Investigating Opportunities for Crowdsourcing in Church-Based Health Interventions: A Participatory Design Study

Elizabeth Stowell[1], Teresa K. O'Leary[1], Everlyne Kimani[1], Michael K. Paasche-Orlow[2], Timothy Bickmore[1], Andrea G. Parker[1]
[1]Northeastern University, [2]Boston University School of Medicine & Boston Medical Center
{stowell.e, oleary.t, kimani.e}@husky.neu.edu, mpo@bu.edu, {t.bickmore, a.parker}@northeastern.edu

ABSTRACT
Churches play a major role in providing social support to address health inequities within Black communities, in part by connecting members to key organizations and services. While public health has a history of disseminating interventions in faith communities, little work has explored the use of crowdsourcing to tailor interventions to the unique culture of each church community. Following Community Based Participatory Research principles, we partnered with two predominantly Black churches, and report on a series of three participatory design sessions with nine participants. We developed a novel storyboarding method to explore how crowdsourcing could promote health in these faith-based communities. Our findings characterize existing supports within the church community, and how church social structures impact member access to these supports. We further identify motivations to engage with a church-situated health application, and how these motivations translate to crowdsourcing tasks. Finally, we discuss considerations for public health crowdsourcing tasks.

Author Keywords
Crowdsourcing; mHealth; Health Promotion; Participatory Design; Faith-based communities; African-American

CCS Concepts
•**Human-centered computing** → **Human computer interaction (HCI);** *Collaborative and social computing;* Social content sharing; Collaborative content creation;

INTRODUCTION
There are significant health disparities among racial and ethnic populations in the United States (U.S.), both in terms of health outcomes and access to health care. People who identify as African American suffer a disproportionate burden from major chronic diseases [21, 35, 16, 11, 17, 36], and have a lower general life expectancy [12, 8]. Religious involvement is a central aspect of African American culture [24], with more than half of African Americans (53%) reporting that they attend religious services at least once a week [33]. Church communities thus represent an important source of social support for African Americans [32]. This potential for social support is an affordance of faith-based contexts for health promotion, given the importance of informational, emotional, and instrumental support during health behavioral change efforts. Additional affordances include the existing health ministry initiatives (i.e., church-led programs designed to promote wellness), rich community-based resources, and frequent and regular opportunities for member interactions (e.g., Sunday service, Bible study groups) [6].

Prior work has used participatory methods to explore how technology can support spiritual practices. This body of work demonstrates how technology can support spiritual practices [43], extend religious experiences into the context of daily life [42], and facilitate shared interactions at a geographic distance [37]. However, limited work has explored how technology, developed in a religious or spiritual context, can promote health and wellness [23]. Most of this work has relied on text messaging-based interventions to disseminate health promotion messages, with little work investigating more innovative ways for technology to build upon the rich social infrastructure within church communities.

While there are distinct benefits to embedding a health technology intervention into faith-based contexts, designers must ensure that these interventions reflect the community's priorities and needs [34]. Designing an intervention for a community with long-term membership poses challenges to engagement. Such interventions require a large quantity of content that is not only culturally relevant, but also continuously updates and evolves with the community. One mechanism for creating and continuously updating socially-relevant content that reflects the values of the intended church community is crowdsourcing. Crowdsourcing, as a production model, gives community members an opportunity to creatively author content, perhaps even more effectively than domain experts [4]. To our knowledge, crowdsourcing has not been used within faith-based communities for health promotion. Crowdsourcing initiatives have largely been used in public health interventions to en-

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.
CHI '20, April 25–30, 2020, Honolulu, HI, USA.
© 2020 Association for Computing Machinery.
ACM ISBN 978-1-4503-6708-0/20/04 ...$15.00.
http://dx.doi.org/10.1145/3313831.3376833

hance content [10], provide timely health feedback [41], deliver health information, and provide social support [7, 18]. Our research extends this prior work into the context of faith-based settings. Specifically, we investigate how crowdsourcing can be used to harness the collective power of church communities to create socially-relevant and meaningful content, tailored to users' specific cultural needs.

As an initial foray into this space, we conducted community-based participatory research (CBPR) with participants from two predominantly Black churches. We report on a subsection of our formative work: three storyboard participatory design sessions in which participants designed mobile health (mHealth) interventions that leveraged a range of crowdsourcing techniques in their church communities. Our work is guided by the following questions: 1) What resources do church members seek in a faith-based health application? 2) How does the church context and culture impact access to these resources? 3) What motivates church members to participate in crowdsourcing within their faith communities?

Our participants were motivated to connect with peers in their church community using an mHealth application, and found crowdsourcing and mHealth technologies acceptable within the church-setting. We contribute directions for future work focused on faith-based health technologies, including further investigation of how crowdsourcing tasks can be tailored to values of spirituality and fellowship.

RELATED WORK

Black churches in the U.S. have a strong tradition of social action and community outreach aimed at addressing inequities faced by their congregation and the surrounding communities [26, 32, 40]. They are often the most visible and respected organizations in the African American community [6]. Because of this tradition, Black churches have long been a focal point in public health efforts to reduce health disparities that exist between African Americans and other ethnic groups [5]. In 2001, President Bush established the White House Office of Faith-based and Community Initiatives, which continues today to direct funds to such organizations for health programming [20, 31]. However, this focus on community-based health promotion has not yet been translated to technology-facilitated interventions. A 2018 systematic review of mHealth interventions in vulnerable populations (including racial and ethnic minority groups), found that few mHealth interventions are grounded in a community context. Further, none of the mHealth interventions were situated in a faith-based community [38]. Our work explores the acceptability of a technology-based health intervention in a church-setting, and how crowdsourcing tasks may support church efforts in addressing health inequities.

Technology Use in Faith Communities

While faith-situated health technology has not been explored in the field of HCI, technology used to engage in spiritual or religious practices, often termed techno-spiritual practices, is a burgeoning field of study. This work aims to understand how technology can help religious users enrich their faith without disrupting core beliefs [1]. This body of work largely explores how technology can support personal spiritual practices [42] and create spiritual experiences [1], and how technology transforms church worship when integrated into religious services [44].

Various information and communication technologies have been designed to support a variety of religions and religious practices. These systems support Islamic pilgrimages [25] and Muslim and Christian prayer [1, 43], connect members to their religious communities even when separated by distance [37], and support the mindfulness practices of Pentocostal users during the course of their daily lives [42]. This work has found that, even in social contexts where technology adoption may seem antithetical to spirituality, technology can enhance spiritual practices and may even be welcomed in faith-situated contexts when designed with intended constituents.

In a study of technology use in megachurch services, Wyche et al. found that large displays are well-accepted as a means for increasing efficiency during worship services; however, the acceptability of other forms of technology in these spaces, including personal technologies, are constrained by both church infrastructure and the personal preferences of community members and religious leaders [44]. Wyche et al.'s work demonstrates the need to identify the unique social structures, technology preferences, as well as distinct infrastructures that could potentially augment or constrain technology integration.

