Tracking During Ramadan: Examining the Intersection of Menstrual and Religious Tracking Practices Among Muslim Women in the United States

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ABSTRACT

Personal Informatics (PI) tools are crucial in helping individuals monitor their physical health, mental health, and overall well-being. Many Muslim women use multiple PI tools to support their religious and spiritual well-being alongside their health. We investigate the religious and health-tracking practices of Muslim women living in the United States during the month of Ramadan. We conducted a month-long diary study and semi-structured interviews with nine (9) Muslim women observing Ramadan. Through this research, we uncover their motivations for tracking, discover the complex interplay between their social roles and religious practices, and identify conflicts arising from competing objectives (tracking their spiritual and physical health). Our findings contribute insights into the inclusive design of Personal Informatics tools tailored to the needs of Muslim women of faith and provide a call to the research community to expand tracking technologies to include aspects that support religious health and wellness. We discuss design considerations for supporting Muslim women during Ramadan and beyond.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**.

KEYWORDS

Personal Informatics, Faith, Muslim Women, Ramadan

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1 INTRODUCTION

Personal Informatics (PI) tools have been increasingly pervasive, helping individuals collect and review personal information to facilitate actionable self-insight. Users of PI tools track a broad range of information, such as their physical activity, mood, location, (social) media usage, productivity, and finances [33, 63]. Notably, there has been a lot of research in HCI focusing on understanding users and how they interact with Personal Informatics tools. Existing research has investigated and provided insights into why people track [94, 96, 111], the accuracy of tracking tools [131], tracking for varied goals [89, 96], user experience and barriers for tracking [49, 107], and why people abandon their tracking devices [26, 69]. Epstein et al. [33] revealed that a substantial portion of the literature on Personal Informatics predominantly concentrates on health-related aspects, including physical, mental, sleep, and dietary research; they advocate for expanding the domain's exploration to encompass various other aspects of individuals' daily lives. As an increasing number of individuals embrace self-tracking practices for diverse motivations and goals, the domain of Personal Informatics has expanded [23, 33, 37] to accommodate understanding people's varying needs. Nevertheless, there remains a notable lack of research on self-tracking for religious well-being and even less literature that explores the intertwined relationships between religious tracking and health tracking. In our work, we explore the use of personal informatics tools for religious well-being in Muslim menstruating individuals.

For many menstruating individuals who identify as practicing Muslims, balancing faith and health-tracking activities can be a challenging experience. Practicing Muslims typically adhere to guidelines that exempt them from performing certain religious acts (e.g fasting) when menstruating [117]. As such, tracking for religious needs becomes inexorably linked with tracking their periods. This underexplored opportunity inspired and motivated our research, which aims to investigate the religious tracking practices of menstruating Muslims in the US. We chose the US because it provides a diverse and heterogeneous representation of Muslims from various parts of the globe. Islam is the fastest growing religion in the US [4], and Muslim women in America comprise the most diverse and heterogeneous population in Islamic history [46]. They comprise immigrants, native-born citizens, and non-citizens from a broad spectrum of races and cultural backgrounds. These individuals are united by shared beliefs and ideologies, communicate in a diverse array of languages, and represent a wide range of cultural, economic, and educational status [46]. The approximately 65% US Muslims who were born outside the United States, come from at least 68 different nations (35% are born in the US) [50]. Investigating such a heterogeneous population offers several advantages[40, 46]: first, it provides the opportunity to gain insights into various approaches individuals employ to implement their underlying beliefs

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and practices of the faith. This broad perspective helps prevent the prioritization of one specific interpretation of faith over others. Second, it helps minimize biases and unintentional exclusions that may arise from focusing on a narrower subset of the Muslim community. Finally, it ensures that designs and solutions are created to address the needs of a wider range of users, reflecting the diversity of the Muslim community. Our results, therefore, reflect various traditions and beliefs within the Muslim faith [40, 46].

