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Understanding Health Researchers’ Perception and Use of Human-Centered Design

THESIS

submitted in partial satisfaction of the requirements
for the degree of

MASTER OF SCIENCE

in Informatics

by

Sharmaine Galvez Poblete

Thesis Committee:
Assistant Professor Elena Agapie, Chair
Professor Madhu Reddy
Professor Kai Zheng

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ABSTRACT OF THE THESIS

Understanding Health Researchers' Perception and Use of Human-Centered Design

by

Sharmaine Galvez Poblete

Master of Science in Informatics

University of California, Irvine 2022

Assistant Professor Elena Agapie, Chair

Health researchers are increasingly using human-centered design methods in order to design usable health technologies and interventions. However, there is little research done about how design is used by Health researchers as well as what challenges Health researchers face when employing design methods and approaches in their work. In addition, conducting multidisciplinary research can be challenging because HCD and Health researchers might value different research outcomes, or might not know how to value each other's research methods. While prior work documents HCD researchers' perspectives, little is known from the Health researchers' perspectives. In this thesis, I investigate multiple Health researchers' lived experiences with using design methods: how Health researchers perceive design, what challenges they face when using design, and what challenges they face when collaborating with HCD researchers. I conducted semi-structured interviews with 16 Health researchers who self-identified as having used design methods and worked alongside a design collaborator. I found that Health researchers felt that incorporating user feedback was an integral part of their technology design process; they had difficulty understanding how to implement design approaches and incorporating design into their project timelines; and they had miscommunications with their collaborators due to a lack of shared language. I propose ways in which individuals, universities, funding agencies, and research communities can better support collaborations and the use of design methods by HCD and Health researchers.

INTRODUCTION

The goal of Human-centered design (or HCD) research is to understand how people engage with technologies and interventions as well as how to improve those interactions (Kasdaglis, 2016). Technology has been playing an important role in society, and it has especially been playing a large role in supporting people's health needs. This support can include self-tracking apps (Consolvo, 2014; Niess, 2018; Li, 2010; Williams, 2020), online peer communities for mental health support (Pina, 2017; Newman, 2011), health information portals (Sakaguchi-Tang, 2019; Thayer, 2021), and more. Because of this, HCD has been increasingly applied to the development of Health technologies, which can help in making these interventions and technologies more usable. This has led to an increase of Health and HCD researchers working in collaborations. These types of multidisciplinary collaborations between HCD and Health have gained increasing support through U.S. public funding agencies, such as NSF and NIH, which have funded almost 500 projects involving human-centered design approaches (NIH; NSF). Within human-centered design, there are a couple of methods that are characteristic of the field, such as participatory design, co-design activities, prototyping and iterative design, etc. The typical process can look like the following: conducting a needs assessment to understand end users' needs, turning those needs into design ideas, developing a low fidelity prototype, evaluating the prototype with stakeholders, iterating the prototype based on stakeholder feedback, and then repeated evaluations and iterations until a satisfactory design has been reached (IDEO;

Norman, 1986). By including stakeholders in the process, it allows for the intervention to be more easily adapted and usable to those end users.

However, the value, or even the knowledge of HCD methods, are not always visible to the eyes of Health researchers because each field prioritizes their own expertise and prioritizes different outcomes (Blandford, 2018a; Blandford, 2018b). In addition, having a loose understanding of what design entails can create challenges when Health researchers apply these methods to their work. The challenges that surface in collaborations at the intersection of Health and HCD include getting incorrect clinical or user context for the projects, not properly understanding user needs, not designing the proper solution, and not accurately evaluating the innovation (Buis, 2020). Thus, Health researchers might develop technologies without keeping in mind the needs of their end users (Williams, 2020). However, these challenges are interpreted and understood through a Human-centered design researcher's perspectives and misses those of Health researchers.

To understand this gap of how design is being used in developing Health technologies, I investigated the following research questions:

- How do Health researchers perceive design and design methods?
- What challenges do Health researchers face when implementing design methods and approaches in their work?
- What challenges do Health researchers face when collaborating alongside HCD researchers to develop Health technologies?

I, along with the research team, interviewed 16 Health researchers who self-identified as using human-centered design approaches and worked alongside a design collaborator in health and technology projects. Our participant sample included Health researchers who worked at R1 universities in the United States and had a wide range of expertise in design work.

Through an empirical study of semi-structured interviews with Health researchers, I found that Health researchers had varied understandings of what design entails. Most Health researchers felt that gaining and incorporating user feedback played an important role in their design process. In addition, they also saw design work as a variety of other tasks, such as proofreading texts, deciding what features are included in the intervention, as well as the aesthetics of the final product. I also found that although Health researchers were able to learn and use design methods through resources and their collaborators, they still struggled with their understanding of how to implement those design methods. Health researchers also encountered challenges with their collaborators due to a lack of shared language as well as a disconnect between their expectations and goals of each other and from the project.

The main contributions of this work are the following:

- An empirical understanding of the complexities and challenges that Health researchers face when incorporating design in their work and working alongside design collaborators
- Suggestions and implications for supporting and improving the successes of multidisciplinary research between HCD and Health, which include recommendations for funding agencies, universities, research communities, individual researchers, as well as the development of resources and toolkits

CHAPTER 1: Background & Literature

1.1 Multidisciplinary Collaborations

In multidisciplinary research, team members of different disciplines work towards solving a common research problem by bringing together their unique and discipline-specific perspectives (Team Science Toolkit). These multidisciplinary teams are important because having individuals with a wide range of expertise can improve and maximize team decisions and actions, which can encompass a wider perspective of the issues surrounding the problem (Jackson, 1995; Zakarian, 1999). However, success within multidisciplinary collaborations is heavily influenced by the ability to integrate diverse expertise, knowledge, and perspectives and it can be difficult to do so. Based on different understandings from organizational science to information systems and software engineering, Balakrishnan & Kiesler et al introduced research integration and defined it as *"the extent to which a research team combines its distinct expertise and work into a unified whole"* (Balakrishnan, 2011). In addition, Team Science focuses on understanding and improving the strategies that facilitate successful collaboration between team members (National Research Council, 2015; Stokols, 2008).

Within work done in research integration and team science, there are many elements that can discourage multidisciplinary collaborations, such as deep integration of knowledge and skills (Balakrishnan, 2011; Blandford, 2018b; Knorr-Cetina, 1999), goal misalignment with other team members (Cash, 2003; Hall, 2012), permeable team and group boundaries (Cash, 2003) as well as working in collaborations across long distances

(National Research Council, 2015; Olson, 2000; Olson, 2013). Multidisciplinary teams are able to successfully integrate knowledge by maintaining a strong focus towards project goals, engaging in integration techniques, and having strong leadership (Balakrishnan, 2011; National Research Council, 2015). Salazar et al contribute to the concept of research integration and argue that teams are able to achieve successful integration if they are able to continuously engage with social, psychological, and cognitive processes (Salazar, 2012). Although there are toolkits to promote communication between team members (Team Science Toolkit; Team Science Initiative), there may be further challenges that arise when being utilized specifically by Health and HCD researchers.

Infrastructural differences can also create barriers to achieving research integration. Although there are incentives that promote multidisciplinary collaborations (Toubia, 2006; National Research Council, 2015), team members may have difficulty in exploring creative work and other aspects of their projects because they are navigating organizational structures that surround their work (Adler, 2011), such as differences in university practices and professional development opportunities (National Research Council, 2015). For example, grant proposal requirements influenced the assembly of teams because they prioritized having diverse expertise on the project, but it also led to a series of factors that worked against research integration. These factors included working alongside collaborators they lacked chemistry with, experiencing competitiveness in joining multidisciplinary teams, and prioritizing lead PI's ideas over others (Balakrishnan, 2011).

Although there is research highlighting the challenges of working in multidisciplinary collaborations of various fields, it is important to understand how these challenges apply to Health researchers when working in collaboration with design researchers and how to better support them

1.2 Challenges of Using Human-Centered Design in Health Research

Because HCD is applicable to many domains, it has been increasingly applied across various fields, including the health domain. Within the health field, HCD approaches have been used to develop technologies that address many problems. However, multidisciplinary teams of HCD and Health researchers may face challenges when incorporating design methods into Health technology projects and these challenges are typically presented through the lens and personal experiences of HCD researchers. The known challenges of using HCD in Health research and in these HCD-Health collaborations manifest through the differences in methodological approaches (Buis, 2020; Blandford, 2018b) as well as differences in expected outcomes between collaborators (Buis, 2020).

According to Blandford, the value of HCD methods is not always visible to the eyes of Health researchers because of the "focus on clinicians' expertise in defining requirements for and evaluating interventions" (Blandford, 2018a). Health research has more focus on summative evaluation (overall efficacy at the end of evaluation) whereas HCD research focuses on formative evaluation (conducted during the development process). The contrasting cultures of both the Health and HCD field may make these interdisciplinary collaborations challenging, which contributes to the development of non-user-friendly technologies (Blandford, 2018b). Health researchers may prioritize seeing clinical impact, which influences the way in which they design and develop technologies. Nunes et. al highlights that many studies about the development of self-care technologies have a larger focus on the medical perspective, and the methods and approaches used in the process are strongly rooted in the biomedical sciences (Nunes, 2015), and thus have a stronger emphasis on seeing the behavioral change outcomes. For example, when reviewing technologies for chronic disease management, many Health researchers emphasize the analysis of a health impact (El-Gayar, 2013; Hesse, 2010) and neglect to address any evaluation of how it impacted the users' everyday life (Koch, 2006). In addition, Health researchers may seek to conduct evaluations on more well-established technologies, such as text messaging, whereas HCD researchers might focus on smaller-scale studies that prioritize innovation and prototypes (Mamykina, 2021; Blandford, 2018b). These differences in expected research outcomes suggest that there is a need to balance and reach a compromise between both the Health and HCD perspectives in multidisciplinary collaborations.

Implementing design when developing Health technologies can also lead to methodological challenges. Some challenges that surfaced in literature include the following: not getting the correct user context for the innovation, not properly identifying user needs, not designing the correct solution, and not accurately evaluating the innovation (Buis, 2020). In addition, emphasizing user needs can lead to developing more complex and ambitious designs, which may not be compatible with the Health context or may be difficult to evaluate (Mamykina, 2021). Researchers have also had to navigate conducting research in clinical settings, which can lead to more tensions in the collaboration, such as difficulty in navigating hospital infrastructure (Aggarwal, 2020 ; Blandford, 2015) and insufficient designs due to constrained time with the target users (Buis, 2020; Williams, 2020). This can cause researchers to adapt their traditional methods in order to do work in health settings (Mitchell, 2021). As a result, Health researchers and research teams may develop technologies without keeping in mind the user needs, resulting in an end product that is not relevant or useful to its target audience (Williams, 2020).

There are many benefits to including HCD approaches in the development of digital health interventions, which include improving interaction outcomes and having longer-term effects on individuals' health (Smith, 2014). Although it may be acknowledged that it is beneficial to integrate HCD in interdisciplinary collaborations, there is little work that describes how to do so. Researchers have retrospectively reflected on the outcomes of studies and how it would have benefitted from using an HCD approach, such as understanding how users interacted with certain systems and why existing technology failed in real-world settings as well (Williams, 2020; Poole, 2013).

These challenges have been evaluated through an HCD researcher lens (Aggarwal, 2020; Blandford, 2015) and are based on the personal experiences, challenges, and frustrations of HCD researchers doing Health research (Blandford, 2018; Buis, 2020). Thus, it is important to empirically gather information and develop an understanding of what Health researchers identify as challenges, if any.