Our work extends the field of techno-spiritual practices, wherein we explore how technology can leverage strengths within a faith community to accomplish additional church goals (e.g., promoting constituent health) in predominantly Black protestant churches. To our knowledge, no work in HCI has examined the intersection of techno-spiritual practices and wellness technology. In each of these techno-spiritual examples, community member input was critical to the success of the design. Therefore, crowdsourcing in a faith-based app has the potential to create ownership and empowerment in the health tech intervention which helps to sustain engagement. Crowdsourcing initiatives present an opportunity to tailor content to the unique culture of a church.

Crowdsourcing for Health

Crowdsourcing is an efficient means of collecting and enhancing user-generated contributions, allowing networked communities to provide information, resources, and creatively author content to solve problems [3, 7, 28]. In public health research, crowdsourcing has the potential to empower community members to become directly involved in the development of health promotion strategies and solutions [4]. Like other types of community engagement research, involving community members ultimately can enhance public health interventions and programming to reflect the underlying principles, values, and beliefs of the target community [4]. This is particularly critical within the church context, where practices, preferences, and priorities vary even between churches of the same denomination. In optimal cases, crowdsourcing has the potential to leverage the strengths of community members in order to identify and alleviate existing problems.

The following public health crowdsourcing typology categorizes four major crowdsourcing tasks suitable for different types of public health challenges: the Knowledge Discovery and Management approach (KDM), Distributed Human Intelligence Tasking approach (DHIT), Peer-vetted Creative Production approach (PVCP), and Broadcast Search approach [4].

A KDM approach tasks the community with gathering relevant information and storing it in a common location. This approach is appropriate for information management problems that require a central repository, accessible to community members [4]. KDM is particularly beneficial to minority communities because the information generated from others within the target community is inherently tailored to the community needs. For example, Kumar et al. utilized a centralized discussion forum for individuals with HIV/AIDS to share and seek information [22].

In a DHIT approach, community members use specific parameters to process small segments of centrally-stored information. Typically, this technique is useful when attempting to synthesize large amounts of data that cannot be easily or reliably done automatically [4]. For example, DHIT has been used in numerous dietary tools to provide timely feedback on calorie totals or relative healthiness of digital images of food [41, 27] and to build databases of nutritional information of foods and their dietary alternatives [10]. DHIT has also been leveraged in chronic pain management where both experts and non-experts provide and rate solutions [18]. These studies demonstrate how DHIT techniques can leverage collective wisdom to provide timely feedback.

PVCP approach is an appropriate use of crowdsourcing when solutions to a problem rely on the preferences and attitudes of community members outside of the external stakeholders. Here, community members or crowdworkers are asked to give valuable insights and knowledge. Those insights will ultimately determine the solution and its implementation [4]. PVCP is easily demonstrated in urban planning projects which seek public feedback or public design contributions. Additionally, PVCP has been used to facilitate volunteer efforts during a hurricane using Slack, a collaborative software tool [7].

Broadcast Search [4] is a request posed to the community for an empirically provable solution to a problem. Conrad, et al. discuss the implementation of Broadcast Search to remotely access domain experts in crisis situations. These systems broadcast a need for assistance with the aim of connecting to critical insight not readily available to volunteer teams [7].

While crowdsourcing has been applied in many public health domains, crowdsourcing techniques have yet to be designed to create tailored behavior change content for unique spiritual communities. In this work, we explore church member motivation and willingness to engage in crowdsourcing initiatives within their faith communities.

METHOD

This work is part of the formative first year of a four year CBPR project to design, develop, and evaluate an mHealth intervention in predominantly Black church communities. The focus of our first year was to work directly with community members to identify community needs and strengths, and to engage church members in the participatory design of the mHealth application. In this paper, we report on a subset of the formative work. We conducted semi-structured interviews and participatory design sessions with nine participants to understand the unique challenges to health promotion that church members face, as well as how to leverage volunteer behavior prevalent within these church communities. In addition, we conducted modular storyboard activities to identify crowdsourcing tasks appropriate for faith-based mHealth applications. This process yielded crucial input from our participants, resulting in the identification and discussion of potential crowdsourcing tasks.

Participant Recruitment

We partnered with an organization that provides resources to over a hundred faith organizations serving predominantly Black churches near our city in the Northeast U.S.. In our findings, we refer to this organization as the 'partner organization.' This organization identified two churches to support the formative year of the project: Church A is a historical Baptist church with approximately 600 members. Church B is a more recently founded African Methodist Episcopal (AME) church with approximately 500 members.

We worked closely with health ministry leaders from both churches to identify members of each community who could provide different perspectives and expertise regarding the strengths and needs of their respective church communities. Participants were eligible to participate in the formative work if they were 18 years or older, self-identified as a member of one of the two churches, were English-speaking, and owned a smartphone. We actively sought out participants with various levels of "embeddedness" in the church community to represent a cross section of experiences reflected in the church laity. Participants were consented at the start of formative work by a project member.

Prior to the sessions reported in this paper, participants had each engaged in five focus groups of 2-3 hours each (11 hours total). One participant missed one, and one participant missed two of the prior five focus groups. The first four focus groups explored various dimensions of participant experiences in their church communities (e.g., religious practices, social support, health priorities, and technology use), helping us gain important context about the church communities before exploring concepts for technology-based interventions. The 5th focus group engaged participants in the design of preliminary concepts for a health app, allowing us to examine opportunities for app-based support as well as feature requirements important to the participants.

Modular Storyboards

To answer our research questions, we developed a *modular storyboard* method. Our modular storyboards combine elements of two traditional storyboarding methods (i.e., a set storyboard versus a blank canvas), by presenting participants with the same overarching storyline [14] while also allowing them to customize, change and remove parts of the board [2]. The similar storylines facilitated participant comparison of each

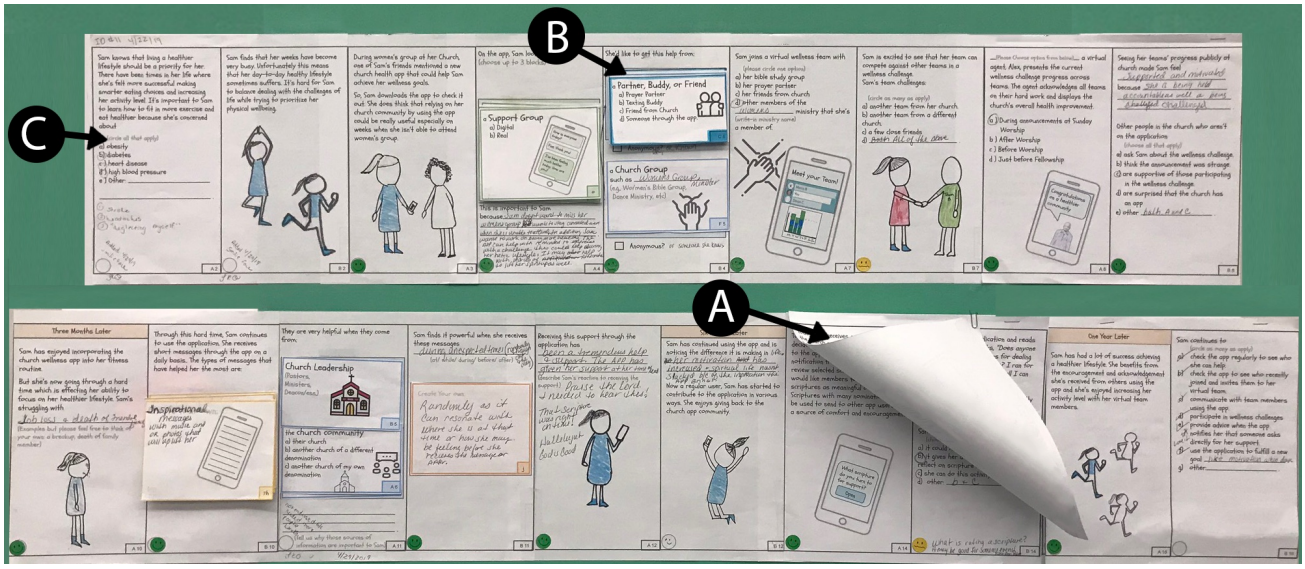

Figure 1. Completed Wellness storyboard with customization options.