The Muslim faith is characterized by rituals, beliefs, guidelines, and religious laws, which influence how people perceive and interact with the world. While the Muslim population accounts for 18–25% of the global population and is estimated to be approximately 1.1–1.5 billion people worldwide [6], there has not been an abundance of technologies designed to support the lived experiences of practicing Muslims - fundamentally, their religious, cultural, or social lives that may need tracking support [11]. To this end, our research contributes to expanding an understanding of the use of personal informatics tools to support religious and faith-based aspects of people's lives. We set out to explore the following two research questions. **Research Question 1:** What are menstruating Muslims' goals and tracking practices during Ramadan? **Research Question 2:** How do menstruating Muslims engage with tracking technologies to support their goals, and what challenges do they encounter in their tracking experiences? Our work situates itself at the intersection of personal informatics, religion, and women's health within the domain of HCI. Our research explores the previously uncharted territory of personal informatics tool usage within the realm of religious contexts. In the course of our study and in the outcomes we have achieved, we make the following contributions to the field of HCI:

- We contribute to the empirical understanding of what motivates Muslim menstruating individuals to track aspects of their lives beyond health and well-being, broadening the scope of Personal Informatics to include religious well-being.
- We provide recommendations for designing technologies that simultaneously support health and religious well-being to foster and enhance the development of faith-inclusive tracking technologies.

2 RELATED WORK AND BACKGROUND CONTEXT

To provide background for our research study, we draw on literature from personal informatics emphasizing self-tracking for women's health and wellness. We also explore the literature on religion and HCI and provide background information on our study context.

2.1 Self-Tracking for Health and Wellness

To date, Personal Informatics (PI) Systems have focused on a distinct aspect of people's lived experiences, such as persuasive behavior change interventions [28, 104] health-focused games [44, 60], online health communities [82], menstrual health tracking [35, 54], physical activity [45, 58, 132], mental wellness [11, 64, 90], and chronic disease management [57, 80, 122]. Considerable research effort has been invested in building models for self-tracking (e.g., the Stage-Based Model [71] and Lived Informatics Model [36]), understanding self-tracking [75, 76], and the attributes of self-tracking apps people consider when selecting a tracking tool [70]. However, there is a notable gap in research regarding the tracking practices of specific populations. In the context of their study on fitness tracking, Neiss et al. [97] pointed out that marginalized groups, who are often ethnically diverse, have been largely unexplored in studies on self-tracking. In alignment with this perspective, our work is geared towards amplifying the voices of these understudied populations. Doing so aims to enhance our understanding of the motivations and values driving self-tracking in these communities. Ultimately, our research contributes to furthering the design and development of culturally and faith-inclusive tracking tools and experiences.

Self-tracking involves "practices in which people knowingly and purposely collect information about themselves, which they then review and consider applying in their lives." [77]. Rooksby et al. [111] observed that self-tracking practices are intricately enmeshed into people's daily lives, distinguishing between different self-tracking styles. Although there have been extensive efforts to understand people's tracking habits, tracking styles, and lived experiences, there is still a significant gap in understanding how people track for other purposes beyond health, e.g., religious purposes. Lupton et al. [75, 76] coined the concept of 'self-tracking cultures', urging the broadening of personal informatics research to include social, cultural, and political aspects and emphasizing the importance of recognizing social inequalities within the realm of self-tracking. As self-tracking practices become more prevalent, research examining the social, cultural, and political implications of self tracking is crucial. This growing trend of "quantifying oneself" [77] through self-tracking, in pursuit of "self-knowledge through numbers," raises concerns about the potential for further marginalization and the socioeconomic disadvantaging of groups that have not been adequately studied. Lupton [78] emphasizes that significant portions of research on self-tracking focuses on privileged social groups, while marginalized or stigmatized groups engaged in self-tracking receive minimal attention. This lack of representation could lead to the development of technologies that exacerbate existing inequalities.

Therefore, our research aims to provide an understanding of self-tracking practices within a religious context (Ramadan). Specifically, we are interested in exploring religious tracking among individuals who actively track aspects of their health, such as menstruation. Thus far, research on self-tracking for women's health comprises of menstrual tracking [35, 72, 121], fertility tracking [29, 30, 52, 84], pregnancy [22, 79, 95, 112, 118] and menopause [120, 125]. In some communities, especially faith-based communities, tracking the menstrual cycle is important for planning for the "break" (or exemption) in performing religious rituals [92], highlighting the need to plan for these breaks. Prior research [92, 117] has uncovered a connection between religion and health. However, the intersection of personal informatics for health and religion is relatively underexplored. Through our research, we seek to address this gap by contributing to the empirical understanding of menstruating Muslims tracking practices and behaviors, particularly during Ramadan.