1.3 What is Design/Human-Centered Design?

The activity of design entails having to develop solutions to the different problems at hand (Cross, 2021). Human-centered design (also known HCD) research focuses on how humans engage with technology as well as how to improve those experiences (Kasdaglis, 2016). Thus, it is most commonly used for the development and evaluation of digital technologies and interventions (Altman, 2018; Schroeder, 2018). The HCD process is typically described as a multistep and iterative process that involves understanding user needs, developing prototypes, and adapting those designs based on user feedback. Furthermore, the evaluation and iteration steps involve multiple repetitions, which can result in a more usable and unique solution (Norman, 1986). Figure 2.1 describes an overview of the design process, pulled from Norman (2013) and IDEO Design Kit (2016). Involving the end users in this procedure to improve overall usability and user experience is key to conducting HCD research (Hartson, 1998; Kasdaglis, 2016; Lyon, 2020). By improving usability, this ensures that the technologies or interventions being designed will actually address user needs and be easily adopted by the target audience (Kasdaglis, 2016). Moreover, applying HCD principles can lead to more opportunities for improving and sustaining the use of these interventions and technologies. **For the purposes of this study, I will be defining human-centered design as the development of technologies that focus on how humans interact with those technologies as well as developing technologies based on their needs.**

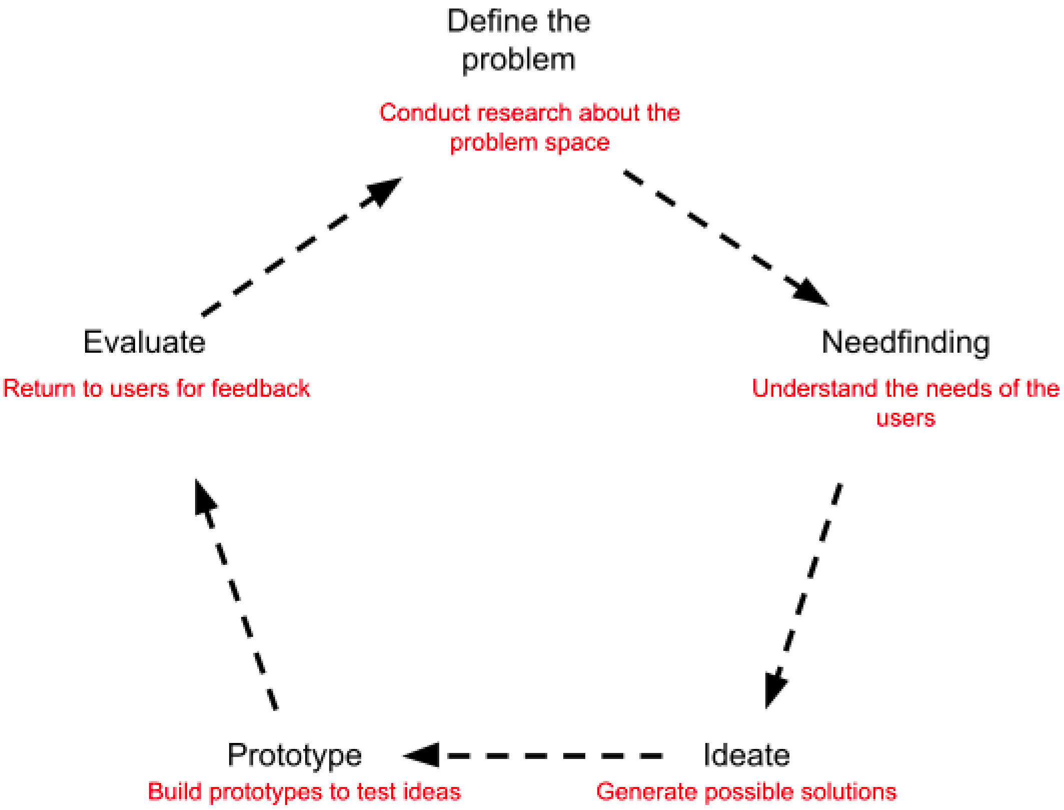

Figure 1.1 Design Process pulled from Norman (2013) & IDEO

CHAPTER 2: Methods

To understand Health researchers' perspectives on human-centered design and using design methods in their research, I conducted semi-structured interviews with Health researchers who self-identified as having used human centered design approaches (user centered, participatory design, etc.) and worked alongside a design collaborator in health technology projects. After completing the interviews, I used deductive and thematic analysis to analyze the interview data. This study was approved by the University of California, Irvine Institutional Research Board.

2.1 Interview Procedure

I worked with my advisor to develop an interview protocol that helped us gain a deeper understanding of Health researchers' perspectives of human-centered design as well as what challenges they face when using design in their work as well as when collaborating with HCD researchers. We began the protocol with 3 overarching research questions and expanded upon them with further scoped questions:

- How do Health researchers perceive design and design methods?
- What challenges do Health researchers face when implementing design methods and approaches in their work?
- What challenges do Health researchers face when collaborating alongside HCD researchers to develop Health technologies?

However, as we began interviewing more participants, we adjusted the protocol to gather more information on interesting topics that surfaced in interviews. The interview protocol included questions about the Health researchers' experience working on health technology projects, such as what design work they were involved in, what challenges/benefits they had when using design methods, as well as overall takeaways from their projects. I was particularly interested in how Health researchers engaged in specific design methods and how it affected their work, if it did. The interview introduction statement and the interview protocol have been through several iterations over the course of the study, but a final copy has been included in Appendix A and Appendix B.

All interviews were conducted remotely using Zoom. A maximum of two researchers were present for each interview, with one primarily conducting the interview and the other asking additional probing questions and taking notes. The interviews typically lasted between 30 to 60 minutes. With the permission from the participants, the audio was recorded on Zoom, auto-transcribed using Otter.ai, and manually revised to correct any transcription errors. Each participant was offered compensation of a $30 Amazon gift card for their time.

2.2 Eligibility and Recruitment

We interviewed self-identified health researchers that fulfilled the following qualifications: 1) over the age of 18; 2) currently working or living in the US; and 3) were involved in technology projects that involved both health and technology or design researchers. We recruited participants by reaching out to eligible researchers from CHI conference proceedings from the last 3 years (2019-2021), who had previously published a health related paper involving human-centered design methods as well as participants who used human-centered design as part of the work that they do. In addition, we recruited through email addresses available on public domains (e.g. university directories and online CVs) with information about the objective of the study and what participation in the study entails. However, not many participants were responsive to cold emails and invitations to the study. Thus, we were able to recruit participants through personal connections with centers that used design as well as through snowball sampling. Participants were able to self-evaluate their eligibility through a pre-interview survey that was distributed in the initial invitation email. We were particularly focused on United States-based researchers because of its unique university and healthcare infrastructure, which entails its own challenges from those of other countries.

2.3 Anonymization

Because our study focuses on Health researchers who work at the intersection of HCD and Health, I went through several steps to anonymize and protect the identities of the participants. Many participants revealed very specific aspects of their project as well as names of their collaborators and affiliated institutions. Thus, when preparing interview transcripts for data analysis, I excluded any identifying information, such as names, previous professional roles, institutions, and any other potentially identifiable details. In addition, participant backgrounds as well as findings are presented at an aggregate level to prevent the risk of deanonymization. Participants are referred to as their participant ID (H1, H2, H3, etc.) and participant IDs are not included in the participant backgrounds because it could lead to identifying participants.

2.4 Participant Background

The study included 16 Health researchers, which included 1 Postdoctoral Fellow who had previously held an adjunct position, 9 Assistant Professors, 3 Associate Professors, and 3 Professors. In addition, the participants were associated with 9 different institutions; 15 participants were from R1 universities with a medical school and 1 participant was from an R1 university without a medical school. Participants self-identified as only a behavioral/clinical health researcher (11 participants); a behavioral/clinical health and technology researcher (4 participants); or a behavioral/clinical health, technology, and design researcher (1 participants). All participants hold a degree in behavioral/clinical health while their experience with technology and design varies; 1 participant holds a degree with a design focus, 1 participant holds a degree with a technology focus, 1 participant holds a graduate degree with a technology and a design focus, and others have gained their knowledge through classes, workshops, previous collaborations or are self-taught. In addition, 5 participants were able to gain design knowledge through research awards, such as K or Career Development awards.

At the time of the interview, the sample had participated in a range of technology projects that involved both clinical and design processes; 11 participants had been involved in 5 or less projects. In addition, participants had been conducting research in design/technology contexts for over a range of years (4 participants had been working in these types of projects for 1-3 years, 2 participants for 4-5 years, 7 participants for 5-10 years, and 3 participants for 10+ years). Participants also self-reported that their work involved cross-disciplinary collaborations with technology/design researchers 0-20% of their time (1 participants), 40-60% of their time (1 participant), 60-80% of their time (7 participants), and 80-100% of their time (7 participants).

Participants were between the ages of 33 and 52 (median = 38, mean = 40) and included self-identified women (8 participants) and men (8 participants). In addition, our sample consisted of Caucasian (13), Asian (2) and Caucasian/Hispanic (1) participants. Participants have expertise in clinical psychology, digital health and mental health interventions, nursing, obstetrics, pediatrics oncology and hematology, behavioral sciences, and human nutrition. They were involved in a variety of projects that focused on creating and delivering digital and mobile application interventions for managing and assisting in behavioral, chronic, and mental health conditions. These projects involved a wide range of populations, such as youth and adults with chronic conditions as well as their families, youth and adults with mental health conditions, pregnant and postpartum women, underserved youth, and fellow clinicians. These projects were conducted in settings such as hospitals, community settings/libraries, and universities.

2.5 Data Analysis

I performed deductive and thematic analysis to analyze the interview data. After conducting the interviews, I drafted memos and noted the important themes that emerged. Beginning with a deductive approach, my advisor and I developed initial codes about the types of challenges that Health researchers face when conducting design methods. Once the interviews were auto-transcribed, my advisor and I independently coded through two interviews and talked through our thought process and reasoning together. We were then able to create a preliminary codebook, in which we used to independently code a new set of transcripts. As we coded through more interviews, we discussed coding patterns, revised the codebook to address any discrepancies, and applied the codebook to all the interviews. My advisor and I met several times per week to discuss and revise themes. The following are examples of codes that emerged through thematic analysis: dividing work based on expertise, misalignment of expectations and perspectives, seeing value of design methods, center health researcher perspective, and more.

2.6 Positionality of Author

I am not an expert in human-centered design or multidisciplinary collaborations so I am looking at this data through a junior researcher lens and providing a newcomer perspective to the findings. In addition, coming from a human-centered design background, my lens on this discipline may affect the way in which I weigh the value of HCD design methods.

CHAPTER 3: Results

3.1 How do Health Researchers Perceive Design?

Through experience and seeing design first hand, Health researchers found that it added more valuable insights to inform their decisions when designing technologies and interventions. They also had different views of what they perceived as design: many Health researchers felt that gaining and incorporating feedback played a large role in their overall process, but they also saw design as other tasks, such as focusing on the aesthetic and appearance of the end product, proofreading the presented information on their intervention, and more. As a result, this influenced how Health researchers thought of their own roles, which include self-identifying as the designer of the project. In addition, Health researchers were able to gain design knowledge through available resources as well as collaborators who served in mentorship roles. However, even with these kinds of support, they still struggled with using design methods in their work.

3.1.1 How Health Researchers Define Design and Design Work

Several Health researchers found that an important aspect of design work is incorporating user input and iterating feedback into their product (H1, H2, H6, H8, H9, H11, H12, H14, H15). They begin to understand their target users' problem by looking into what technologies are already available for their target population and thus, providing a starting point to their evaluation (H1). Then, they gain more insights about their target population's problems from initial feedback groups, codesign workshops, focus groups, in which they will make adjustments to their intervention/technology and conduct usability testing (H1, H8, H11). Although they did not have extensive knowledge about design work, they found that this information from end users played a large role in designing impactful technologies for their target audience: *"from my very quaint understanding, I would say a lot of it is implementing user preferences and needs, while also… ensuring that you have a balance of evidence based things as well, in terms of… the participants."* (H6). In addition, some Health researchers also saw design as making the intervention easy to understand and navigate for their target audience, such as getting through the tool without many instructions (H10): *"I think… even just the sort of icons or the figures that represent what the researcher is trying to get across. It may not even be text, right? Just images. Are they understandable images?... Is it very easily navigatable [sic] for a patient or a family caregiver?... Can you figure it out without much instruction, right?"* Along similar lines, participant H14 described design as how to make things more usable: *"I guess if I think about design, it's how things are made or more how things are made functional. So you can make something, right? But it might not work, it might not serve the purpose… How do you make things that accomplish goals, but that are also functional?"*

On the other hand, some Health researchers also understood design as other tasks separate from incorporating user feedback. Their design work on their respective projects included proofreading texts, deciding what content presented on intervention screens of the end product, the aesthetics of user interface as well as the organization of the behavioral intervention (H3, H7, H10, H14, H16). Participant H7 understood design as having multiple components: *"when we think about design, there's lots of different ways to* *think about what design means… there's the aesthetics of things, there's the organization of things, there's just kind of design is just thinking about it from a process perspective. It's not necessarily even some physical artifact that you create. …when I think of design, I think of all those things."* When deciding on what is presented on their intervention screens, some Health researchers saw their design task as simplifying the flow as much as possible as well as reducing the amount of content/colors/information on every screen (H3): *"My role was often to reduce all of the ideas by 85% on a per screen basis… I saw it as my job to impart, to simplify that by a great deal and also to simplify the flow as much as possible. It's important to me that users feel like… there's a consistent look and feel, and buttons are in a similar place throughout and things don't get moved around or complicated."* Participant H16 described design as a variety of things that help the end product in user engagement: *"When you say design, I think of user interface, images, recruitment materials are things that are attractive to lead people to show interest and engagement. Maybe user process for flow to an experience."*

3.1.1.1 Who Does Design Work?

Although Health researchers identified themselves as doing design tasks, they did not identify as the designer of the project (H1, H4, H5, H8, H13). For example, Health researchers (H1, H8) stated that they were responsible for the majority of the design work, such as evaluating user feedback, incorporating that feedback into the design, and creating the implementation plans and study protocols. However, they referenced the designer as the individual who was responsible for developing the prototype or wireframes as well as managing the design of the application: *"When I'm talking about the designer, I'm talking about the app design itself… like, he developed the higher fidelity designs to hand off to the developer within the company to program itself"* (H1).

Because participant H7 is also a clinician, they are aware of the problems of their target population that need to be addressed in the projects they are working on, in which they use to guide in how they involve clinicians in the process. They found that there were challenges in being both a designer and a user: *"Now, work that I do for clinicians, it's a little bit harder because I am a user. And so… there may be less of that because I understand what our needs are, but because I am my target audience, but I will still kind of involve clinicians, kind of helping us to kind of decide when we're working on our projects…"*

3.1.2 The Importance of Design Work

Health researchers felt that design work was integral to their overall process (H1, H7, H12). Participant H1 said that it was difficult to distinguish between their typical research process and the design process: *"it's hard to tell, like, which things… which things from design are informing my thinking versus this is just the way that the groups that I'm part of think now."* Participant H7 also reported that their work incorporates design practices *"in the sense that anything that I'm doing… needs to be designed."* When speaking about design, they made a distinction that they were referring to user centered design work: *"that's key to everything that I do"* (H7). Participant H12 also explained that they typically worked alongside design researchers: *"Working with design researchers is part of my typical process."*

Health researchers were also able to see the importance of design work by having mentors guide them in using design as well as experiencing first hand the benefits of using design in their work, such as collecting more valuable and informative data, evaluating and implementing prototypes, and more (H2, H5). When designing Health technologies and interventions, it is common for them to not get translated into practice: *"So a lot of interventions just die in the laboratory and never get into places, but then also to the hands of folks that need it. And so it kind of started with that of how do we make a tool that can be implemented?"* (H5). By using design methods, they were able to navigate how to get these technologies and interventions past the prototyping stage and into the dissemination stages of the end product to reach their end users: "*To me, user centered design is so impactful… this idea of… if you do it right early on… you will most likely save a ton more work and redesign later… If you don't do… the right steps up front, you're likely having to change a lot later. And that costs money"* (H2).