others boards. Through the customizations, participants drove major design decisions and outcomes within the scenarios, resulting in end products that reflected their personal values and experiences. The storyboards explored participant attitudes toward, and preferences for, a health application used within the context of a church community, as well as motivations for contributing to the application using crowdsourcing.

The storyboards depicted a fictional character's interactions with a church-based mHealth application at key points in their health journey. Storyboards were structured into three phases of the character's health journey: introduction to, seeking support from, and contributing to the health app. The jumps in time probe the types of support a key informant would seek in the app, motivations to engage in crowdsourcing, and motivations for longer-term app use. In previous focus groups, participants identified three health concerns and priorities for themselves and for their church communities: depression, joint pain, and wellness (focusing on physical activity (PA) and nutrition). These health concerns were developed into three distinct storyboards, and allowed us to explore the unique dimensions of each health journey. Participants were instructed to customize the storyboards in the following ways:

- *Storyline Options* (Figure 1A). Participants were instructed to choose from multiple storylines to explore different types of engagement with the application (e.g., including public vs private acknowledgements). Multiple storylines allowed for a contrast between options to test acceptance and feasibility of various design choices and edge cases.
- *Blocks* (Figure 1B). Participants were given four packets of blocks: social support and resources (e.g., free and discounted resources, preventive health information, and places to vent), people (e.g., health professionals, church leadership and laity, family), context (e.g., church service, downtime), and message blocks (e.g., health, inspirational, social). In the character's time of need, participants were encouraged to tape on blocks. Enabling participants to mix and match blocks allowed us to explore factors that might impact their preference for app-facilitated social support. Participants were encouraged to create their own blocks if the existing blocks did not fit their needs.
- *Fill in the Blank OR Multiple Choice* (Figure 1C). At key plot points, the storyboards had multiple choice and fill in the blank sections to allow the participants to create a story that felt authentic to their own experiences. These customizations prompted for the character's reasoning and reactions to block choices and storyline options depicted in the storyboard.
- Participants were additionally encouraged to customize the storyboards however they saw fit, including to write directly on the storyboard.

Depression	Testimonials
Joint Pain	Rated health messages
Wellness	Authored health messages
	- to individuals or community
	& Nominated scripture messages

Table 1. Crowdsourcing Activity by Storyboard Health Topic

Procedure

In this paper, we report on the storyboard design sessions, which included two individual storyboard focus groups, eight individual interviews, and two group storyboard focus groups for a total of 12 data collection sessions.

Individual Storyboard Focus Groups: In the first session, each participant customized their own individual storyboard. Participants chose from three different health scenarios. The storyboards took approximately 90 minutes to complete. Participants then presented their storyboards to the group and answered questions about the choices they made. At the end of the session, participants briefly discussed differences and similarities they saw in the storyboards. These sessions were 3 hours each.

Interviews: Given the time constraint of the individual storyboard focus groups, participants were invited to a follow-up

1-on-1 interview where they walked through each decision they had made in the storyboard. Participants were further prompted to reflect on whether the storyboard they created was reflective of their personal experience and their preferences for engaging with a health promotion application. Each interview lasted 1 hour.

Group Storyboard Focus Groups: In the third session, participants worked in teams of two or three to complete a wellness storyboard to help achieve consensus around crowdsourcing tasks. We chose the wellness storyboard because it contained the greatest number of crowdsourcing tasks within one storyline, as well as content that sparked discussion in the previous sessions (e.g., nominating scripture, anchoring intervention content in church services.). The storyboards took approximately 90 minutes to complete in groups. At the end of the session, each group presented their storyboard, and were asked to discuss differences and similarities in storyboard designs between groups. The group discussion gave participants an opportunity to insightfully challenge each others storyboard decisions, allowing them to explore design ideas more fully. These sessions were 2.5 hours each.

Participants were compensated $24 per hour, for a total of $156 for the complete 6.5 hours. The Institutional Review Board at our university approved the study protocol. In this paper, we report upon the findings from 4 focus groups (2 individual storyboard sessions, 2 group storyboard sessions) and 8 participant interviews.

Analysis

Interviews and focus groups were audio recorded and transcribed, resulting in a total of 11 hours and 10 minutes of audio files and 506 pages of transcription used. We conducted a thematic analysis of focus group content guided by our research questions with the aim of identifying design insights. In our analysis, we used elements of grounded theory analysis, including constant comparisons, axial and selective coding, and memo writing [39]. Using NVivo 12.5.0 software, two researchers inductively coded transcripts separately, labeling emergent phenomena in the data to arrive at a codebook. Two researchers then independently applied the codebook to participant transcripts, 9 individual storyboards, and 3 group storyboards. We met regularly during the analysis process to discuss discrepancies in the applications of the codes, reexamine the codebook, and reflect on contradictory data.

Participant Overview

Nine church members participated in the individual storyboard session, 4 from Church A and 5 from Church B. One member of Church B dropped out of the study for personal reasons before individual interviews and the group storyboard session. One member of Church A could not attend the group storyboard session. *Demographics:* All church-members self-identified as Black. 6 were female and 3 were male. Participant ages ranged from 33 to 73. One participant had completed some high school, 2 had some college, 3 had a BS/BA, and 3 had advanced degrees. *Church Engagement:* Participants from Church A have been members for an average of 12 years (SD = 11.5, Range: 2-27), whereas participants from Church B have been members for an average of 4.5 years (SD = 2.4, Range: 2-7). They range from no involvement in any church affiliated group or ministries to serving multiple roles in the church. These roles include attendee, ministry team leader, choir member, and trustee.

FINDINGS

In the individual storyboard session, 4 participants chose the joint pain board, 2 chose the depression board, and 3 chose the wellness board. In the group storyboard session, all 3 groups completed the wellness board. Through the storyboard activities, participants provided rich descriptions of types and sources of support they could benefit from, existing resources and barriers to access in their church, and attitudes toward crowdsourcing tasks to address these barriers. In our findings, we first describe the strengths and challenges that church members perceive in their church communities, namely how privacy and need for confidentiality can impede access to existing peer and professional support. We then apply a public health crowdsourcing typology to contextualize participant motivation to engage in crowdsourcing tasks [4]. Our findings extend previous work by illuminating attitudes and preferences for crowdsourcing tasks when designing a faith-based health technology.