2.2 Religion and Technology in HCI

This subsection explores the HCI literature on intersection of technology for religious purposes. First, we present a broad overview and follow it up with Islam and HCI.

2.2.1 Other Religions and HCI. Statistics have shown that approximately 85% of individuals globally adhere to organized religions [68]. Religious rituals directly influence individuals' religious needs, goals, values, lifestyle, norms, and aspirations [9]. These rituals and values inform perceptions of privacy, identity, and security while influencing how individuals use and engage with technology. While HCI researchers have long applied rigorous processes for understanding users and designing human-centered solutions, centering religion, faith, and spirituality in design is only beginning to be explored [55]. Bell et.al [14] and Muller et.al [88] have theorized that there may be underlying tensions between religion and technology [14, 88]. Bell et al. coined the term "techno-spiritual" technology to describe technology that can help individuals in their spiritual or religious activities– arguing that there is a need to design technologies to support spiritual life because religion and spiritual practices are seamlessly woven into the day-to-day lives of individuals who adhere to them [14]. Bell further speculates that religious systems and values impact how technologies are created, consumed, and possibly rejected. For instance, research [51] explored ways technology may support or collide with the Christian priority of cultivating human relationships. Claisse et al. [25] studied supportive digital technologies for the community practice of Buddhism and provided recommendations for designing a meaningful spiritual experience. Hammer [48], in contemplating the perceived deficiency in the literature concerning HCI and Jewish practices, highlights that the technologies researchers introduce may pose challenges (and seldom facilitate ease) for Jews in maintaining their way of life. Emerging research has also begun to explore the intersection of religion and gaming [31, 32, 67, 124].

Bjørn et al. [16] emphasize that, given the widespread use of technology, researchers and designers must consider how social inequalities in technology intersect with specific social markers. They coin the term "diversity classification scheme," which comprises a non-exhaustive list, including gender, age, religious beliefs, sexual orientation, disability status, and more. Regarding religious beliefs, the researchers highlight that integrating a digital compass into smartphones, now a standard feature in most phones was inspired by Muslim prayer practices (p. 89) [16]. Today, instances exist where technology mediates and facilitates religious practices and rituals [14]. Illustrations of this techno-spiritual mediation are seen in examples such as an exploration of practicing Muslims using a mobile phone or wearable to determine the direction for prayer (what is called *qiblah*) [14], religious use of technology by American Christian Ministers [130], a prayer companion for cloistered nuns [42], BibleCell, a tool that supports personalized reading plans, scripture reading, and social sharing [65], and the use of mobile apps to read the Bible while receiving treatment for cancer [57]. Other studies have highlighted the use of technology in Buddism [41, 43], the intersection of race, religion, and community in exploring how technology can promote well-being in churches with historically Black memberships [100, 101]. Kaziunas et al. [61] have also highlighted the role of local churches in providing health support to marginal groups, with further research highlighting the importance of designing culturally tailored mobile apps for church-going individuals [17]. Ahmad et al. [5] speculated that older adults become more spiritual as they age; therefore, there is a need to study user experiences from the point of spirituality. These research efforts indicate the increasing demand and focus on studies exploring the intersection of religion, technology, and HCI.

Thus far, HCI Researchers [19, 51, 92, 101, 109, 116, 130] have called for the inclusion of faith, religion, spiritual practices, and values in the design of technology, arguing that the act of not prioritizing faith in design has resulted in the secularized nature of HCI [18, 93, 109, 116] and that we, as HCI researchers, have fallen short of the goal of achieving "truly human-centered design" [116]. Estelle [116] argues that for a *"truly human-centered approach, we must account for the spiritual values that form a core part of the human identity"* [116]. With this objective in mind, researchers have initiated speculation and proposed emerging design principles [127, 129, 133] specifically tailored for religious and spiritual contexts. Undoubtedly, the intersection of religion and HCI will continue to grow.

2.2.2 Islam and HCI. Conducting research the intersection of Islam and HCI is a relatively nascent activity. The existing research supports that the practices of the Muslim population are heavily influenced by Islamic teachings and beliefs [2, 7, 56, 108, 123]. Relevant examples of existing research with and for the Muslim population that centers their faith include an investigation into the perception of privacy in the use of technology [3], incorporating faith in substance abuse recovery [81], app to support muslim prayer practice [128] ,creating a mobile app with Islamic prayertext on pregnancy for Muslim women [112], designing to support US-based Muslim women who experienced domestic violence [105, 106], expanding privacy principles to take into account privacy of Muslim women [4], designing to support Muslim women's spiritual coping as they experience miscarriage and loss [8]. Furthermore, researchers have studied using technology for faith-based purposes- including using TikTok to provide Islamic religious teachings [12, 83] and taking selfies during the Muslim pilgrimage of Hajj as a means of expressing religious identities [21]. This work highlights the limited but ongoing research at the intersection of Islam and HCI.