Health researchers acknowledged how using design opened their eyes to the different implications or ideas that can be concluded from the qualitative data that was collected (H2, H3, H10). For example, participant H2 stated that they had not realized how rich the data would be from using HCD: *"Turns out, that data has been more rich than I even expected it to be… it's been really rich, in terms of, sort of, how I could think about how people might want to think about behavior change, get started with an intervention, and sort of the implications for the app. It's been really impactful."* Participant H10 felt that their design collaborator brought valuable insights and contributions to the project: *"it totally brought* *new insights, things I don't even think about because they're not my area of expertise. No, I don't think it impacted the timeline, if anything, was only added value."*

After conducting design work, some Health researchers found it surprising how much it contributed to their work and how much their clinical expertise and design complimented each other: *"I was surprised about… how much better the science was altogether by, kind of, combining our efforts and our tools"* (H5). In addition, they learned about how important it was to focus on the users and include them in the process, and they even felt that it may be more important than focusing on the outcomes of improving anxiety or depression symptoms: *"I think what I've learned now is just how important focusing on the user is… including them throughout the process and how that's as, if not, more important than the outcomes that we receive"* (H5). Participant H8 also thought that involving users and stakeholders was important in building technologies that were meant to serve those users: *"It really comes down to if nobody is involved in the process, you may develop the greatest app… but nobody's gonna really use it because it just doesn't address the needs that users really have."*

Participant H7 also stated that they have seen unsuccessful projects because they have clinicians develop tools based on what they perceived would be helpful rather than involving users throughout the process: *"And I've seen so many failures, or what I view as a failure, because you have clinicians trying to develop something that was done in a haphazard or not in a, in a rigorous way, or didn't really involve people, but they're like, 'Oh, yeah, well, we got to solve this problem,' but didn't use good design principles and theories and methods to do it."*

3.2 How Health Researchers Collaborate with Design Researchers

Participants had a variety of reasons for wanting to include a design collaborator on their projects, which included not having the knowledge to conduct design methods, seeking insights to improve the design of their projects, and more. There were also various ways in which participants were able to find potential collaborators: training programs/mentorship, proximity to other researchers, social connections, and funding grants. In addition, participants had a variety of criteria when assessing potential participants, which include being open-minded to the proposed methods, having similar interests, showing dependability, and evaluating benefits for all involved team members.

3.2.1 Motivation for Starting Collaborations with Design Researchers

Health researchers who did not have formal training in HCD (H7, H10, H11, H12, H13, H15) voiced that their motivation for bringing in a design collaborator was to fill in the gaps of their knowledge and further improve the design of their projects. These gaps include improving the appearance and deployment of apps (H6), providing feedback from a more design perspective (H1, H7, H13, H15), not having a grasp in the engineering field (H9), or simply not being able to do this work on their own (H2, H10). Health researchers found that even after reading the surrounding literature and speaking with design researchers, they still did not know how to integrate design methods in their work. It was essential to *"bring people in so that I could… do the job well because if I tried to do it completely from a clinical side, kind of, perspective, there's a lot of stuff that gets lost"* (H1). By having a design collaborator on the team, Health researchers were able to get direct feedback about the design of the product and what would work best so that the end product would actually be usable: *"They always came up with something that was like, 'Oh, this doesn't look right… this doesn't fit here…. And when a user does this… it doesn't make any sense. Like the flow doesn't make any sense.' So there was, there was always something that was like, 'Yeah, that's a really good point'"* (H13).

In addition, although they were able to learn about design methods, Health researchers felt that it was still important to include a design collaborator because they were able to catch specific details that the Health researcher would have missed if they had done the job on their own (H1, H7, H9, H10, H13). For example, participant H7 said that *"I couldn't necessarily articulate all of the steps that are required to do something. I would just do them, and I might miss something."* Participant H13 stated that they expected this kind of expertise from their design collaborators: *"That's what I expected from design folks and design researchers… is that they're going to have this keen eye that I don't have, you know, that they're going to catch things that I would never catch."* Participant H10 acknowledged that they needed assistance from a design collaborator: *"... I knew I wouldn't be able to do it on my own… And so this type of work requires a lot of really knowledgeable team members."*

Other health researchers felt that they had no idea how to conduct qualitative research or analyses and actively looked for collaborators that could provide that assistance (H1, H2). Participant H2 said that their motivation for bringing in a design collaborator was *"I knew I needed to do this, and I had no clue how. So I truly had not done qualitative analysis, I had not designed interview guides, I hadn't thought about, not just like how to do the qualitative analysis, but truly how to synthesize something into design decisions."* Health researchers also had past projects that made them aware of gaps that they sought to address in their future projects. For example, participant H1 had conducted a past project in which they switched the delivery of their intervention from face-to-face to video. However, there were many aspects that they had missed because they had not tested it with users and thought through the different nuances that could happen due to that switch: *"I think the teams that I work on now take a little bit more time to think through, like, where are the gaps from my discipline that are going to get in the way of something being helpful for real people?"* (H1).

Along with discussing their motivations behind seeking out a design collaborator, Health researchers noted their thought process when deciding to bring them into a collaboration as well as adding value to the project that would benefit their collaborators. Health researchers were particularly interested in making the collaboration fruitful for all parties involved (H5, H7, H12, H13). Participant H7 highlighted that they wanted to make sure everyone on the project is able to gain something that would further their career or research field: *"But we are working together… in an attempt to generate knowledge for both of our fields so that we're both getting some type of benefit out of it, or we're helping advance the knowledge and both of our respective fields."* However, participant H7 stated, *"I don't think you should prioritize the design impact over a clinical impact if you're working in a clinical area"* as well as vice versa; there needs to be more background knowledge based on the side that you are working to make an impact in. Participant H12 also emphasized how they are trying to add value for the different members of the collaboration: *"I often want there to be a design research question… we both need to have research questions that… make* *this project interesting for the disciplinary lenses we're approaching this from. It needs to be… mutually interesting and mutually beneficial."* Participant H13 would ask their collaborators about their needs from the project: *"I would be upfront with people [in the] design space; what you want, what you need… what are the things that they can get out of the collaboration because obviously, they need to get something out of it."*

3.2.2 Finding Design Collaborations

Some Health researchers had an easier time finding collaborators because it had been part of their training programs and career development awards (H1, H2, H3, H4, H5, H9). These types of infrastructural support has allowed Health researchers to meet and work alongside other researchers working in similar fields. For example, participant H5 stated that their award focuses on bringing "*behavioral scientists together and human computer interaction scientists together for digital mental health… and there's a huge focus on user centered design."* While their training provided a space to learn these methods, some Health researchers in these training programs still needed to bring in design collaborators because they found gaps in their own knowledge about navigating design methods in their work (H1, H4). Participant H1 said *"I needed to bring people in so that I could, like, quote unquote, do the job well because if I tried to do it completely from a clinical side kind of perspective, there's a lot of stuff that gets lost."*

Health researchers were also able to find collaborators due to being in close proximity to other researchers who wanted to conduct similar research projects (H2, H6). Because they came from a center that promoted health and design collaborations, participant H2 stated that *"there's a lot of folks… a handful of those in our center that we go to… each other about, like how do we do this in our sphere, so to speak… There's been a few different postdocs come through the lab… that I've engaged with so far, you know, like we collaborate in that way."* In addition, some Health researchers worked at smaller institutions that had a culture in which they felt comfortable to reach out to others: *"We're smaller, so it's much easier to reach across the aisle to find collaborators… just the culture of the institution… they are willing to go the extra mile, like everyone I've been able to talk with"* (H6).

Another way in which Health researchers found collaborators was through networking with other researchers as well as through their social connections, such as peers or friends of another colleague (H8, H11, H13, H16). When building their project teams and before they had started any work on the project, they looked for individuals who were able to provide missing expertise to the research question and talked to colleagues who they could potentially work with them. In some cases, the first person they would talk to would agree to work on the project: *"I randomly met the guy in a conference call… and it was a random breakfast chat, and then that ended up being the first person who ended up developing the app for me, the first kind of prototype"* (H8). Health researchers were also able to find their collaborators through their social connections, such as being introduced through common friends (H13, H16): *"We met through a mutual friend and colleague… there was a pilot grant opportunity… I think that helps spur the collaboration."* On the other hand, if their colleagues did not have the capacity to work on those projects, they were happy to connect them to another colleague who had similar research interests: *"And we* *found him by, you know, talking with a faculty member in Informatics department that had previously worked with us, but didn't have the bandwidth to sort of take on take on the project"* (H11). Participant H11 talked about how asking around for potential collaborators played a big role in finding those collaborators: *"whether it's that person or whether they recommend a postdoc… that's a big one is honestly just word of mouth and networking to bring people together and bring ideas together."*

There were funding opportunities that impacted how Health researchers cultivated their collaborations (H1, H2, H5). On one hand, there were certain grants that specifically gave health researchers the opportunity to build and develop a partnership with their collaborators and stakeholders. For example, participant H5 received a pilot grant from their university that allowed them to cultivate a deeper relationship with their partners: *"I'm hoping it can be like this in all grants, but it was really neat just to take a whole year of just getting to know… the community, getting to know their needs, valuing them as equal partners in this."* On the other hand, there were also certain financial structures that influenced the formation of different collaborations. Based on their experiences, participant H1 said that *"it is unfortunately common in the medical school environment that I'm in for people to learn about a great grant funding opportunity and then really kind of scramble over a couple of month period to write the grant for that grant opportunity and are trying to find people to like fill in the plugins of like here's expertise in this field here is expertise in this field. Because of financial structures, it impacts who is included in the grant."* In addition, some Health researchers explicitly stated that they are responsible for finding sources of funding (H6, H9). Because they are not on tenure track, participant H9 explained that they had to find projects that will cover part of their salary. Thus, they come into projects with clear goals and intentions as well as who is dependable rather than jumping into a collaboration without thinking of the outcomes and feasibility of the project: *"So I think that's… a very huge barrier, which is that I have to bring my own funding. I'm not in a tenure track position… So people in my position, you know, we have to rely on the next project [that] is going to fund the cover part of our salary… So the idea of collaborating without a clear sense of ways… taking into a brand new grant proposal, it's kind of hard to conceive that"* (H9).

There was a unique case in which one Health researcher was able to easily find and work with their design collaborators on different projects. Depending on their mutual interests as well as their capacity, participant H10 found that most of the people that reached out to work on a potential project shared a similar value system, which allowed them to align their goals for the outcome of the project (H10). Participant H10 said, *"I've been fortunate that it's been folks who have reached out to say, 'Hi I'm interested in this and I see you're working on this,' or 'I read your paper on this and I'm interested'... a lot of the times that folks have reached out to me, I have pretty much been willing to work with them."*

However, not all encounters with potential collaborators are successful. There were instances in which Health researchers did not necessarily agree with what their potential collaborators thought or the ideas that they brought to the table (H4). For example, participant H4 had originally intended to work with researchers from their institution's School of Art for help with the design process of their app, but they found that there was a missed understanding, and they did not feel the need to change their minds or continue pursuing a collaboration with them: *"We had a meeting… they're not HCI, they're mostly all* *graphic design… they were just like, 'Why can't they just use their phones differently instead of making a whole new app?' and I was like, 'Right, so I'm not doing that, so nevermind.'"*

3.2.3 Criteria for Potential Design Collaborators

When discussing their criteria for searching for potential collaborators, Health researchers wanted to work with other researchers who were open-minded and embraced both fields involved in the collaboration (H2, H5, H7). They found that their collaborations were most successful when collaborators were open to learning more about the other and not remain siloed in their own discipline. When reflecting on their past collaborations, participant H2 said that *"I think a collaboration was most successful with both parties… they really see the value of the clinical side and recognize what each collaborator is bringing to the table. And when it was just too siloed… well, that's not what I do. That's problematic."* Participant H5 has also seen that when working in academia, it is important to breaking the power dynamic of only valuing one discipline over another: *"I think that's where I've kind of witnessed, it is an unwillingness to hear other viewpoints or an unwillingness to understand the importance of multiple- of collaborating across disciplines."* In addition, Health researchers voiced how they enjoyed collaborations in which they were able to truly work alongside their collaborators and communicate back and forth throughout the project (H2, H5). For example, participant H5 said that their current collaboration has been *"really beautiful, our partnership… I'm able just to talk about these things with my partners, that we can kind of brainstorm it out together."* Participant H2 stated that they were able to get more out of the collaboration *"when I engage people who were able to more quickly communicate* *about stuff and like more, sort of go back and forth on the ideas… And so like, when as a team, you're sort of really working in tandem regularly."*

Health researchers also wanted their collaborators to be enthusiastic about the work they were doing and that their research expectations align (H4, H13). Participant H4 discussed that it was important for them to find someone who enjoyed working and collaborating to develop mHealth tools: *"I only work with people who are actually excited to be doing this, because there's just only so many hours in the day… So it's not that I couldn't find other people, I think it's just finding the people who enjoy it is the most important thing."* In terms of expectations, participant H13 was concerned that they would have a collaborator that *"is really good at writing… they look good on paper… but then you get the grant, they don't help you at all, right?"* Thus, they stated that there has to be some sort of alignment and overlap in terms of investment by everyone on the team to accomplish their project goals.