Accessing Community Professionals

Health Experts: Health experts, including health liaisons (n=7) and practitioners (n=6), were described almost exclusively as a source of informational support. The need for information from a credible source was deemed critical at the beginning of a health journey (e.g, with a recent diagnosis) when one might not know what questions to ask. P7 explained that in her personal experience with surgery, "*...the person who told me that [...] I absolutely wanted to go into rehab and not just go home. Um, was a health professional who was just, who had me think about something that I hadn't thought about.*" These health experts are particularly useful, in that they can anticipate informational needs. One of the differences between the churches was the make-up of the congregation. While Church A largely discussed health professionals as individuals from the surrounding communities, Church B noted that many members of the church work as health practitioners. In fact, P7 described how she leveraged this resource, "*I also have the advantage of, [some of our church leadership] are [health professionals]...I did talk with him a bit about [joint] surgery as well.*" However, even with medical professionals within the congregation, participants remain uncomfortable using fellowship or worship to approach these gatekeepers to health resources. As P6 stressed "*it's their day to worship with their families; this isn't the time or place,*" suggesting a concern that inquiries about health resources may interfere with a fellow church member's day of worship. Another participant added that just by publicly approaching a health professional in the congregation, one may inadvertently reveal some aspect of their health to the broader community.

Church Leadership: Similar to the role of health experts, church leadership (e.g., pastors, ministers) were imagined to assume a less active role in the health application given

that they tend to an entire congregation. In the group storyboard session, church leadership was neither selected nor discussed as a direct source of support. In the individual storyboards, only three participants chose church leadership as a source of support on the application. The church leadership block was always paired with the scripture-based message and emotional support blocks; however, this support was directed at the broader community as opposed to the individual. For example, P3 suggested that the Pastor's support on the app, "*. . . doesn't even necessarily have to be specific, but it could just be like, 'hey, I posted a song in the app that, you know, really gave me some great motivation last week. So I just wanted to share it with you all.'*" Similar to a Sunday sermon, a church leader can provide inspiration throughout the week with congregation-wide messages, even without knowing the details of each member's challenges. Even with numerous options for support to choose from, participants select support from church leadership that is commensurate with the support they currently receive face-to-face; reinforcing a place-based social relationship using computer mediated technology.

When asked why P5 did not select church leadership within her board, she explained, "*I personally don't have time to call and say my woes to my pastor- or cry. I don't have time for that energy. But a friend or my prayer partner would know because we have that intimate time.*" P5 would rather vent to a friend who is up-to-date on her life than have to retell the entire story to her pastor. P5 described her hesitancy to accept a pastor's offer of support: "*I always feel that with [church] leadership, certain levels of leadership, there's other people that may need support more than I do.*" This participant viewed direct support from church leadership as reserved for those in desperate need. While she might benefit from this support herself, taking up a church leader's time becomes an egocentric act.

Even with experts within the congregation, church members face barriers accessing the support that they need. Church members require methods to connect to community experts that are respectful of these experts' time and that feel appropriately situated within the social context of the church community. Seeking expert help through computer mediated interactions may both ameliorate privacy concerns and validate user decisions to seek help by reminding them that their health concerns warrant support.

Privacy & Close-Knit Communities

While participants sought informational support from health experts and expressed an interest in connecting to church leadership, they more frequently selected support from peers with similar past and present experiences (9/11 boards, all boards if both partner blocks are combined). Participants from both churches describe the social structure of the church as a tight knit community composed of, in the case of Church A, many members who have belonged to the church for their entire lifetime. While Church B is a younger organization, participants describe a community rich in social connections as well as support. Building on existing social ties within these close-knit communities afforded the participant-designed interventions numerous advantages characteristic of peer support. These advantages include: 1) established trust, 2) connections in the community and 3) regularly seeing each other. While these advantages have been identified as motivations for non-technological faith-based health interventions [6, 15], they remain benefits when translated to the faith-based mHealth applications our participants conceptualized. In an mHealth setting, access to a healthcare practitioner or peer are the same in the imagined application; whereas in non-tech, community-based health research, access to a health practitioner is limited by finances, location, and time [32, 20]. Even when removing these constraints, participants still focused on building connections to their peers as a critical requirement of the application.

P7 described the advantages of an unofficial joint replacement support group that she joined at her church, where church members who had undergone a similar procedure would check in and share tips while at unrelated church events. P7 explained, "*They were people that I knew and I trusted. And um, I saw them regularly. [...] we had a relationship that was greater than just [joint] replacement. That preceded and has continued to past [joint] replacement surgery.*" In this way, the group connected over multiple shared experiences, including a shared health journey and a shared church experience. As a result of the deep connection this group shared, P7 explained that the group still exists, but now with the purpose of serving others in the church community. She stated, "*. . . [we] continued to refer each other to other people who are having or have, who are anticipating or who have had [joint] replacement surgery.*" While support groups based solely around a health journey may disband after the immediate need is gone, this group's continued connection enables them to serve the church community more broadly through the wealth of resources and knowledge they have collectively built. Sustaining these deeply connected groups not only benefits the group members themselves, but also the larger church community.

While P7 experienced this support group before an app was created, P4, a member of Church A, described similar ways in which his character would benefit from these types of connections. He explained, "*So you want a team that can be able to talk about it, have a sit over coffee [laughs] and stuff. You know? Or it- this can be part of their- um, their fellowship. Um, I mean, after church.*" Even in the context of a technology-based intervention, P4 saw the benefit of in-person meetings and the convenience of using existing fellowship practices to promote wellness.

While participants felt that the app could strengthen social ties within the church community, they did not want newer or more isolated church members to feel excluded. P6 explained, "*I wouldn't want them to be excluded just because they don't have close friends [in the church].* " Almost all participants echoed this sentiment and emphasized that continuing to retain and attract new members is an important aspect of the church's mission and should be translated to the app.

The close-knit fellowship shared amongst church membership is a clear strength of the community; however, participants explain that this closeness also decreases privacy at crucial moments. While participants feel close to other church mem-

bers, depending on the health concern, they are unsure of who to approach and worry that asking for that type of health networking assistance could simultaneously lead to lack of privacy. In the context of sensitive or stigmatized healthcare topics, lack of privacy was identified as a deterrent from seeking resources, recommendations, or support. P3 explained her hesitation discussing health concerns in church, "*maybe you go to the church, but you don't have someone specifically [who can help] or you're like, I'm not ready to let you specifically know what I'm dealing with.*" Because of this, anonymity was most frequently discussed in the depression boards and for additional stigmatized health topics (e.g., sexual health). When prompted for an appropriate or desirable time to use anonymity in a health app, participants who did not complete a depression storyboard referred to mental health and sexual health. However, P4 reminds us that privacy may still be a concern, even with more mundane health issues. He explained, "*it's that some [church members]... and I will call them "busybodies". That you just don't want [them] to know ... what you're doing until it's that time. So if you're talking about... your health problems..., and I could've said [the storyboard character] could've been diagnosed with one of these issues here [diabetes, high blood pressure], and just don't want to speak it out.*" P4's concern with privacy and anonymity on his wellness board demonstrate the sensitivity of any health diagnosis. Indeed, prior health interventions in churches have found privacy to be the largest barrier to accessing peer support in numerous health contexts [15, 13].

