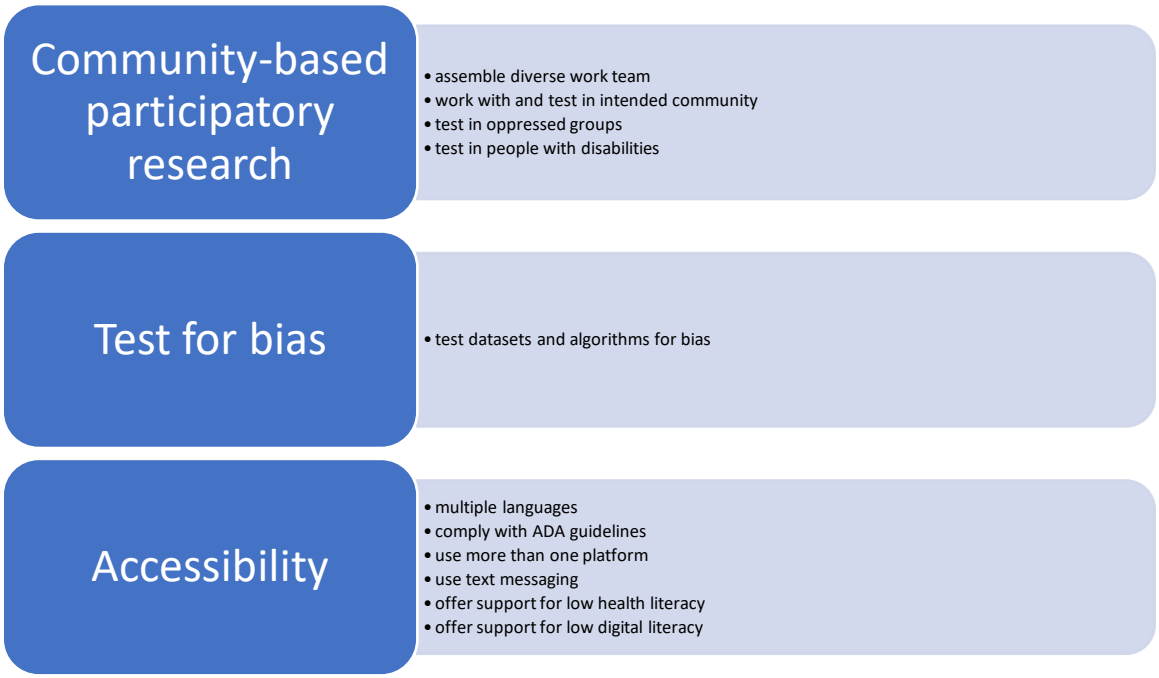

Figure 4. Elements for companies to consider in creating applications using health equity lens

We're in the early stages of thinking about this problem of digital health inequity. In 2021, Henry Ford Innovations held their first Digital Inclusion Challenge, an international competition to encourage entrepreneurs to reduce health inequities using digital technology. The focus was threefold: 1) make healthcare more affordable and accessible for digitally excluded

patients 2) make it easier for patients to learn about their health and healthcare services and 3) empower care teams to deliver better services (Henry Ford Health, 2021). They received nearly 150 entries from 13 countries. The winner was Koda Health, whose goal is to increase equity of access to advance care planning through a free, easy-to-use, bias-free platform. More innovative ideas such as competitions like these could spur the development and advancement of equity-minded digital health companies.

Another interesting effort to help create more equity in the digital health space is the Rock Health Summit Innovation Fellowship program. It's an opportunity to convene digital health leaders along with other stakeholders in the digital health ecosystem. Much like the work of think tanks, programs like these increase awareness and keep the conversation moving forward.

As the healthcare ecosystem continues to evolve, it is hopeful that the emerging digital health industry understand the gaps and attempts to address them. Companies innovate first and foremost because they're motivated by profit. But with more digital health research and measurement-based approaches to address health equity, companies may be compelled to incorporate the elements described in this pilot study. Resource-rich companies willing to make the investment to create equitable products should see returns on their investment thereby reinforcing their commitment to do the right thing.