When working with their collaborators, some Health researchers were particularly focused on the consistency with their collaborator's work ethic as well as their commitment to the project (H6, H12, H13). Participant H13 stated that they see pursuing a collaboration as worthwhile *"when there's consistency in someone's work, in someone's work ethic, and getting things done, and their commitment to the project, or commitment to that area of science. Then that says, 'Yes, we should work together.'"* Having witnessed their previous working style, this would lead them to decide if they would continue working with them on future projects. For example, participant H6 had good rapport with their collaborator because they *"had a working relationship with the instructor before because he was also a* *postdoc at [university] before he moved to a different [country]... We knew each other's working styles immediately."*

It was important for some Health researchers to have collaborators that had similar research interests and backgrounds, such as working in the mental health space, and shared similar expectations on outcomes, such as getting out publications (H4, H9, H14). Because they work with vulnerable populations, some Health researchers need their collaborators to understand the context surrounding that work. For example, participant H9 stated that *"it's really important they have a background and they understand mental illness… I would appreciate working with someone with an academic background… that can relate to our values as a scientific community. So I value making an effort to publish the results of users and design, even at early phase."* Thus, they are able to understand the nuances that come with working in that field.

Health researchers also kept in mind their project needs as well as what kind of expertise or assistance they needed when searching for potential collaborators (H7, H8, H9, H12, H13, H14). Participant H12 discussed how they try to differentiate between what kinds of design expertise they need: *"Do I need… any research collaborator? Or do I need an expertise collaborator, or someone who can help me? You know, they'll… design the intervention… I think designers the same way, it's like, do I need someone to help me sort of understand the design principles and the design features and the design ideas?"* Because HCD can entail so many different activities, participant H13 also stated that they reflect on whether they need a design researcher or a designer: *"I don't always need someone that's a design researcher, necessarily, I need someone that's more of a designer… And so that is* *something else from the clinical side is like determining whether you need a design researcher to help you with things or like an actual person that does design work."* Participant H8 also reflected on what their project goals are and what their potential collaborators could contribute to the project: *"I would say it's really, kind of, personality a little bit… and then also the look and feel of the actual product. Is this something that aligns with what you want? And is this something that… you would consider having your patients use as well?"* In contrast to collaborating with a design researcher, when participant H9 was looking to hire a collaborator to join their team, the collaborator needed to have someone who was knowledgeable of design, but also have some understanding of health and mental illness to lessen their own workload: *"I think one of the challenges of interdisciplinary research… I'm covering so many ends that is hard to train… I need someone who can touch on like, multiple areas at the same time…"* Participant H7 also noted the difference between working with an industry and an academic collaborator. They found it more beneficial to work with an academic collaborator because they were able to learn and understand the problems from their collaborator's perspective as well as engage in academic publications: *"With my academic collaborators, I'm learning something new as well. And it's more interesting to me… to hear about the problems from their perspectives… And it also leads to more academic productivity for myself because they can take the lead on papers or manuscripts that are more in their field, but I can participate in that as well."*

3.2.4 Preliminary Work and Additional Labor for Health Researchers

Because the Health and HCD fields have different approaches when conducting research, Health researchers also take on additional responsibilities when using design methods or with design collaborators (H4, H7, H11). While conducting needs assessments and initial usability testing, they had to wear multiple hats and work on different tasks outside of design (H4, H11). For example, participant H4 had to do *"all the recruiting and interviews; and we're using an outside technology company, so I'm the one that communicates with them about what issues the families are having or caregivers are having."* In addition to going out to their target community and doing needs assessments, participant H11 was also involved in the implementation plans of the project: *"And then in the middle, writing specification documents, helping the design team sort of think through how the product will be developed. And then you know, also on the back end, working with implementation for training people how to use it, and then managing, kind of, the ongoing consultation and technical assistance, parts of the implementation plan."* In one project, participant H4 had to do additional labor in order to work alongside potential collaborators. For example, participant H4 approached their potential collaborator, a technology company, who initially stated that the project was not in their capacity, but after meeting and discussing all the preliminary work that had been done, they had come up with an idea they were satisfied with: *"But it was interesting because it was like 'Listen, we're actually busy, I don't know if we're gonna have time to do this… and then I visit pre-COVID… and by the end, you know, we had named the app and he* *was super excited about it!... We just kept whiteboarding until we created what we thought would be the best initial framework."*

3.3 How Health Researchers Use Design Methods in Their Work

Participants identified the different tasks that they considered as design work: they were involved in gaining and using user feedback to iterate on their designs and emphasized that it was an iterative process. Before diving into the research, some Health researchers took on additional tasks, such as recruitment, implementation plans, as well as conducting preliminary studies to recruit collaborators. Participants discussed the steps they take in beginning their design process, how they valued finding a balance between the clinical and design aspects of a project, and emphasized the importance of communication with their collaborators.

3.3.2 How Health Researchers Implement Design Methods

When incorporating design in their work, Health researchers used user feedback to guide their design decisions as well as performed iterations on those designs (H1, H2, H8, H9, H12, H13, H14, H15, H16). For example, participant H1 engaged with their end users by getting their opinion on the app prototype and making adjustments based on that feedback: *"through usability testing, and feedback and reviews on that higher fidelity prototype… and collected user feedback and clinical outcome assessments over those eight weeks. And then from there, we made some kind of final tweaks to the program itself and opened it up to two campuses that any student could download and use and give us some feedback."* In addition, participant H9 had a similar process, in which they had developed a prototype and made adjustments based on their end users' experiences: *"We iterated and we made modifications to the app. And we made changes because people were struggling with certain issues, and we made the change… then we tested it, then we made another iteration… based on the qualitative feedback that we received…"* Participant H13 briefly mentioned that they used user feedback for the development of their mental health tool: *"There was a, you know, mock ups of it, to get user feedback from them, and then iterate on that a little more…"*

In terms of gaining user feedback, participant H2 found it surprising that they were still able to get insightful feedback while not having an elaborate design. They explained how because they previously worked on teams where they get grant money to design the best tool, it was difficult to adjust and put an unfinished product in front of their target audience: *"sort of the idea of putting out things earlier to people to get feedback is really, that was also a culture shift for me… it was hard for me to… sort of like… I'm not ready to show you it's not perfect yet. And then literally, I showed… the intervention to people on day one of a four week practice, like immediately, it was like I needed to revise the whole thing."*

Health researchers also emphasized that the design work was very iterative throughout and those interactions can change their original design ideas (H3, H6, H12, H15). As they engaged more with their end users, participant H12 identified that their original design idea was not as important as originally anticipated, which influenced them to focus on a different aspect: *"Initially, when we did the project, we thought it was going to be a sleep intervention, and then sort of our early design work and focus groups, we sort of identified that youth were not at all interested in the sleep intervention… I think the design* *work really did help us sort of shift gears a little bit and, you know, think about something that would be helpful and feasible."* In addition, participant H3 discussed how much they had to go back and adjust their intervention design: *"I worked more closely with two of the clinicians from [university], we went back and forth quite a bit on, kind of, the specific, you know, nitty gritty of the project and of that content. And we tweaked and improved and tweaked and improved until we thought we were done."* Participant H6 discussed that it helped when keeping in mind that it was possible to go in a different direction or change directions in terms of design: *"Just knowing that this is not going to be a very straightforward process, as you know, research isn't… being willing to let that go is another thing. I think even just prophesying to each other, like I totally understand how much work went into this, but maybe we can hold that off to another version or we can do something else with it."*

3.3.2.1 How Health Researchers Begin their Projects Using the Design Process

Health researchers had a variety of approaches when beginning their projects, which included pulling from what is known and what works in a similar context to the problem being addressed (H3, H6, H13). Their design decisions were based on and started with looking at literature about evidence based approaches and how to translate that to a technology delivered format (H3): *"I just looked at the literature an awful lot on what it was that made software easy to use, what made it acceptable, what made it engaging, and did my best to incorporate that into the software."* In addition, participant H6 discussed how they also looked to the literature to understand how to approach their research problem: *"You* *observe an issue, and then you try to address the issue… and then you do a review of literature on the current understanding of what's out there… move on to finding out what people actually want and need, if that's already in the literature. Then we implement those features, test it, refine it, test it, refine it, and then do a feasibility usability engagement…"* However, participant H3 also stated how they would not approach a project: *"I've never gone to a group of participants and said, 'Okay I'm going to make whatever you think would be best,' because I'm always starting from the literature."*

Health researchers also looked into other resources that already exist to inform their current projects (H6, H11, H13). Because of tight timelines and limited resources available to them, they sought out what tools have worked before and how to implement them in their project as well as what did not work and how to refine and adapt it for their project needs. Participant H6 described how they conducted their design work when they did not have the resources: *"We don't have the labor, time to do it. We don't have the resources. Then why do we reinvent something that someone has already done, right? It's just incremental, so what you could do it find out what has worked, but then find out if it still works, right? And if it doesn't work, then what parts don't work? And how do we refine it to make it work?"* One of the workarounds of not having a designer on the team include taking a design that has already been well established by a designer and trying to borrow elements and implementing them into their app (H13): *"So it's really, kind of, a makeshift thing when we don't have a designer. Or we try to take the design that has already been, like, well established with a designer– with a design team, and try to copy that again in another app or another,* *you know, intervention, as long as it's in the same line of work, or you know, same age distribution of participants, like we feel comfortable doing that."*

While Health researchers began their design processes by looking into the surrounding work, they still begin understanding the problem by thinking through who their target population is as well as making sure that they are included in the technology and intervention development process (H1, H5, H6). For example, participant H1 stated that they keep in mind how their target end users will use the intervention: *"I thought of the primary stakeholder in something that I was developing for mental health, being the person who's going to be using the program themselves. And so like, if I was designing, if I was thinking about designing a program for a college student, I would think about the college student as being, like, the end user and the main stakeholder."* In addition, participant H5 explained that they have been keeping in mind their end users before beginning the project: *"So even at the beginning, when we haven't even written a grant yet… when we haven't even started the project, making sure that we're including folks, stakeholders, and folks that will be affected by it."*

3.3.3 Balancing Both Clinical and Design Aspects of a Project

When designing Health technologies, Health researchers emphasized the importance of understanding both the clinical and design aspects of the project (H2, H4, H5, H7, H11). Because of constraints from both sides of the collaboration, participant H2 was pushed to understand both processes as well as important outputs, which also caused them to quickly learn how to use these methods but also ensure that these design decisions were actually translating to clinical outcomes: *"When you're constrained by some of the research constraints that can be at odds with each other. And so, I think it's pushed me to really… understand both processes, both outputs that are important for people… we need in order to be able to really ensure that the design decisions we're making are actually translating into clinical outcomes."* In addition, participant H4 was able to understand what processes need to happen in order to achieve their goals: *"I think it's just really helped me see research in a slightly different way in that I really value, how you have to be able to speak the language, and then how important it is to bring the end users into the beginning and all parts of the development of an app or some sort of technology."* Some health researchers also found that by understanding both sides, they are able to see how one can better inform the other, how to design and implement better research as well as how to take what design methods they learned and apply it to other aspects in their field (H4, H11): *"Just, kind of, seeing how understanding the two sides helps with both designing and implementing better research, but also changing the way we interact clinically… I think the usability stuff is the most important thing I learned because I think it's broadly applicable to a lot of things, right? … taking into clinical care…"*

Health researchers also acknowledged that they do not know everything coming into their collaborations. Although they are able to provide their respective expertise, they are also open to different perspectives from their collaborators, which as a result, helps them understand the problem in a more meaningful way (H2, H4, H13). For example, participant H4 discussed how they were more open-minded when it came to understanding the users' problems: *"I assumed I didn't know anything at all. And that was really helpful* *because I think it kept the door open to understand what they mean in a more meaningful way."* In addition, participant H2 waas open to the different perspectives of their design collaborators. They had collaborators who were not experts in eating disorders, but they were all engaged in doing design activities that allowed them to bounce ideas off of each other and see their understanding of the problem from a different perspective: *"That's been a helpful, sort of, team member as well to bounce things off of… And we've done some really fun sort of design activities internally.. what I like about that is they are not experts in eating disorders… I would say essentially, know more about it than they might."*

Depending on what the different researchers on the team value and find meaningful, there are different emphases that can affect the outcome of the project. Because of the different disciplinary backgrounds of the researchers, it may influence whether the project has a more clinical or design impact (H1, H7). For example, as a clinician, their focus is more on programs and products, which lead to favorable clinical outcomes for their users (H1): *"There's sometimes a little bit more of a focus on some parts of the project than others… For me, as a clinical psychologist, what I care about is probably programs and products, leading to favorable clinical outcomes for users, so I do focus on mental health outcomes more than I focus on processes and design considerations as an ultimate goal."*