The above findings highlight a participant identified need for opportunities to access resources in the Church that simultaneously maintain an individual's privacy and promote safe conversations about sensitive health issues. While the churches provide some resources to their members, and Church B has many health professionals within its congregation, church members still face barriers to accessing these resources. The lack of appropriate channels for accessing resources and a need for privacy obscure the existing resources within the church. Thus, participants prioritized visibility of existing informational resources in their storyboards, and identified their own crowdsourcing initiatives to solve issues of access.

Crowdsourcing Tasks

To our knowledge, no prior work has explored what motivates members of a faith community to partake in crowdsourcing. During our storyboard sessions and interviews, participants discussed three main motivations to contribute to the application: 1) supporting the missions of the church 2) extending one's faith practices, and 3) strengthening connections to the church community. These motivations were illustrated in the types of crowdsourcing tasks participants endorsed and created. To understand how these motivations mapped to different crowdsourcing tasks, we grouped tasks into the public health crowdsourcing typology. Tasks within the storyboard fell into three of the four categories described in the related work: KDM, DHIT, and PVCP [4].

Central Repository of Community Resources

Several participants articulated the usefulness of leveraging the application to collectively create a central repository of resources in their community (e.g., Black-owned gyms, free clinics, local fitness classes). Participants saw numerous benefits to this repository, including that the information would be: 1) accessible, 2) extensive and 3) culturally relevant.

Access: Participants indicated that such a repository of resources could make relevant information accessible whenever needed. P3 discussed how the application could facilitate in-the-moment assistance: "*[if] her schedule won't allow her to physically go [to a therapist], the app has the support groups... the words of affirmations are things that could kind of help her cope in the meantime.*" In this scenario, the participant saw value in providing an individual with immediately actionable resources while waiting on longer-term support (e.g., therapist appointments).

Collective Wisdom: Two of the youngest participants discussed the benefit of posting a healthcare question to the wider application community to receive a multitude of opinions and recommendations. Indeed, Brabham, et al. posits that community sourced solutions in the aggregate may be of higher quality or comparable to the recommendations of an expert [3]. In addition, our oldest participant went so far as to say, that while companionship support should be personal, informational support is better coming from the larger community. This participant explained, "*What makes most sense, is, accumulating data, uh, you know- Accumulating data for a month. Like... you know, Doctor A, Doctor B, I mean, who could they accumulate data on what those doctors have done, with respect to your malady. Now, that would be interesting.*" For this participant when talking about his health, the opinions of many outweigh that of a single individual, making the information more credible when coming from a wider source.

In the group storyboard session, participants explored how larger organizations, such as this project's partner organization, could provide additional resources and support through its large network. Upon hearing another group present a storyboard that included the use of the partner organization to collectively bargain for and acquire access to resources, P7 stated, "*... I'm impressed by the fact that we didn't think about the, um, volume of contact[s] that the [partner organization] has. Because...that very much expands the access to resources that people have.*" This example demonstrates how a central repository of community resources could benefit church members given that the church's affiliation with a powerful resource partner is still relatively unknown to church members. As a result, resources through this organizational affiliate are essentially inaccessible due to lack of publicity and communication within the church community.

Culturally Relevant Resources: Creation of a central repository developed by peers in the community has additional benefits, including that it would contain culturally relevant support. Participants explained that accessing culturally relevant resources remains a problem for both themselves and other individuals in their community; however, as a whole, the community could provide these resources. Participants saw benefit in crowdsourcing amongst church members for resources such as culturally competent physical and mental health practitioners (i.e., providers who understand that health inequality based on

social characteristics affect how a non-White patient may be treated in various healthcare environments), or support groups as well as Black-owned fitness organizations. P3 described a recent experience of her search for local fitness centers, saying "*I just discovered a Black-owned gym... which I had no idea it ever existed...*" P3 described multiple motivations for accessing this gym, saying, "So it's like, oh, okay, it's serving health, and you're supporting a local business and you're supporting a Black-owned business. So it's like a three for one." Despite living in her community for a number of years, she was unaware of a culturally relevant resource only steps from where she lives that would 'understand her needs.' Throughout interviews, participants shared their frustrations with knowing that members of their community likely have useful culturally relevant resources; however, accessing these resources remains difficult due to a lack of visibility of these resources and lack of social interaction opportunities to ask others in the context of the church. Additionally, a central repository of resources may increase a church member's opportunity to locate culturally relevant and tailored resources and recommendations by tapping into the collective brain of the wider church community.

Place-Based Calendar System: The simplest form of reinforcing community using a place-based mHealth application is through awareness of events by keeping a community wide calendar up-to-date. A church calendar was not a block option, and yet multiple participants saw benefit of a calendar in the storyboards. P3 shared with us a church events calendar, which was displayed within an application used by her previous church. P3: "*you can like download stuff and you can figure out...they're having like a kids camp. And they're doing a food drive. Even out of state*", P3 uses the calendar feature in the church application to feel connected to this community through awareness of upcoming events. P3's experience in her previous church contrasts starkly with P1's description of their church's online calendar, which displays out-of-date information for ministry gatherings. She explained that an up-to-date calendar benefits current church members for keeping track of church events, and also could impact a potential new church member's decision to join, "*That could, um, influence your decision on staying with that church ... if you don't see things constantly moving, constantly changing, like would you want to keep going [to church]?*" P1 suggested that by supporting these church events through a simple solution, like an up-to-date church calendar, not only impacts current member's ability to participate and increase fellowship opportunities for interaction, it also promotes the growth of church membership. While a digital calendar may not pose a technical challenge or innovation, understanding how these existing technologies can be leveraged for community level health behavior change provides insight into sustainable mHealth interventions.

Rating Content

User Rated Health Messages: In the wellness storyboard, one optional storyline proposed a Distributed Human Intelligence Tasking approach, where the application asks the character to rate a series of short health messages as helpful or unhelpful. The user is told that highly rated messages would serve as customizable templates for their community. While participants generally found message templates acceptable, some participants had concerns about the authenticity of message content constrained by templates. One participant mentioned that while she felt the activity was extremely beneficial, she worried about how time consuming the activity would be. Participants agreed that rating health messages as helpful or unhelpful was appropriate, and especially useful for tailoring messages directly for their community.