Marketplaces can also be powerful drivers of change and the marketplaces beginning to emerge for digital health is no exception. UCSF's ADviCE initiative is just one of many marketplaces with a goal of bringing together health systems and digital health companies. As marketplaces begin to define themselves, they can add pressure to companies' efforts to innovate for health equity. By highlighting and reinforcing key elements of a digital health product,

companies can respond to the growing pressure in the marketplace to produce products and better serve health for all thereby reducing the problems of health inequity.

Finally, this paper would be remiss to not recommend policy action. Policy is an important driver of change. As the Lancet editorial comments, “no amount of technical innovation or research will bring equitable health benefits from digital technologies without a fundamental redistribution of power and agency, achievable only through appropriate governance” (2021). Establishing guidelines and providing applicable infrastructure to support the build-out of an equity-based healthcare ecosystem is paramount. From grant programs to help provide more access to broadband to programs to enhance health and digital literacy, there are numerous opportunities to help ensure that digital technologies improve health for all.

Conclusion

Digital health can be considered as the next frontier for health equity. Digital health companies can and should do more to consider the issue of health equity as they design and deliver their innovative products. After surveying over 30 digital health companies and interviewing three, it became evident that the majority of these companies are actively considering how to improve health equity with their products. To create with an equity lens, companies can assemble diverse teams, utilize CBPR principles, test in oppressed groups and disabled people. They should test their datasets and algorithms for bias and use the appropriate tools to de-bias them. Companies can make their products more accessible by offering them in more languages than English, complying with ADA guidelines, offering their product on more than one platform, utilizing text messages wherever possible, and offering support for low health and low digital literacy. By incorporating these elements, companies can help begin to close the health inequity gap with their innovative ideas. These are exciting times with many possibilities that have the potential to reshape the way healthcare is designed and delivered such that the gains to be made can happen for all.

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Appendix

Survey questions

Question #1:

Designing for health equity: Which of the following were used in the design and development of your application? (select all that apply)

__ Community-based participatory design (solution co-created with intended community)

__ Application tested in oppressed groups

__ Application tested for bias in datasets and algorithms

__ Application tested for use by people with physical disabilities

__ Other

Question #2:

In which ways is your application made more accessible? (select all that apply)

__ Support for languages other than English

__ Support for low health literacy

__ Support for low digital literacy

__ Compliant with American with Disabilities Act (ADA) guidelines

__ Accessible by more than one platform (e.g. iOS, Android, desktop)

__ Utilization of text messaging

__ Other

Semi-structured interview guide

Objective:

Understand how digital health companies are addressing issues around health equity. How central is it to their company mission? What policies are being created to stem the growing disparities in health and health care?

After an introduction and explanation about the ADviCE program, shift the conversation towards health equity matters.

A more general comment that brings curiosity could start the conversation. For example: "As exciting as digital health and its promises are, I'm wondering if companies are thinking about addressing health equity. And if so, how exactly are digital health companies doing this work?"

Introduction:

Hello, my name is Patricia Martell. I'm currently pursuing a Masters in Public Health at USF. As part of my program, I am also doing an internship with UCSF. I am the program manager of ADviCE, or the Accelerated Digital Clinical Ecosystem. ADviCE is a digital health collaborative which is working to create a trustworthy and useful marketplace for digital health tools.

Part of our work at ADviCE as well as my own personal interest, is an effort to understand how digital health companies develop products and services so that it can be used equitably.

While digital health has incredible opportunities to improve the health of many, we also fear that the gaps which exist could widen. And so, by equitably, we mean, are there ways in which companies can do things to ensure access for all and especially vulnerable populations?