3.3.4 How Collaborative the Work is

Health researchers described how collaborative the work can be when working alongside design collaborators such as designing and defining the project together and writing publications (H5, H10, H14). Participant H5 compared how their current project with a design researcher was more collaborative than past projects without one: *"So normally, I would likely lead things that I've been doing for quite a while, but… being led by them and because it was their expertise… it was a lot more collaborative, which I really liked. A lot of things I've done in behavioral science world was you write the whole paper, and then you give it to people to look over. And maybe you'll get feedback from mentors, maybe not, but this was pretty cool."* In addition, participant H10 discussed the different aspects of the project that they worked on together with their design collaborator: *"... developing the design protocol together, defining what the outcomes of interest are, the methodologies that are going to be used, just talking about… you lead this aspect of the project, and then I'll lead this aspect of the project."*

3.3.4.1 Expertise

Some Health researchers also emphasized how they and their collaborators brought together their different expertise and how they can further inform each other (H1, H4, H6, H7, H11, H15). Participant H4 discussed how they combined their health expertise with their collaborators' HCD expertise when designing technologies: *"Putting the two sides together really makes it information that's wanted by both clinicians because I have the ability to say, like 'This is why it's critically important that we're doing this kind of thing.' But then [collaborator] gives the framework and logistics of like 'Well, this is when you analyze it, this is what you are doing…'"'* Another participant discussed how working in these multidisciplinary collaborations and using design methods can fill in the gaps that they faced in their clinical field: *"And so I think the kind of multidisciplinary collaborations and the* *methods of diving a little bit deeper into what people want… fills in a lot of the engagement kind of gaps that clinical psychologists had been running into. And we still run into because… nobody's cracked the code in making something perfect to solve mental health care"* (H1). In contrast, participant H15 acknowledged that because of their clinical background, it may cause them to think they know what's best, which leads them to neglecting the needs of the users: *"From my education, that you know, as, as healthcare providers, a lot of times I think we know, we think we know, what is best for the patient. And what we sometimes I think, forget is the patient has to understand, the patient has to buy in that they also think it's best for them."*

On the other hand, some Health researchers discussed how their own as well as their collaborators' expertise contributed to the project (H7, H10, H11, H12, H14). Aside from designing and defining the project together, some Health researchers divided the work based on their respective expertise (H7). For example, because it would be difficult to be a part of all the qualitative interviews, participant H7 planned on conducting the more clinically oriented interviews while their collaborator would conduct the more design focused interviews: *"We've come up with our protocol and leverage our mutual skills to accomplish that… and we are actually planning on conducting the study and we're dividing up the tasks, so I might take… some of these interviews… because it's going to be more clinically oriented, or my collaborator might do the second set of interviews that are more design focused… we can leverage our skills and… elicit the information we need based on our own skills…"* In addition, participant H11 felt that they had a niche set of knowledge, which allowed them to serve a special role on the project. They felt that their expertise allowed them to facilitate the language between both the strictly design/technology and the research team members: *"I felt like that was something I could bring to the table… I could fill a role between the design folks that are hardcore designers and technology folks, and then the hardcore research folks, I could help facilitate the language between both of them… "*

The roles of Health researchers are also not limited to just providing expertise from their discipline, but can also expand upon the needs of the project. Health researchers identified as playing multiple roles on their projects, and not sticking to a role that is limited to their educational or professional background (H7, H11, H12, H15). On these multidisciplinary teams, although they have specific training in one field, Health researchers also have built expertise in other fields. Because they had more design experiences than other clinicians on their team, some Health researchers took on the responsibility of doing the design work by themselves (H7). On a similar note, Health researchers also discussed that it was difficult to distinguish between what kind of researcher because it depends on the needs of the project: *"For me on that project… you know, it's hard for me to say which specific hat I would be wearing in that project… I certainly wasn't the main driver of the technology development. But on that project, I was probably more towards the technology design and interaction design, then the content design"* (H11).

3.3.5 Communication Between Design Collaborators

Because Health researchers and design researchers come from different disciplines, there are instances in which terminology, methods, or concepts do not align. Thus, Health researchers discussed how they valued open communication with their design collaborators in order to better understand each other and work together (H4, H5, H6, H13, H14). In previous projects, participant H6 had design collaborators who were open to having side conversations and taking time to further explain everything in simple terms and in more detail. This fostered a space in which Health researchers felt comfortable asking questions when they needed further explanations and also influenced the way in which they clearly communicated back to their collaborators: *"One of the things too, that I really like about our collaboration… it's very easy to get along with them… we don't understand something, like we don't feel like we're too dumb to ask… I've been lucky in how they communicate, they always go from the base and they build upon it."* In addition, participant H5 found success in their collaborations with more open communication and asking questions about each other's discipline: *"I think exposure was the biggest, but I think just asking questions… I chatted with HCI postdocs a lot… and so just learning through that, we kind of learned the outskirts of each other's disciplines…"* Participant H14 emphasized how it was important for all team members to reach a shared understanding of the project goals: *"It's been really helpful to have multiple people on board who have some understanding of what the goal is, rather than just being brought on board for some piece of expertise that they have. Because if we all have sort of the same end goal, rather than just 'I'm going to do this part, and then I step out,' it makes it much easier to figure out where the pitfalls might be, before we follow them."*

Within their respective fields, Health and HCD researchers prioritize different outcomes, which can be improving user engagement and improving patient health outcomes respectively. Thus, in order to accomplish their project goals, they work together in the beginning to design the study and negotiate what needs to be done from the lens of each discipline (H4, H5, H6, H7, H11, H14). *"So the next step is kind of, well, how do we accomplish this goal that we're trying to get out? And we often go back and forth… So I present it from my clinical perspective, and they present it… from their [HCI] perspective"* (H7).

3.4 Challenges Health Researchers Face When Using Design Methods

Because they have more formal training in the clinical field, Health researchers face a variety of challenges and difficulties when implementing design methods into their work (H2, H7, H9, H11, H13). Some of the difficulties with design methods that they face include timeline issues, conducting qualitative interviews and usability testing, bringing in users to evaluate low fidelity prototypes, choosing methodologies, and more (H2, H7, H11, H13).

3.4.1 Method/Design knowledge tensions

Health researchers were concerned about designing a tool or intervention that incorporated inputs from their target end users, but also improved patient health outcomes (H1, H2, H3). When conducting interviews with their stakeholders, they were eliciting any preferences or ideas from their end users. However, they struggled with incorporating both clinical and user inputs into the end design: *"How much do you sort of give people what they want versus creating things that are clinically potentially impactful?... Because not to say that designers would design things people don't know about, but it's not only about it. To me, it's not just only what they want, but sort of how to make that really clinically impactful"* (H2). Some researchers were also concerned about maintaining the feasibility of the tool within the project, but they were still able to turn that feedback into fruitful decisions because it allowed them to figure out the features for their intervention. For example, in the beginning of their career development award, participant H1 felt stuck about eliciting preferences and ideas from their stakeholders: *"There was this part of me that felt like I knew what was feasible, and I knew what likely wasn't feasible. So like, why would I be asking people to, you know, more freely come up with stuff?... It would up being super helpful to elicit ideas more freely because there were things that came up and we were able to come up with… workarounds for one of the features that had come up for this particular program…"*

Another challenge that Health researchers faced was conducting qualitative interviews and how to ask questions that would lead to fruitful qualitative results (H7, H9). Participant H9 was attracted to qualitative interviews, but still found it difficult to conduct: *"I think one part that was difficult was qualitative interviews… I really liked the approach… but it was still difficult because I was never trained as a qualitative methods [researcher]..."* In addition, participant H7 and their team conducted focus group interviews to understand how to design an app to support self management and engagement with their health, but found that they had not done the interviews correctly: *"As we went back and reviewed the transcripts from the focus group interviews… these were not done very well, we asked a lot of leading questions, like we didn't conduct the interviews in a way that was truly generating… we conducted them in a way where we knew the answers and we didn't really let them express or get a full range of answers that potentially could have been generated if we had been a little bit more non-leading with the format… perhaps if I had been working with someone* *with more expertise and doing this type of work that we would have collected better data to begin with."*

When navigating how to work with design researchers, Health researchers acknowledged that they did not understand the design research practices and frameworks enough to know when to use different methods or how to address certain design problems (H5, H11, H13). For example, participant H5 found it difficult to contribute to writing when they did not know the key theories in HCD: *"One of the challenges… was when we were writing up the paper, not knowing the different frameworks and the models… that were pretty traditional, are pretty main course for HCI… I think a challenge for me was wanting to meaningfully contribute…"* In addition, participant H13 reflected on their previous project and what they did not understand in terms of choice of design methodologies: *"I don't fully understand when they're like, 'Oh, we're gonna do this methodology.' And then six months later, we switch methodologies… I don't understand why we do a certain methodology to get a certain outcome versus other methodology to get a different outcome."* However, because they did not have that knowledge, they were heavily dependent on their collaborators' expertise: *"Sometimes in my head, I don't understand that, but that's why I have collaborators, so I don't have to understand that"* (H13).

When thinking of what to design, one of the concerns that Health researchers had was about designing an intervention or technology that they would be able to integrate into a wider setting or apply their findings to a broader population (H2, H7, H11). For example, although they were able to create a concept design of a tool, it will be useless if they are unable to integrate it with the existing electronic health record. Participant H11 articulated this particular issue of not having technology work very well with the problems they want to address: *"Working with systems to integrate our tools into larger systems is a huge problem. So we can make, kind of, a proof of concept design of a tool, but if it doesn't integrate with somebody's electronic health record, or it doesn't pull information from the Medicaid database the right way, we're kind of screwed… That's certainly a challenge in the design process, is understanding how do we integrate our tools into larger systems…"* In addition, participant H7 explained that they want to improve health outcomes for a larger population, so they are concerned about how to do research in which they are able to generalize the results to be applied for a larger audience, and not just to a particular population: *"When I'm doing work, I try to think about how can my work be as broad as possible? How can it be adopted by more than just a small segment of a population? … the problem is that nobody's going to pay for you to do some work in such a small segment of the population, and so your work needs to be broadly applicable."*

Some Health researchers explained how their Health colleagues did not value the contributions of qualitative research and design approaches (H7, H9). When gaining feedback about their data from qualitative interviews, participant H9 found that researchers, and even mentors, in their field did not find the qualitative work as rigorous or reliable: *"I actually had mentors that will say, 'Oh, this is just qualitative data… you can make people say whatever you want' and absolutely dismissing qualitative research… there's this bias against qualitative [research]..."* In addition, participant H7 found that there was skepticism surrounding doing design work when they delegated a non-physician to ask a physician for help: *"I think it's sometimes can be a little bit of a higher up problem when the* *physician is doing some of these interviews… I found that when non-physicians ask physicians for help with projects that there's a lot of skepticism… When I reach out to physicians, it's a lot easier to get people to participant or to help me with my projects… We can reach a common ground… and I bring credibility in ways that others can't who are not clinicians."*

3.4.1.1 Need Support in Gaining Design Knowledge

Although Health researchers had conducted design work, they felt like they were still learning how to do tasks, such as making design decisions, conducting interviews, and choosing methodologies (H2, H5, H7, H11, H12). Because qualitative data can lead to design implications, participant H2 was still learning how to translate their findings into design decisions: *"I think it's, sort of, learning how to translate. And I'm still learning this, how to translate sort of findings into design decisions, right? So there's a lot of design implications, but truly, like making some decisions are? I don't know. And of course, you're gonna get it wrong. For some people, you're gonna get it right. For some people? I don't know. So I think that's one of the neat learnings that I'm walking away with."* Participant H5 was also navigating how and when to follow up on participant responses when conducting qualitative interviews: *"I don't know if it was a challenge, but it was …me learning when to follow up. And especially since it was a new method that we were using, knowing when is it important to follow up? And is it just when my own interest is piqued? … Or is it since it's so out of my- my wheelhouse? Yeah, just so I guess when to know when to follow up."*

Some Health researchers were also still learning how to choose certain methodologies (H7, H12). Because of their limited design background, participant H7 did not have a deep understanding of what methods would be best for the project. Thus, they had a harder time adapting what tools or methods to use and decide what to do because they feel it is right rather than knowing why it would be right: *"I would say… I probably don't have as deep of an understanding of the methods, or necessarily the exact right way of applying methods that the design professionals would… I'm just more of a user of the tool, and so… I probably have a harder time… really understanding why this tool is better… than maybe the other tools I didn't use… whereas I think having the design professionals involved, they could give me a lot better idea of why we did what we did whereas I just kind of do something that I think seems right, but can't necessarily tell you why it's the right thing to do…"* In addition, while conducting their study, participant H12 switched the types of design activities in order to gain the right kind of engagement from their participants: *"the methodology we're starting with was all kind of group based, you know, focus group/group based design sessions… we just found a lot of the youth were not really participating in those group sessions, or if they did participate… they wouldn't really talk about what it is that they did. So for a lot of the youth, we ended up following up with them and doing individual sessions."*

While not unique to this particular context, some Health researchers were still figuring out how to recruit and work with certain participants, especially those from under-resourced and traditionally marginalized populations (H12): *"So we did individual follow ups with some of the participants following the group based work, so I think a lot of the challenge was really just learning about how to do this, when working in a population that is, you know, has challenges in terms of working with them."*

Despite having the resources and mentorship available to learn design methods, Health researchers still felt that there was a need to have more support around gaining training or learning to do work with their collaborators (H11, H16). Participant H11 voiced that they felt there was a need to have more support towards communicating with their collaborators: *"And I think if there was a support that they could be given around some training or learning that can happen on both ends, about how to do basic communication with each other."* In addition, participant H16 felt that it would be beneficial to have courses that teach researchers how to apply design into more health contexts: *"One takeaway would be people in medicine and health… they would benefit from a design course, for developing health promotion materials more effectively… We have very good theories on how to change behavior… but how to design and implement it is a much weaker area."*

3.4.1.2 Gaining Design Knowledge

Health researchers were able to gain design knowledge from teaching themselves and looking into available resources to further inform their work (H3, H6, H8). After seeing a gap on their previous project, they sought out resources that taught them to improve and incorporate those findings that would help address those issues. These resources include literature, webinars, seminars, colleagues and mentors (H3, H6, H8). They also gained experience from doing user evaluations, in which they were able to *"figure out what worked and what didn't"* in the context of their studies (H3). Looking into these resources also opened their eyes to what design actually entails (H8, H9). They saw how certain technologies were being developed and looked into how they could adapt it for their own work. For example, some Health researchers thought that user centered design was similar to software engineering, but as they read more, they found that it was similar to what they had previously done before, such as behavioral psychology: *"I thought it was more about… software engineering – the user centered design… I didn't have a strong sense and was about to complete different things. So I got into… the first readings… It was just amazing. It was like, opened up my eyes… it was like… as a behavioral psychologist, and all my training…"* (H9). After becoming familiar with the field, they felt that they had learned enough once they felt comfortable with answering difficult questions related to the methods or the field: *"I want people to ask me the hard questions. And then if I feel like I can answer them adequately, then I feel comfortable …to move forward"* (H9).