User Nominated Scripture: Within each storyboard, participants selected types of support, including scriptural messages, to deliver to the characters during a time of need. Participants found scriptural messages impactful when working towards a health goal, and as a result, included scriptural messages on most boards (7/12 boards). Participants viewed this type of faith-based support as most authentic when provided by members of their faith community. Our research team created an optional storyline to probe participant motivation to create these faith-based messages. In the optional storyline, the character participates in a DHIT where they are asked to "rate scripture" as most helpful when in need of comfort or encouragement. While some participants chose this storyline as a way for the character to contribute to the application, all participants stated that using the term 'rating' scripture was inappropriate and that earlier language contained in the storyboard of "nominating scripture" was a more sensitive description of the activity. P5 explained why scriptural messages required a more nuanced approach to crowdsourcing, "*But what's rating a scripture? Like what scripture may be good for me on this day may not be good for that person... that scripture may not be something that resonates with me, but on this particular day that scripture could uplift the next person.*" This discussion of the term 'rating' during the storyboard sessions demonstrates the strengths of the long term relationships researchers have with community members when conducting CBPR. Through rapport building over the course of the project, our participants were empowered as experts of their faith community and thus felt comfortable correcting our terminology and generating their own description of and design for working with scriptural content in the app.

Contextualizing Scripture: Participants emphasized that there is no such thing as bad scripture, and thus the initial polarization of rating was a missguided oversimplification of scriptural content. P5 reminded us that,"*all scriptures are good and when they are received in the right moment.*" Therefore, participants suggested that a more interesting and meaningful activity would be to nominate scripture by relating that scripture to contextual circumstances. Participants felt that context, such as how that scripture has helped them in the past and under what health circumstances, was critical for nominating socially-relevant messages. Further by leveraging the church community in the approach, these messages could reflect a congregation's preferences for the scripture use and Bible translation. In this scenario, participants used a PVCP approach to generate faith-based support messages. Such a crowdsourcing task could facilitate the use of spiritual support in a mobile app for health behavior change. Participants from Church B already thematically tag and compile scripture in a paper-based monthly prayer calendar. Members of an inreach

ministry (i.e., a ministry that directly serves members of the church) at Church B manually compile a monthly prayer calendar, in which each month has a different theme. Members then assign a scripture to each day of the month, using the theme as the guiding principle of selection. The monthly prayer calendar activity in Church B, as well as participant enthusiasm of Church A, highlights how the practice of tagging scripture and thinking about its application to health experiences in one's daily life is also a form of Bible study. Nominating and tagging scripture within the application both supports an existing faith practice by promoting reflection on scripture, and increases access to this activity beyond a particular ministry.

Authoring Messages

User Authored Health Messages: Storyboards completed by participants included the opportunity to select optional storylines that contained various distributed human intelligence tasks to ascertain the motivations as well as the usefulness of the crowdsourcing technique. In the joint pain and wellness storyboards, the application prompts the storyboard character to create health messages for others in the church community. In both scenarios, participants felt that receiving health messages from peers would be beneficial; however, they perceived the task of authoring the messages as burdensome and expressed concern about the need for curation of the content shared with the broader community. In the wellness board, participants could choose between writing health messages to the general church community or to a specific friend. Participants overwhelmingly opted to author messages to a friend, suggesting that this personal connection could motivate them to complete an otherwise tedious task. This motivation to connect with others complements the aforementioned frequency with which participants chose peers as sources of support within the storyboards.

DISCUSSION

Our findings illuminated participant desires to connect with their peers and build stronger connections with the church community through an mHealth application. They further stated preferences toward crowdsourcing tasks and conceptualized how such tools could benefit their community. We conclude with a discussion of the reciprocal benefits of mHealth interventions when anchored in these church communities, and how crowdsourcing tasks can be leveraged to support longitudinal community engagement.

Building Community

Throughout the creation and discussion of the storyboards, participants prioritized how the application could serve to both extend and strengthen their existing church community. While the application was presented as primarily targeting health, participants stressed the importance of the application reinforcing existing fellowship and, as a result, building an even stronger church community. While mHealth interventions are often used to deliver social supports that are "spatially liberated" (i.e., not tied to a geographic location), these interventions are often plagued with low adherence [9]. Driskell et al. suggest that, while the virtual communities created by these types of interventions provide some level of social support and connection, these virtual communities lack important features central to true communities [9]. For virtual communities to grow and sustain themselves, members must feel a sense of loyalty to the community, have rich social interactions with one another, and feel that their ties to each other are close, deep, and personal [9]. One strategy for creating a true community is to anchor the virtual community in a physical space and an existing community. Minimal prior work has explored mHealth interventions embedded in community settings [38]. Parker et al. explored the value of embedding mHealth interventions into various community organizations, and how physical meeting spaces may support mHealth interventions' engagement and interest [30]. In our work with these church communities, we identified opportunities for anchoring an mHealth intervention in a physical space. We further discuss the ways in which spatial anchoring could benefit the church community while simultaneously supporting application adoption and engagement.

Public Digital Displays: Participants from both churches endorsed the delivery of app content through announcements during Sunday service. These churches currently use public monitors to display announcements. By incorporating digital displays within churches, the virtual community in the mHealth app is no longer "spatially liberated" [9] but now anchored within the physical environment. Situating an mHealth application into a worship service may support user adoption and engagement with the app, as well as create opportunities for additional app interactions with other church members. Announcements during church serve as a nudge to users to interact with the application, and may pique the curiosity of church members not currently involved. Additionally, these announcements could be designed to prompt church member interactions and provide new topics of conversation. Prior work has explored the use of public displays to enhance the mission of organizations such as the Young Men's Chrisitan Association and "mega churches" [29, 44]. This work found that while these public displays were accepted, organization staff and members had divergent values and preferences for the design and use of the tools. Indeed, a future aim of this work is to engage other church stakeholders, including church leadership, to determine the attitudes and preferences towards the use of these physical spaces.

Digital Calendars: Churches often lack the organizational and financial capacity to hire administrative staff who could maintain online church resources (e.g., digital calendar) [6]. Both churches in this formative work have defunct online calendars. Despite no mention of calendars in the storyboards, participants envisioned how the crowdsourcing tasks they had seen in the storyboards could support church events though an updated calendar system. Using a KDM approach to populate this digital church calendar would allow church members to add church related events (e.g., Bible study, health ministry meeting, or choir practice), while circumventing the reliance on staff labor. By designing a computational artifact that provides a critical function not currently supported within the church environment, we offer an alternative means of assisting the church in building organizational and structural capacity. When conducting CBPR, Campbell et al. emphasizes the im-

portance of 'leaving something behind' to help the community sustain health promotion activities [6].

Evolving Content

One unique affordance of church communities is long-term membership, sometimes over the course of a lifetime. Thus, the content and features of church-based mHealth applications must evolve to maintain long-term interactions. HCI researchers have begun to focus on questions of temporality in health technology design. For example, Jacobs et al. examined how technology can support extended health journeys where complicated health conditions with multiple diagnostic phases require different levels of care management, coordination, and treatment [19]. Similarly, the design of a church-situated mHealth app should also focus on temporality to support system engagement and adherence. Over time, the needs and priorities of the church communities may shift and thus, health technology should support this evolution. Crowdsourcing could provide a mechanism to engage community members in dynamically collecting, sharing, and promoting socially-meaningful information to reinforce fellowship. Engaging the community members in crowdsourcing has the potential to empower traditionally socially marginalized users, such as communities of color, to enhance app content by improving its cultural sensitivity and relevancy. This is particularly critical when members of the project team may not be members of the target community. In the following section, we discuss the crowdsourcing tasks participants not only perceived as useful and engaging, but also perceived as reinforcing community-held values while simultaneously promoting health.