Would you be willing to talk with me about how your company approaches issues around health equity as well as inclusivity? This discussion will take 15-30 minutes. I will use the results of this interview to support my thesis as well as help ADviCE develop its features. I would greatly appreciate the opportunity to record the conversation to help with my notes. At no time will I identify your company by name in either my thesis or in ADviCE materials.

Specific questions to ask:

Interviewee questions:

- Please describe your role within the company
- How long have you been with the company?

Company questions:

- Please describe your company mission and vision

We can think about health equity efforts in and around the company (e.g. hiring practices, training and performance plans) and we can also think about how you might be working to integrate health equity into your services and resources (e.g. feedback from the community, increasing access). I'd like to briefly ask about equity within the organization and then focus on equity as it relates to your health product and service.

Organizational equity:

- How does your company consider issues around equity within the organization? In what ways does your company do this?
- Are there policies in place? If so, what kind of policies do you consider to have impact on ensuring an equitable workplace? (e.g. policies around diversity and inclusivity)

Product equity (how your company develops its product to ensure health equity):

- Please tell me about the goals of your product and the problem it is intended to solve
- How did your company evaluate your product's usability by patients?
- How did your company determine your product's effectiveness?
- When did you test your product for use in diverse populations?
- How did you accomplish this? If not, why not?

Sub questions:

- Can you tell me about how your company works with the community for which your product is being designed?
- Can you tell me what kinds of accessibility issues your company thinks about?
- Is your company paying attention to technology-embedded bias—especially around gender and race? i.e. do you work to identify biases in any algorithms being used and attempt to de-bias them? Are there tools being used to do so?
- Is your technology available in different languages?
- What reading level/health literacy level do you assume when building your products?

- How about digital literacy? Is that a concern for getting adoption?
- Are ADA guidelines important for your product?
- Tell me about the actual devices and user interfaces that your product is designed for. Do you accommodate a wide range of devices and user interfaces? Do you need to also program for flip phones as an example?
- What, if any socioeconomic data does your application capture?

  -race?

  -ethnicity?

  -primary language?

  -income level?

  -education level?
- Is health equity an important consideration for your investors? For the growth of your company?

Looking to the future:

What do you think are the biggest challenges to developing software for use in traditionally marginalized communities?

Are you aware of any promising solutions or approaches to narrowing the digital divide?

We know that COVID has really pushed the digital health space along more rapidly as well as highlighted the growing health and digital divide between different populations. Do you think

that innovators such as yourself in the digital health space will be able to start to close that gap or do you see that gap growing larger? Why?

Thank you for your time and help. Is there anything else you would like to add before we end this conversation?

MPH Competencies

Competency	ILEX paper and presentation
Evidence-based Approaches to Public Health	
2. Select quantitative and qualitative data collection methods appropriate for a given public health context	Determined survey questions for quantitative data collection and conducted semi-structured interview for qualitative data collection
4. Interpret results of data analysis for public health research, policy and practice	Analysis of results yields important insight and helps guide future framework development and policy recommendations
Public Care and Health Systems	
6. Discuss the means by which structural bias, social inequities and racism undermine health and create challenges to achieving health equity at organizational, community and societal levels	Worked to understand the ways in which elements of application design and accessibility can present challenges for digital health equity for individuals and communities
Policy in Public Health	
13. Propose strategies to identify stakeholders and build coalitions and partnerships for influencing public health outcomes	Described non-profit organizations and other stakeholders which are creating opportunities to build frameworks and partnerships through fellowships, competition and marketplaces
Communication	
19. Communicate audience-appropriate public health content, both in writing and through oral presentation	Completed ILEX research paper and created PowerPoint to be shared at Health Professions Day
Community and Public Health Practice	
1. Apply qualitative methods to assess community assets for addressing public health and environmental issues	Conducted qualitative semi-structured interviews to determine companies' attitudes and actions around digital health equity
3. Develop a research project proposal using mixed methods to address a public health problem	Developed and conducted a pilot mixed-methods research project to better understand digital health companies and their efforts around health equity