Many of our participants were able to navigate the HCD space and integrate design into their work because they were part of training programs or worked at Health and Design centers (H1, H2, H4, H9, H13, H15). Within those training programs, many of them had collaborators who served in mentorship roles and provided guidance on how to use design in their work. They had a structured opportunity to learn methods that were being used by their collaborators and gain their expertise, such as defining design protocols, analyzing design data, etc. (H1, H13) Participant H13 said that being at a multidisciplinary center allowed them to be in contact with other researchers who could provide guidance: *"it was a center, so there were all staff folks… the center director as a researcher, and so that person would pop in and out every once in a while and give some direction or some thought"* (H13). Although they were not expected to be at every step of the project, Health researchers were still able to engage with their mentors, who provided feedback about the different elements of the project as well as trained them in both HCD and clinical science (H1, H2). For example, participant H2 had mentors who helped facilitate their learning of design methods because their mentor had them first conduct a needs assessment, which they felt was *"a blessing in disguise… sort of, the need to add in a component to the project that I hadn't even expected I would do."*

One Health researcher discussed how they gained their design knowledge through formal courses (H4). Initially, they had no idea what human-centered design entailed, but after taking courses, it gave them a better understanding of the reasoning behind implementing human-centered design methods: *"And I honestly had no clue what I was talking about… So I started taking classes and was like, 'Oh, that's what this all means.' So I think the language of human-computer interaction is just foreign to clinicians, right? And so, you know, I think being able to take the coursework has now solidified in my mind why we do what we do and what I'm talking about in more concrete ways"* (H4).

3.4.2 Project Timelines

Health researchers also had challenges navigating their project timelines, specifically how to incorporate doing design work alongside following the limitations of the original grant proposal (H1, H7, H12, H13). Health researchers said that design work takes too long to fit into the work cycle that they have towards achieving their expected outcomes (H1, H11). They stated that many medical research grants have tight timelines on what needs to be done and what needs to be completed next, rather than having more time for *"pure innovation and discovery"* that they can pull key points to hand on to the next phase of project development: *"I've started to grow more comfortable with over the last couple of years is that to do in depth qualitative analysis, it's going to take more time… And so trying to find the balance of how can we carve out both the resources and space for that [exploration in research interests] while still keeping funding projects on schedule"* (H1). In addition, participant H7 discussed their struggle with navigating their design interests of the project. Because beginning the design aspects of the project took more time due to IRB approval, interest from the clinical side faded because it had taken too much time and lost its momentum: *"I want to do it through IRB… and get consent and be able to report findings and stuff… we had developed a protocol to evaluate it, but it took us forever, and then we kind of lost interest from the clinical side of things, and so it's just fizzled out"* (H7).

Health researchers also struggled with the tight deadlines and how to bring different iterations of their prototypes to users because it would take more time and effort than what their grants would allow (H1, H11). Participant H11 stated that being able to gain feedback from end users on which interfaces work best is appealing, but not practical in their clinical field: *"The actual technological implementation of randomly showing people two different interfaces to get feedback on a live mobile app is difficult and challenging and takes a lot of time and effort."* Participant H13 did not properly assess the time needed for the design aspects of their project. For example, participant H13 and their team took one year to build an app during a two year grant, which caused them to rush the latter half of the project: *"In that specific project… there was a bunch of timeline issues. I think it took us a year to build the app in a two year grant, which is not good. And it was really eye opening to me about what it takes to get that stuff done."* In addition, participant H1 stated that they saw some of the design aspects, such as doing in depth qualitative analysis for publications, did not match the timeline of project development: *“We're going to get 10 people in to provide reactions to this and get their ideas. And then we'll take a week or two to think through what we learned from them, and then we'll take that and move on to the next step. And so it makes sense from a project development kind of standpoint, but it doesn't match into that timeline of, like, digging deep into stuff to write a paper for CHI or CSCW.”*

3.5 Challenges Health Researchers Face When Working with Design Collaborators

In addition to the challenges that surfaced when implementing design methods, Health researchers also faced challenges when working alongside their design collaborators, which include miscommunication about goals and expectations and lack of shared language between disciplines.

3.5.1 Miscommunication between Health and Design Researchers

After seeing these challenges around miscommunication about the project, some Health researchers voiced a desire for toolkits that would align Health and HCD researchers’ expectations (H13): “*So I think if there was tools and toolkits more readily available to help people get on the same page with kind of how they're going to go about the design process, and, and identify what metrics they want to be looking at, what the timetables are, and all that kind of stuff. I think it would just hopefully reduce some stress and cost overruns later in the process and ultimately develop better interventions.”* In addition, participant H11 discussed how they would need support for how to quickly reach the same page as their collaborators because of how long it normally takes: *“It takes a long time for them to become* *some kind of working understanding of where are we going? What do we need to do? And how do we get on the same page with things? So training and support around that, I think, is critical… I think it's actually more helpful to just have some kind of co-developed training that people can take to make sure they're following a model of intervention development that works for everybody, instead of taking a year and a half to figure it out."*

Some Health researchers explained the obstacles that occurred during their projects due to miscommunication with their design collaborators, which prevented them from meeting their goals and affected their end product (H5, H6, H11). For example, participant H6 had adapted an existing survey evaluating nutrition apps, but they did not communicate with their collaborator about how to administer it to their target audience: *"I think there was a miscommunication about how to administer it because what I thought she had done was… if she needed to remove any aspects, like what are the key audiences that this app is for? So I told her and she had sent me… and I had just released it… it was still there, so then I think it could have created confusion…. About how people responded to the responses."* In addition, some Health researchers reflected on how miscommunications caused failures in collaborations (H6, H11). Participant H11 said that they saw how harmful miscommunication can be towards collaborations: *"... lead to disagreements and sometimes complete failures in terms of collaboration, so having to completely switch partners in the middle of a project… not good, you know, it's not good, it's expensive… it can be pretty harmful when there's miscommunication and just people aren't on the same page."* In addition, participant H6 reflected on their past failed collaboration and how they should have been more communicative with their collaborator: *"I should have been more in* *correspondence with her because I think that was the issue was the communication part… I did not have weekly meetings with her, right? Like we only met once in person, and… just discussed data."*

Considering that these types of interdisciplinary collaborations take a significant amount of time and dedication, some Health researchers also did not think it was worthwhile to work with collaborators who did not communicate for months on end or put in time commitments to meet for the project (H13). The misalignment as well as miscommunication of priorities can lead to disagreements or failures in terms of collaboration, causing them to find new collaborators to work with in the middle of a project and start over. For example, participant H13 expressed their frustrations when their collaborator was not available for three months because they dedicated their time to writing a book to advance their career and neglected the needs of their collaboration: *"Once you get to a certain point, you have to kind of stop working together, right? It just won't work anymore… especially if you're really busy, like, I'm really busy, so I can't spend not meeting with someone for three months. You know, it's just not worthwhile to keep doing that… It just after a while kind of wanes on you."*

One of the main barriers that Health researchers discussed when working with design researchers was the lack of shared language, which includes key concepts and approaches of each discipline (H7, H11, H13, H14). Many researchers who work in this space are not cross-trained, so it is hard to communicate what needs to be done from both the Health and design sides of the collaboration: *"One of the barriers is lack of shared language between people speaking different languages of what needs to happen, what can* *happen, and a shared understanding of what the technology development process and research is, and what the needs of the health delivery research is"* (H11). In addition, when bringing on students to assist with the project, they found that their students were writing through a design perspective whereas the project was targeted towards a clinical audience. Thus, Health researchers had to translate for the clinical audience and rewrite their students' work: *"We're trying… to write something for a clinical audience… the students really don't know how to write for a clinical audience… most of the time they're writing for a design audience. And the writing is so different for a clinical audience than for a design audience. So that's been a big challenge. And so I have to rewrite a lot of things"* (H7).

3.5.2 Contributing to Health and HCD Communities Through Publications

Health researchers were also interested in contributing knowledge among their peers and research community (H2, H4, H5, H7, H11, H14). Because Health venues prioritize seeing behavioral change outcomes and health insights, Health researchers discuss trying to bring HCD to their clinical field through publications (H2, H7, H9). For example, participant H2 recognized that clinical scientists are not aware of how to incorporate the user centered design process, so they wrote a review paper of how to apply the design process for digital intervention services before beginning their original project: *"I ended up writing a review paper on the user centered design process for digital services for eating disorders as, like, a primer for clinical scientists in my field because we don't know about this kind of stuff."* In addition, participant H7 found validation in their work because it was published in a more design focused venue, such as CHI or CSCW: *"What matters most is the impact of the work* *that I do… When I can say that I published at CHI and it's got a 10% acceptance rate… that's the same as being able to say you publish in a high impact journal."* Participant H9 also discussed having published one of their first papers in bringing human-centered design into the development of a behavioral change application: *"It was the first study ever, you know, bringing user centered design of a smoking app in patients with SMI. And it barely, barely caught the attention. But then a lot of people started, you know, now it's everywhere."*

Because of their background, Health researchers expressed that they are expected to know what will work for their audience (H4, H15). However, participant H4 was motivated to bring new knowledge to their research community, which was the idea of including their target population in order to create tools and applications that are useful: *"And I think, you know, my intent is that, you know, I think having clinicians understand that it's okay to not know everything. And then also, even just by partnering together between clinicians and health, or human computer interactions, specialists to try and make an app, you're still missing the target population and lost the population is supposed to be clinicians, right?"*

3.5.2.1 Differences in Publication Expectations

Some Health researchers emphasized that there were large differences between the publication practices of the Health and HCD disciplines (H4, H5, H13). One main difference was the length of publications from their respective fields: papers in medical journals were much shorter and presented in a more concise way whereas they felt that HCD papers were significantly longer and saw that it required much more work. Participant H5 articulated why they did not want to publish at HCD conferences: *"We just write so differently. So HCI* *folks, their journal articles… feel like they're dissertations each year. They're so long and so much work goes into it."* Due to the differences in paper length, participant H4 expressed that they thought no one would read the longer publications: *"In medical journals, papers are 3000 words or less… and in HCI, they're like 10,000 words… and this 10,000 words is not gonna fly, nobody's gonna read it."* Another difference that surprised some Health researchers was that because the qualitative data is so rich, it can be analyzed in different ways and be used to write multiple papers versus only producing one paper per project: *"There's so much data that you can have four or five different papers, and I'm used to in behavioral sciences, like this one project is one paper… But there's so much data… you use the same dataset for multiple analyses or multiple papers"* (H5).