Value-Based Crowdsourcing

Participant reactions to writing and rating health messages differed from their reaction to writing and nominating messages with scripture. While our work focused on exploring design requirements for an mHealth application, designing for values beyond health behavior change enhances engagement [34]. Prior research demonstrates that Black members of protestant faith communities feel a strong affiliation between their faith and health [6, 32]. Promoting scripture for health topics and concerns was proposed as a low-burden crowdsourcing activity to create tailored mHealth intervention content that reflects values important to church members: spirituality and faith. However, unlike rating health messages as helpful or unhelpful, nominating the most helpful scripture was rejected by participants. A crowdsourced DHIT activity was perceived as trivializing scriptural content. In contrast, participants expressed enthusiasm for contextualizing the scripture to create more meaningful health communication messages. This activity both increased community access to faith-based support, and served as an opportunity for the individual to practice their faith through reflection on scripture.

In reaction to our nominating scripture activity, participants reimagined the activity and proposed a solution using the PVCP approach. As defined by Brabham et al., the PCVP approach is used for 'ideation problems that are a matter of taste or market preferences.' We expand the definition of the PVCP approach to include the cultural preferences of a spiritual community. Scriptural content related to health is a matter of authoring personally relevant content, not merely rating information (DHIT). Participants proposed other methods of creatively crowdsourcing the activity, including authoring content on the contextual relevance of scripture (e.g., "this scripture puts life into perspective"). Providing this context was critical to producing useful scriptural support for a variety of health concerns. While participants expressed little interest in authoring health messages, they expressed enthusiasm for the same task when applied to scripture-based messages. Participants involved with this work either attended Bible study regularly, studied the Bible daily, or expressed a desire to expand their knowledge of the Bible. Reading and reflecting on scripture and content related to their faith is highly valued. When applied to scripture, this PVCP activity not only mirrored the participants' current faith practices, but also supported techno-spiritual practices that they hoped to incorporate into their daily lives. Designing crowdsourcing tasks that reflect multiple values of this population (e.g., faith and wellness) can simultaneously nurture application engagement and strengthen spiritual practice.

Limitations

This work was conducted with two denominational faith communities in collaboration with a community-based partner organization. Further work is needed to explore how these findings translate to different denominations and different faith communities. Furthermore, our work focuses on church members; however input from additional church stakeholders is critical in the development and adoption of these findings.

CONCLUSION

Through our participatory design study, we investigated motivations and preferences for engaging with an mHealth app among church members of predominantly Black churches. Our findings shed light on how social structures in these churches impact access to social supports and health resources, and how crowdsourcing tasks can be leveraged to increase this access. We further discussed the acceptability and benefit of anchoring an mHealth intervention in the physical space of the church, and the importance of aligning crowdsourcing tasks with participant values of fellowship and faith. We propose crowdsourcing approaches that may support long-term engagement in a community-based mHealth app by generating culturally-tailored content. The needs, priorities, and strengths of social organizations shift. Therefore, future HCI work in mHealth intervention delivery should focus on how implementing crowdsourcing approaches may positively compliment this evolution.

ACKNOWLEDGEMENTS

This material is based upon work supported by the National Science Foundation under Grant No.1831755. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

REFERENCES

[1] Genevieve Bell. 2006. No more SMS from Jesus: ubicomp, religion and techno-spiritual practices. In

International Conference on Ubiquitous Computing. Springer, 141–158.

[2] Andrew BL Berry, Catherine Y Lim, Tad Hirsch, Andrea L Hartzler, Linda M Kiel, Zoë A Bermet, and James D Ralston. 2019. Supporting Communication About Values Between People with Multiple Chronic Conditions and their Providers. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM, 470.

[3] Daren C Brabham. 2009. Crowdsourcing the public participation process for planning projects. *Planning Theory* 8, 3 (2009), 242–262.

[4] Daren C Brabham, Kurt M Ribisl, Thomas R Kirchner, and Jay M Bernhardt. 2014. Crowdsourcing applications for public health. *American journal of preventive medicine* 46, 2 (2014), 179–187.

[5] Ronald L Braithwaite, Sandra E Taylor, and Henrie M Treadwell. 2009. *Health issues in the Black community*. John Wiley & Sons.

[6] Marci Kramish Campbell, Marlyn Allicock Hudson, Ken Resnicow, Natasha Blakeney, Amy Paxton, and Monica Baskin. 2007. Church-based health promotion interventions: evidence and lessons learned. *Annu. Rev. Public Health* 28 (2007), 213–234.

[7] Eric J Conrad, Mikaela Becker, Brent Powell, and Kelly Corrine Hall. 2018. Improving health promotion through the integration of technology, crowdsourcing, and social media. *Health promotion practice* (2018), 1524839918811152.

[8] Timothy J Cunningham, Janet B Croft, Yong Liu, Hua Lu, Paul I Eke, and Wayne H Giles. 2017. Vital signs: racial disparities in age-specific mortality among blacks or African Americans—United States, 1999–2015. *MMWR. Morbidity and mortality weekly report* 66, 17 (2017), 444.

[9] Robyn Bateman Driskell and Larry Lyon. 2002. Are virtual communities true communities? Examining the environments and elements of community. *City & Community* 1, 4 (2002), 373–390.

[10] Elizabeth Dunford, Helen Trevena, Chester Goodsell, Ka Hung Ng, Jacqui Webster, Audra Millis, Stan Goldstein, Orla Hugueniot, and Bruce Neal. 2014. FoodSwitch: a mobile phone app to enable consumers to make healthier food choices and crowdsourcing of national food composition data. *JMIR mHealth and uHealth* 2, 3 (2014), e37.

[11] Keith C Ferdinand and Samar A Nasser. 2017. Management of essential hypertension. *Cardiology clinics* 35, 2 (2017), 231–246.

[12] National Center for Health Statistics (US and others. 2016. Health, United States, 2015: with special feature on racial and ethnic health disparities. (2016).

[13] Melissa A Green, Justin Lucas, Laura C Hanson, Tonya Armstrong, Michelle Hayes, Stacie Peacock, Sharon Elliott-Bynum, Moses Goldmon, and Giselle Corbie-Smith. 2014. Carrying the burden: Perspectives of African American pastors on peer support for people with cancer. *Journal of religion and health* 53, 5 (2014), 1382–1397.

[14] Sajanee Halko and Julie A Kientz. 2010. Personality and persuasive technology: an exploratory study on health-promoting mobile applications. In *International conference on persuasive technology*. Springer, 150–161.

[15] Laura C Hanson, Tonya D Armstrong, Melissa A Green, Michelle Hayes, Stacie Peacock, Sharon Elliot-Bynum, Moses V Goldmon, Giselle Corbie-Smith, and Jo Anne Earp. 2013. Circles of care: development and initial evaluation of a peer support model for African Americans with advanced cancer. *Health Education & Behavior* 40, 5 (2013), 536–543.

[16] Shakia T Hardy, Katelyn M Holliday, Sujatro Chakladar, Joseph C Engeda, Norrina B Allen, Gerardo Heiss, Donald M Lloyd-Jones, Pamela J Schreiner, Christina M Shay, Danyu Lin, and others. 2017. Heterogeneity in blood pressure transitions over the life course: age-specific emergence of racial/ethnic and sex disparities in the United States. *JAMA cardiology* 2, 6 (2017), 653–661.

[17] Maureen I Harris, Richard C Eastman, Catherine C Cowie, Katherine M Flegal, and Mark S Eberhardt. 1999. Racial and ethnic differences in glycemic control of adults with type 2 diabetes. *Diabetes care* 22, 3 (1999), 403–408.

[18] Simo Hosio, Jaro Karppinen, Niels van Berkel, Jonas Oppenlaender, and Jorge Goncalves. 2018. Mobile Decision Support and Data Provisioning for Low Back Pain. *Computer* 51, 8 (2018), 34–43.

[19] Maia Jacobs, James Clawson, and Elizabeth D Mynatt. 2016. A cancer journey framework: guiding the design of holistic health technology. In *Proceedings of the 10th EAI International Conference on Pervasive Computing Technologies for Healthcare*. ICST (Institute for Computer Sciences, Social-Informatics and . . . , 114–121.

[20] Catherine Nuss Kotecki. 2002. Developing a health promotion program for faith-based communities. *Holistic nursing practice* 16, 3 (2002), 61–69.

[21] Richard L Kravitz. 1999. Ethnic differences in use of cardiovascular procedures: New insights and new challenges. *Annals of Internal Medicine* 130, 3 (1999), 231–233.

[22] Pinky P Kumar and Mahmood A Rashid. 2018. Crowdsourcing based social awareness for taboo diseases like HIV/AIDS. In *Proceedings of the Australasian Computer Science Week Multiconference*. ACM, 25.

[23] Daisy Le, Cheryl L Holt, Darlene R Saunders, Min Qi Wang, Annie Coriolan, Alma D Savoy, Jimmie L Slade, Bettye Muwwakkil, and Nancy L Atkinson. 2016. Feasibility and acceptability of SMS text messaging in a prostate cancer educational intervention for African American men. *Health informatics journal* 22, 4 (2016), 932–947.

[24] C Eric Lincoln and Lawrence H Mamiya. 1990. *The black church in the African American experience*. Duke University Press.

[25] Khalid Majrashi. 2018. User need and experience of Hajj mobile and ubiquitous systems: Designing for the largest religious annual gathering. *Cogent Engineering* 5, 1 (2018), 1480303.

[26] Susan Markens, Sarah A Fox, Bonnie Taub, and Mary Lou Gilbert. 2002. Role of Black churches in health promotion programs: lessons from the Los Angeles Mammography Promotion in Churches Program. *American Journal of Public Health* 92, 5 (2002), 805–810.

[27] Anne Moorhead, Raymond Bond, and Huri Zheng. 2015. Smart food: Crowdsourcing of experts in nutrition and non-experts in identifying calories of meals using smartphone as a potential tool contributing to obesity prevention and management. In *2015 IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*. IEEE, 1777–1779.

[28] Oded Nov. 2007. What motivates wikipedians? *Commun. ACM* 50, 11 (2007), 60–64.

[29] Andrea Parker, Vasudhara Kantroo, Hee Rin Lee, Miguel Osornio, Mansi Sharma, and Rebecca Grinter. 2012. Health Promotion As Activism: Building Community Capacity to Effect Social Change. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12)*. ACM, New York, NY, USA, 99–108. DOI: http://dx.doi.org/10.1145/2207676.2207692

[30] Andrea G Parker, Herman Saksono, Jessica A Hoffman, and Carmen Castaneda-Sceppa. 2018. A Community Health Orientation for Wellness Technology Design & Delivery. In *Designing Healthcare That Works*. Elsevier, 59–76.

[31] Healthy People.gov. 2014. Faith Communities Inspire Good Health - A CDC Preventive Health and Health Services Block Grant Success Story. (2014). https://www.healthypeople.gov/2020/healthy-people-in-action/story/faith-communities-inspire-good-health-%E2%80%93-a-cdc-preventive-health (accessed September 20, 2019).

[32] Jane Peterson, Jan R Atwood, and Bernice Yates. 2002. Key elements for church-based health promotion programs: outcome-based literature review. *Public Health Nursing* 19, 6 (2002), 401–411.

[33] Neha Sahgal and Greg Smith. 2009. A Religious Portrait of African-Americans| Pew Research Center. (2009).

[34] Herman Saksono, Carmen Castaneda-Sceppa, Jessica Hoffman, Magy Seif El-Nasr, Vivien Morris, and Andrea G Parker. 2019. Social Reflections on Fitness Tracking Data: A Study with Families in Low-SES Neighborhoods. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM, 313.

[35] Rohan Samson, Andrea Qi, Abhishek Jaiswal, Thierry H Le Jemtel, and Suzanne Oparil. 2017. Obesity-associated hypertension: the upcoming phenotype in African-American women. *Current hypertension reports* 19, 5 (2017), 41.

[36] American Cancer Society. 2008. *Cancer facts & figures*. The Society.

[37] Rhiannon Sterling and John Zimmerman. 2007. Shared moments: opportunities for mobile phones in religious participation. In *Proceedings of the 2007 conference on Designing pleasurable products and interfaces*. ACM, 490–494.

[38] Elizabeth Stowell, Mercedes C Lyson, Herman Saksono, Reneé C Wurth, Holly Jimison, Misha Pavel, and Andrea G Parker. 2018. Designing and evaluating mHealth interventions for vulnerable populations: A systematic review. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. ACM, 15.

[39] Anselm Strauss and Juliet Corbin. 1990. *Basics of qualitative research*. Sage publications.

[40] Stephen B Thomas, Sandra Crouse Quinn, Andrew Billingsley, and Cleopatra Caldwell. 1994. The characteristics of northern black churches with community health outreach programs. *American Journal of Public Health* 84, 4 (1994), 575–579.

[41] Gabrielle M Turner-McGrievy, Elina E Helander, Kirsikka Kaipainen, Jose Maria Perez-Macias, and Ilkka Korhonen. 2014. The use of crowdsourcing for dietary self-monitoring: crowdsourced ratings of food pictures are comparable to ratings by trained observers. *Journal of the American Medical Informatics Association* 22, e1 (2014), e112–e119.

[42] Susan P Wyche, Paul M Aoki, and Rebecca E Grinter. 2008a. Re-placing faith: reconsidering the secular-religious use divide in the United States and Kenya. In *Proceedings of the SIGCHI conference on human factors in computing systems*. ACM, 11–20.

[43] Susan P Wyche, Kelly E Caine, Benjamin Davison, Micheal Arteaga, and Rebecca E Grinter. 2008b. Sun dial: exploring techno-spiritual design through a mobile islamic call to prayer application. In *CHI'08 extended abstracts on Human factors in computing systems*. ACM, 3411–3416.

[44] Susan P Wyche, Yevgeniy Medynskiy, and Rebecca E Grinter. 2007. Exploring the use of large displays in american megachurches. In *CHI'07 extended abstracts on Human factors in computing systems*. ACM, 2771–2776.