3.5.3 Improving Health and Patient Outcomes

One of the biggest goals that Health researchers had during these collaborations was to make a difference and improve health outcomes (H1, H3, H10, H12). Although they wanted to make sure that participants found tools or interventions useful, they put greater value in seeing that the tool led to some measurable change in health outcomes: *"To me, I think that would be a truly successful collaboration, that you identified and disseminated new information or knowledge that truly impacts patients and caregivers. So I'm from the perspective of healthcare, so you can see most of my answers are geared towards healthcare"* (H10). In addition, participant H3 explained that it was not sufficient to just create tools that would be usable, but it had to also lead to improving health outcomes: *"Ultimately, I want to make a difference in health outcomes… so to me, it's something that, yes, that* *participants say [the intervention] was useful… Great, yes, necessary, but not sufficient… [the intervention] leads to actual measurable change is an important health outcome."* Participant H1 also articulated that as someone from a more health-related background, their goal was to improve patient outcomes: *"I don't think there's dramatically different goals, there's sometimes a little bit more of a focus on some parts of the project than others… for me, as a clinical psychologist, what I care about is probably like programs and products leading to favorable clinical outcomes for users."*

3.5.3.1 Personal and Professional Goals

In addition, Health researchers were also driven by the opportunity to be a part of projects where they were able to learn something new as well as produce outputs that can lead to job security (H6, H7, H11). For example, participant H11 expressed that in addition, to improving patient and client outcomes, they also keep in mind how these projects can progress their professional careers: *"My goals have always been to try and be a part of the projects, where I can learn something new… that's my own sort of selfish professional development…"* In addition, participant H6 said that just as their collaborators, their goals are oriented towards progressing their career, such as publications for achieving tenure: *"It's pretty much the same because a lot of my collaborators are in the same position, as I am. We're assistant professors trying to get tenure. So I think that as long as the publications are being done, as long as we get grants, so it's our key personal professional goals."*

3.5.4 What Health Researchers Wish Their Design Collaborators Would Understand

Some Health researchers face frustrations when working with their design collaborators, such as disagreements about practical design decisions as well as not understanding each other's field or context surrounding the problem (H3, H7, H14). Although they acknowledge the benefits of involving a design collaborator on their team and wanting their end product to be as accessible as possible, participant H3 felt their design collaborators made suggestions and decisions that were not practical and could cause a distraction from the clinical impact of their intervention: *"It's going to result in a distraction… You could have a button that says click here… and 10% of participants are going to click that button, and it kind of messes up the flow and stuff is going to happen… They thought it was important to have it [transcriptions] available in every screen… that could very likely lead to distraction."* Participant H7 also stated that they felt their design collaborators did not understand the complexities that come with doing research in health: *"I think I've struggled to figure out how do I train HCI researchers about some of the [health] challenges that I've seen in their work… They don't understand how complex healthcare is and they don't recognize all the intricacies and interdependencies and how challenging it is to overcome some of those types of things."*

Another frustration some Health researchers expressed was surrounding the criticism they received on papers and other work from their HCD colleagues. Participant H7 felt that some of the feedback was too idealistic because design researchers do not understand that Health researchers aim to keep their work as broad as possible: *"I've had* *critiques from HCI researchers saying, 'Well… how can you even consider working with such a broad population because you're gonna have such a wide variety of opinions and needs… but the problem is that nobody's going to pay for you to do some work in such a small segment of the population. And so your work needs to be broadly applicable…"*

CHAPTER 4: Discussion

In this thesis, I outlined how Health researchers perceive and use human-centered design methods as well as described the challenges that they face while working alongside design collaborators and using design methods in their work. The different perceptions of what design entails can affect how and what Health researchers search for in potential collaborators. Thus, this can affect how Health researchers and HCD researchers work together. The themes and approaches represent a set of suggestions/recommendations that can be used to create resources for improving collaborations at the intersection of Health and HCD.

4.1 Implication for Support in Training/Gaining Knowledge in Design Methods

Successful use of design methods can be facilitated through proper training provided at university levels as well as through tools that individual members can reference throughout the project.

4.1.1 University/Department Level Support

Health researchers were able to successfully conduct and incorporate design in their work because of their involvement in research centers and health fellowships/awards that allowed them to spend years dedicated to gain training and learn about HCD. Although many participants had structured opportunities to collaborate with design researchers, it is a very unique program and not widely accessible to everyone. It is unlikely that there will be similar programs that are widely available across the U.S. because there are only a few research centers that focus on using design methods in Health research. In addition, these programs cost millions of dollars, so it would be unsustainable to propose several of these types of programs across the U.S. Some Health researchers were also able to gain some design knowledge through taking classes and sitting in with their design collaborators, who would teach them along the way. However, this is not always an option when working in these multidisciplinary collaborations. It is important to have more accessible approaches for Health researchers to gain this design knowledge. Thus, there is a need to develop more accessible approaches for Health researchers to learn and incorporate design methods and research into their work. Some approaches include creating courses or implementing modules in existing courses of how to incorporate design methods when designing and developing Health technologies. These courses and modules can cover aspects of design that Health researchers particularly struggled with, which include different types of frameworks and theories, surrounding literature, how to conduct qualitative interviews, how to turn findings into design decisions, and other challenges that were highlighted in the results.

4.1.2 Resources, Toolkits, and Publications for Design Methods

Some Health researchers expressed their struggles when navigating how to use design methods in their work. Although they were able to learn about design methods through available resources, such as literature, courses, and their collaborators, some Health researchers struggled with feeling that they had sufficient knowledge to apply it into their work. These findings suggest a need for more support towards using design methods, in which Health researchers are able to refer to throughout the different stages of their research. Translational research methods and toolkits are available in the HCD field for translating from academia to practitioners (Colusso, 2017; Colusso, 2019), but this study shows that there is a need to better translate and tailor methods for the needs of Health researchers, particularly how to integrate different timelines, choose different methodologies, conduct qualitative interviews, employ and iterate upon low-fidelity prototypes, and more. For example, Dopp et al developed a glossary of user-centered design strategies for implementation experts (Dopp, 2019). The development of more accessible resources can support Health researchers in Health researchers' development and learning of design methods.

4.2 Implications for Support in Promoting Design Work

Successful collaborations can be developed by understanding and communicating expectations and goals between individual members of the team, which can be supported through funding agencies and resources.

4.2.1 Funding Opportunities to Promote Multidisciplinary Research

Although there are funding agencies that provide support for conducting research in both the Health and HCD space, there is a need for more financial support and opportunities to explore design interests within these projects, which can promote more focus and attention on the design aspects. Because some Health researchers who worked in medical schools were dependent on grants and other funding opportunities to conduct their research as well as cover part of their salary, they were unable to explore further into more design-related interests because it was not outlined in their original grant proposal. However, navigating the grant writing process is not common knowledge and is learned through experience, and early-career Health and HCD researchers may not know how to account for possible design work when going through this process. In addition, Health researchers also prioritized improving patient and health outcomes, so they felt that the human-centered design aspects come secondary to the health aspects, which can cause further tensions between collaborators or result in designs that are not properly aligned with people's needs. Thus, it is important for funding agencies to support these design goals as part of their grants, which can include accounting for more funding and longer timelines to do design work alongside the clinical aspects or requiring a design contribution in addition to improving health outcomes. Researchers within team science recommend that funding agencies should provide funds that are flexible for design innovation (Hall, 2012) or real-time adjustments that arise during the project (National Research Council, 2015). Providing Health researchers with the opportunity and funding to investigate these design interests can promote the successful use of design methods.

4.2.2 Project Management in Multidisciplinary Collaborations

Because there are many different parts and roles in the collaboration, multidisciplinary teams can be built by including team members of different expertise. In these types of multidisciplinary collaborations, it is common for Health researchers to play a variety of roles depending on the needs of the project as well as what the budget allows in terms of team members. However, taking on these different roles may affect the progress of the project and blur the lines between the tasks that Health researchers need to accomplish to reach their goals. For example, Health researchers may be too focused on recruitment instead of focusing on the evaluation of a tool's usability. Because of limited funding, it is not practical to have a team member for each individual task. There are strategies within Team Science that address team composition and assembly (National Research Council, 2015) to maximize overall team effectiveness, such as taking a "person-task fit" approach, which matches characteristics of individuals with those of the research task (National Research Council, 2013). Health researchers need more accessible resources or strategies to properly delegate work to different members of the research team. Multidisciplinary teams can also promote successful collaborations by facilitating conversations around the different project tasks and responsibilities to optimize resources and to prevent one team member from being overwhelmed with the majority of the work.

4.2.3 Promoting Communication Between Health and HCD Researchers

Health researchers struggled with miscommunication with their collaborators due to a lack of shared language as well as prioritizing different goals. They reflect upon failed collaborations due to not setting expectations or simply not seeing each other to discuss what was happening in the project. One participant expressed that they were frustrated with a collaborator who was not present or responsive for three months of the project. On the other hand, another participant acknowledged that they had not met with their collaborator enough, which led interests in the project to dwindle. Health researchers also expressed their frustrations about how their design collaborators did not understand the Health context surrounding the problem. There are existing Team Science toolkits that help in aligning team member perspectives through guided discussions. These toolkits include question prompts that address overall goals, team member roles and expectations, communication styles, authorship, and possible conflicts of interest (Team Science Toolkit). Having similar toolkits or resources can help Health researchers facilitate expectations from their collaborators as well as coordinate communication styles to prevent obstacles that surface due to miscommunication. As a result, it can also promote more successful collaboration, increase chances of success, and make the collaboration worthwhile for those involved.

4.2.4 Support for Making Contributions to Respective Research Communities

Health research publications value seeing more behavioral change outcomes and health impacts (El-Gayar, 2010), whereas HCD publications have a stronger emphasis on the evaluation of the tools' impact on users' everyday lives (Koch, 2006). Because of this, Health researchers expressed that they needed to lay the groundwork for using design methods and doing design work in their specific health contexts. They felt the need to introduce design in their field, which influenced them to publish papers and contribute to the knowledge of using design methods in creating health technologies and interventions. For example, some Health researchers submitted publications in Health journals as well as HCD publication venues to ensure that their work would reach a wider audience and make an impact. However, this was not the case for all Health researchers: some felt discouraged from submitting to HCD publication venues because they felt that HCD publications were much longer than medical/health papers. To promote making contributions in this unique research space, Health researchers need more accessible support in navigating the publication norms, specifically understanding the different publication requirements and elements as well as understanding how to tailor the project focus to account for health and design impacts. There are resources that describe guidelines for publishing qualitative research in health venues (Ancker, 2021), and having such tools can help Health researchers further understand how to navigate this space and promote more multidisciplinary studies and contributions.

4.3 Implications for Support in Finding Collaborators

Successful collaborations are also dependent upon being able to work with the right collaborator for the project. Thus, the development of professional networks, assistance from funding agencies, and more resources can support health researchers in finding a compatible collaborator as well as learning how to successfully work alongside them.

4.3.1 Developing Professional Career Networks

The Health and HCD communities can provide support for researchers looking to establish connections with other researchers in order to conduct this type of multidisciplinary work. Health researchers currently find potential design collaborators through the following: proximity, social connections, and institutional programs, such as conferences and training programs. Although these methods have worked in the past, it has still become a challenge for some Health researchers, especially those who have not conducted work in this intersection of Health and HCD. For example, a participant still struggled with finding and working with design collaborators because they were unable to get their grant proposal approved. There have been workgroups that host series of symposiums that have brought together Health and HCD researchers from different institutions and provided mentorship opportunities (Weibel, 2019). On a smaller scale, universities and institutions can further promote multidisciplinary collaborations by promoting cross-department connections, such as hosting events for faculty members to meet (National Research Council, 2015; Kraut, 1987). Thus, the Health and HCD communities can further promote multidisciplinary collaborations by establishing more formal connections between them and creating opportunities for Health and HCD researchers to meet and expand upon their professional networks. Organizing these opportunities for networking can assist in finding potential collaborators that best suit their project needs or learning from others about how to navigate different processes of their multidisciplinary projects, such as grant writing or communicating the values of each discipline.

4.3.2 Funding Opportunities to Promote Collaborator Relationships

Health researchers expressed interest in working with design researchers in order to better improve the designs and usability of their technologies or interventions. Although there are funding agencies that help promote these multidisciplinary collaborations, these grants and awards do not account for fostering the relationships between collaborators, which can affect the outcomes of the project due to collaborator conflicts. For example, one participant discussed how it was common for Health researchers to quickly seek out a design researcher because a grant had required at least one team member who held some kind of HCD expertise. However, that did not allow them to explore whether or not they were compatible in terms of working or communication styles. Some researchers were able to successfully work alongside their collaborators because they received grants that allowed them to foster and build a relationship before going into the project. However, these types of specific grants would not be sustainable because of limited funding. While having resources that help facilitate discussions for how to communicate and understand the working styles of each team member (Kraut, 1987; Team Science Toolkit), delegating additional funds within a grant can provide incentives for fostering healthy working relationships between collaborators and as a result, increase the chances of having a successful and fruitful collaboration.

4.3.3 Support with Choosing a Practitioner or an Academic Collaborator

The findings about how Health researchers define design indicate that there are many different interpretations of what design entails for the health community. While some Health researchers see design as incorporating user input, design is also seen as a variety of other tasks that go into their project. This open definition thus influences what Health researchers look for in a collaborator. For example, perceiving design as purely the aesthetics of the end product can lead the Health researcher to seek out a designer. This could lead to several issues, such as not engaging with design early on to make sure the solutions address people's needs or creating tensions with the design collaborator due to a misunderstanding of expectations (e.g. the Health researcher sees their collaborator as someone who is being hired while the design collaborator may actually want to fruitfully contribute and be fully engaged in all steps of the collaboration). These tensions can be removed by supporting Health researchers in understanding what kind of expertise they need on their projects. Existing toolkits (Team Science Toolkit) help facilitate conversations about personal and project needs and goals, such as expected contributions from each team member. These toolkits can support Health researchers to better identify what type of expertise they need and whether or not working with a collaborator will be worthwhile before committing to working on these multidisciplinary collaborations.

4.4 Limitations and Future Work

This thesis presents empirical data about how Health researchers perceive design as well as what challenges they face when using design methods and working alongside design collaborators. In addition, I provide recommendations for next steps towards addressing the challenges that surfaced in this study. However, I acknowledge that there are limitations to this study as well as opportunities for improvement in future work.

Because the target population included Health researchers and clinicians, it was difficult to recruit many potential participants due to their busy schedules in clinics and hospitals as well as other competing timelines. Recruitment was also limited to Health researchers who worked at research-focused (R1 universities with a medical school; one without) within the United States as well as who self-identified whether or not they used or were familiar with doing design work. Thus, this caused the data to cover a small subset of the larger target population. In addition, there were five participants that had been a part of training programs and/or career awards, which caused the data to reflect more of these unique experiences and was not fully representative of my target populations' experiences outside of these training programs and/or career awards. The findings in this thesis are also not representative of Health researchers outside of the United States, those who worked at non-research focused institutions, as well as those who may be implementing design methods in their work but do not identify as doing design work.

In terms of future work, it is important to gain insight on these missed perspectives in order to fully understand the challenges that Health researchers face when incorporating design into their work as well as confirm what themes appear in the data. In addition, because this study focuses on the Health researchers' perspectives, I hope to combine and compare these findings with the perspectives of HCD researchers in order to gain a full understanding of these multidisciplinary collaborations.

CHAPTER 5: Conclusion

This thesis summarizes the findings from a semi-structured interview study with 16 Health researchers who have had experience using HCD methods or alongside HCD researchers in developing Health technologies. I discuss how Health researchers perceive design methods, which include incorporating user input and iterating on feedback, proofreading and content management, as well as facilitating aesthetics and organization of interventions. I also highlight the challenges that participants face when implementing design methods in their work as well as what challenges surfaced when working alongside their HCD collaborators, which manifest through not understanding their collaborators' discipline, not being able to clearly communicate, and simply not knowing how or when to implement certain design methods. I share insights on Health researchers' relationship and lived experiences with design.

This work contributes an empirical study of understanding the challenges of multidisciplinary collaborations between HCD and Health through the perspectives of Health researchers and shares insights on Health researchers' relationship and lived experiences with using design. These recommendations can contribute to supporting these multidisciplinary collaborations by providing structure for individuals, institutions, as well as resources to better support communication as well as the needs of the involved researchers.

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Appendix A

Pre-Interview Survey & Study Information Sheet

Challenges and Opportunities in Interdisciplinary Research in Health, Design and Technology

Lead Researcher - Elena Agapie, Assistant Professor
Informatics Department, Donald Bren School of Information and Computer Sciences
510-621-3536, eagapie@uci.edu

Study Information Sheet

Please read the information below and ask questions about anything that you do not understand. A researcher listed above will be available to answer your questions.

You are being asked to participate in a research study. Participation in this study is voluntary. You may choose to skip a question or a study procedure. You may refuse to participate or discontinue your involvement at any time without penalty or loss of benefits. You are free to withdraw from this study at any time. If you decide to withdraw from this study you should notify the research team immediately.

We would like to interview or survey you to learn more about your experience with doing research that incorporates health practices, design and technology. The interview will last about one hour. In the interview we will ask you questions about your past experience and practices in doing interdisciplinary research at the intersection of health, design and technology. If you choose to take the survey, it will take up to 30 minutes.

Possible risks/discomforts associated with the study are a slight risk of loss of confidentiality. A breach of confidentiality may result in psychological or social harm (embarrassment, guilt, stress). To ensure participant confidentiality, the information about you will be numbered and linked to your name only on a master list that is password protected and will be kept until the study ends and data analysis is complete. We will not use your personal information, but we may show or use specific parts of your data in any reports about this study, such as journal articles or presentations at scientific meetings, university classrooms or other publications.

There are no direct benefits from participation in the study. However, this study may help us understand the challenges in doing interdisciplinary research at the intersection of health, human centered design and technology.

If you agree, we will record audio or video of the interview. All research data collected will be stored securely and confidentially in a university approved password protected, encrypted location. Your personal information will not be attached to any audio-recording or semi-structured interviews. Recordings are used to understand your needs and challenges. These recordings are kept on a secure server. Audio or video recordings will be destroyed at the end of the study. The information about you will be numbered and linked to your name on a master list.

Your personal information may be given out if required by law. All of the information you provide will be confidential. However, if we learn that you intend to harm yourself or others, we must report that to the authorities. Government or university staff sometimes reviews studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, your records may be examined. The reviewers will protect your privacy.

Future Research Use: Researchers will use your information to conduct this study. Anonymized information gathered during this research study may be used in future studies. We will not use your personal information, but we may show or use specific parts of your data in any reports about this study, such as journal articles or presentations at scientific meetings, university classrooms or other publications, or share anonymized data with other researchers.

You will receive $30 for your participation in the interview. If you participate in the survey, you will be entered in a $30 raffle.

Questions? If you have any comments, concerns, or questions regarding this study please contact the researchers listed at the top of this form. It is important that you promptly tell the researchers if you believe that you have been injured because of taking part in this study. You can tell the researcher in person or call the researcher at the number listed at the top of this form.

If you have questions or concerns about your rights as a research participant, you can contact the UCI Institutional Review Board by phone, (949) 824-6662, by e-mail at IRB@research.uci.edu or at 141 Innovation, Suite 250, Irvine, CA 92697.

What is an IRB? An Institutional Review Board (IRB) is a committee made up of scientists and non-scientists. The IRB's role is to protect the rights and welfare of human subjects involved in research. The IRB also assures that the research complies with applicable regulations, laws, and institutional policies.

If you would like to keep a copy of this information sheet, it can be found here: https://tinyurl.com/HealthHCDCollab

1. Are you over 18 years old?

☐ Yes
☐ No

2. Are you currently working or living in the US?

☐ Yes
☐ No

3. Have you worked on technology projects that involved both clinical researchers and technology or design researchers?

☐ Yes
☐ No

4. How many technology projects have done that used both clinical processes and design processes?

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6 - 10
☐ 10+
☐ Other: _________

5. What is your background in behavioral or clinical health?

☐ I have a degree with a behavioral/clinical health focus.
☐ I took classes with a focus on behavioral/clinical health.
☐ I attended workshops with a focus on behavioral/clinical health.
☐ I learned informally from others through projects and/or collaborations outside of the classroom.
☐ I self taught myself concepts in behavioral/clinical health (e.g. books, articles, videos).
☐ None
☐ Other: _________

6. What is your background in technology design?

☐ I have a degree with a technology focus.
☐ I have a degree with a design focus.
☐ I took classes with a focus on technology or design.
☐ I attended workshops with a focus on technology or design.
☐ I learned informally from others through projects and/or collaborations outside of the classroom.
☐ I self taught myself concepts in technology or design (e.g. books, articles, videos).
☐ None
☐ Other: _________

7. How would you identify as a researcher? (choose as many options as apply or add your own)

☐ Behavioral/Clinical health researcher
☐ Technology researcher
☐ Design researcher
☐ Other: _________

8. Which of the following activities were you involved in while working on a technology project that involved clinical and design processes?

☐ Grant writing
☐ Defining the project
☐ Study design
☐ Recruitment
☐ Data collection (e.g. interviews, focus groups)
☐ Design and prototyping
☐ Data analysis
☐ Evaluation (e.g. of designs, prototypes, tools)
☐ Reporting findings (e.g. writing research articles, reports, presentations)
☐ Other: _________

9. In what contexts did you conduct interdisciplinary work?

☐ Academic Research
☐ Practice/Industry
☐ Education
☐ Other: _________

10. For how many years have you been conducting research in behavioral/clinical health contexts?

☐ Less than 1 year
☐ 1 - 3 years
☐ 4 - 5 years
☐ 5 - 10 years
☐ 10 - 20 years
☐ More than 20 years
☐ Other: _________

11. For how many years have you been conducting research in design/technology contexts?

☐ Less than 1 year
☐ 1 - 3 years
☐ 4 - 5 years
☐ 5 - 10 years
☐ 10 - 20 years
☐ More than 20 years
☐ Other: _________

12. How often does your work involve interdisciplinary collaborations?

☐ 0 - 20% of the time
☐ 20 - 40% of the time
☐ 40 - 60% of the time
☐ 60 - 80% of the time
☐ 80 - 100% of the time

13. What types of institution(s) are you associated with?

☐ Community/Junior college
☐ Liberal Arts college
☐ R1: Doctoral Universities – Very high research activity
☐ R2: Doctoral Universities – High research activity
☐ Medical Schools and Centers
☐ Industry Research Lab
☐ Hospital
☐ Health Clinic
☐ Start-up company
☐ Non-profit organization
☐ For profit organization
☐ Other: _________

14. Does your institution have a medical school, or similar?
☐ Yes
☐ No
☐ Other: _________

15. What is your current title? (or the most recent title you held on a technology project that involved clinical and design processes)
☐ ________________________________

16. What is your highest level of education?
☐ No schooling completed
☐ 8th grade
☐ Some high school, no diploma
☐ High school graduate or equivalent
☐ Some college, no degree
☐ Trade/technical/vocational training
☐ Associate degree
☐ Bachelor's degree
☐ Master's degree
☐ Professional or doctorate degree
☐ Other: _________

17. What is your occupation? (or the most recent occupation you held on a technology project that involved clinical and design/technology collaborations)
☐ ________________________________

18. What is your age? (enter a number)
☐ ________________________________

19. What is your race? (check all that apply)
☐ Asian
☐ Caucasian/White
☐ African American/Black
☐ Hawaiian/Pacific Islander
☐ American Indian/Alaska Native
☐ Not listed: _________

20. To what gender identity do you most identify?
☐ Woman
☐ Man
☐ Non-binary
☐ Prefer not to disclose
☐ Prefer to self-describe: __________

21. What is your name? (your name or email address will be kept separate from your other responses)
☐ ____________________________________

22. What is your email address? (your name or email address will be kept separate from your other responses)
☐ ____________________________________

Appendix B

Interview Introduction for Health Researcher Participants

Introduction [to be read before the interview]

My name is ________, I am a researcher at the University of California, Irvine.

Before we begin, I just want to thank you for being available to talk to us. **We will be spending the next hour asking questions specifically about** your experience working on projects involving the technology design and clinical processes, what worked and what challenges that surfaced during this collaboration, and what lessons you took away from this experience.

Before we begin, I wanted to check if you had a chance to read the information sheet we sent you about the study. If you have not, please take a moment to read it now.

- https://drive.google.com/file/d/1TBLssPym9ZibAud9--t_jhANdd5Xa7ac/view?usp=sharing

Do you agree to continue with the study?

- You can feel free to take a break or stop at any time as we move forward.
- You can refuse to answer any question.
- There is no right or wrong answer.

May I record this conversation? This will not be shared with anyone outside of this study and will be saved in a secure location.
[if they say no, the note taker should be prepared to take very detailed notes]

Appendix C

Interview Protocol for Health Researcher Participants

Interview Protocol

- Tell me what experience do you have working on projects involving technology and design as well as clinical processes, specifically those where you worked alongside a design collaborator?
    - What kind of projects were you involved in where you worked with a design collaborator?
- Can you tell me a little about your research and what is your typical research process?
- Can you tell me what is design to you and how do you engage with design methods in your research?
- How have you decided about pursuing collaborations with design researchers?
    - Are there any challenges in establishing new collaborations at this stage in your career?

- We would like to learn about a project where you collaborated with designers or technology researchers to design a technology or an intervention.
    - What was your team designing?
    - What was your role in this project?
    - What were your responsibilities?
    - Who was on the project team, and who did you collaborate with?
- What motivated you to collaborate with a **technology design researcher** on this project?
    - What was easy or difficult with setting up this collaboration?
- What were your goals in this project?
    - How were your goals different from the goals of the design researchers?
    - Can you give me an example of an instance where your goals were misaligned?
- **Can you walk me through the different stages of the project and step by step how you engaged in design alongside your design collaborators?** (for e.g. in grant writing, study design, formative work, prototyping and building a tool, recruitment, all the way to reporting findings)
    - **How did your research process differ from when you did not collaborate with a design researcher?**
    - How did you know what you were going to build?
    - What did you do next / What happened next?
- **How did working with a design researcher affect your typical research process?**

        - E.g. changed timeline, brought new insights, made it harder to do certain clinical parts of the research
    - In what way did your tasks and the technology design researcher's tasks impact each other?
    - How did these tasks affect how you collaborated with other team members?
- What **challenges** did you encounter in your **collaboration** with technology design researchers?
    - How did you manage these challenges?
    - Were there any instances when it was difficult to implement your ideas while using the design process?
    - Were there any instances when your collaborator was not able to implement their ideas because of the research processes you each used?
- Were there challenges in using any particular design method?
    - **Formative + Understanding people's needs**
    - **Prototyping**
    - **Evaluating designs or prototypes**
    - **Iterating on designs**
- Who was involved in the design work (e.g. understand user needs, prototype, evaluate prototypes, iterate on prototypes)?
    - How did you contribute to the design work?
    - What tasks did the **technology design researchers** work on?
        - Give me an example.
- How did you or your team bring together **expertise or knowledge** from the different backgrounds of the team members?
    - What were some steps that you and your team took to understand each other's backgrounds?
    - How did you learn design methods, if you did?
    - How did you bring in your clinical expertise in the design process?
    - How did you align your different expertise?
- What are some things you learned about doing research using design **methods** during this project? (e.g. from understanding user needs, prototyping, iterating, evaluation, or data analysis)
    - What was something that surprised you while using the technology **design methods**?
    - Are there specific insights that the design methods have allowed you to do that you otherwise wouldn't do?
    - What practices did you adopt or are interested in adopting from design research?

- **We’ve only talked about one project and the challenges you encountered. Can you tell us about some projects in which your collaboration with a design researcher did not lead to a successful outcome? What failed in those projects?**
    - [if they only talked about negative things] What were some things that were successful in projects where you collaborated with a design researcher?

- In your opinion, what does a successful collaboration between design researchers and clinical researchers look like?
    - To you, what does a successful use of the design process and clinical process look like?

- **If you could have any support you wanted to work in teams of design researchers and clinical researchers, what would that support look like?**
    - What advice would you give other clinical researchers and technology and design researchers looking to work in these types of interdisciplinary collaborations?
        - What advice would you give them so they have a valuable and successful experience?
- Is there anything else you want to add or we should have asked you about?
- Can you think of one or two other clinical or design and/or technology researchers you know that you recommend we reach out for this study?