Beyond the HCI literature, it is evident that various technologies, particularly mobile technologies, are designed to serve the Muslim community. Instances of this practice include the creation of an application aimed at educating Muslims about the fundamental principles of inheritance laws and the equitable distribution of wealth [134], as well as a mobile app designed to offer information catering to the needs of Muslim travelers [53]. Fewkes [38] examined the intersection of mobile technology and food practices, investigating the influence of mobile app technologies on the religious practices of American Muslims. Collectively, we draw upon the existing body of literature and the prior contributions of the researchers we have spotlighted to guide our research and gain valuable insights into how Islamic expectations, values, and norms

intersect with technology usage. Our current work adds to this body of literature by specifically exploring and trying to understand the personal informatics needs of Muslim women in the United States in the context of Ramadan. Expanding on the existing research [54], we aimed to investigate the experiences of Muslim women during Ramadan and their use of personal informatics tools.

2.3 Study Context: Ramadan

This study was conducted in the month of Ramadan. Ramadan is a month on the Islamic calendar, lasting between 29 and 30 days [6] that occurs annually. Each day in a lunar calendar will precede its position in the Gregorian calendar by approximately 11 days for each consecutive Gregorian year [73]. Muslims observing Ramadan must abstain from eating, drinking, sexual intercourse, using oral medications, and smoking from predawn until dusk. However, there are no restrictions on food or fluid intake between sunset and dawn [6, 15, 87]. The duration of the daily fast may range from a few to more than twenty hours depending on geographical location and seasons [6] and most people consume two meals per day, one after sunset, referred to in Arabic as Iftar (breaking of the fast meal), and the other before dawn, referred to as Suhur (predawn). Individuals must fast, except those who are sick, traveling, nursing mothers, pregnant individuals, menstruating individuals, or older adults, especially if fasting might have harmful consequences for the individual [6]. Most of these exemptions from fasting are temporary if the individual can make up a fast after Ramadan. Therefore, nursing mothers, menstruating, and pregnant individuals may need to track the fasting days they miss in order to make up those days later. Individuals are motivated to track menstruation in order to track the number of missed fast they need to make up later.

Although Ramadan is a personal and individual experience, it also emphasizes some social aspects. Research [110] has shown that while some Muslims may not strictly adhere to the obligation of performing the five daily prayers, they often engage in fasting during Ramadan, partly attributed to both the communal and cultural traditions linked with Ramadan. During Ramadan, it is customary for individuals to demonstrate generosity or charity, extending beyond immediate family and relatives to include the broader community through acts such as donating food or money or alms. Participating in volunteer activities and dedicating time to assisting others during Ramadan is a highly regarded activity [10, 20, 119]. During Ramadan, those fasting enhance their social bonds through joint rituals and worship. While the cultural practices may differ based on regions or countries, the underlying principles of Islamic rituals for Ramadan are the same [92].

3 METHODS

All parts of this study were approved by the Institutional Review Board (IRB) in March 2023, and the study was conducted from March 2023 through June 2023. Our study included a pre-intake survey, a diary study, and semi-structured interviews. The pre-intake survey was conducted in March of 2023. The diary study was conducted during Ramadan, from March 22nd to April 22nd, 2023. In May, we conducted a preliminary analysis of the data collected from the diary studies to inform the questions we asked participants in the semi-structured interviews. The semi-structured interviews took place in May and June 2023. The pre-intake survey collected demographic information and was an eligibility filter and recruitment tool. During the diary study, participants completed ten daily logs during the month of Ramadan (typically 1-2 days elapsed between completion of a daily log), a reflection log when halfway through the process (after the 5th daily log), and a second reflection log upon completion of the final and 10th daily log. After completing the diary study, we conducted semi-structured interviews. Participants were compensated on a 3-tiered/milestone level, receiving compensation halfway through the diary study ($15 Amazon e-gift card), upon completion of the diary study ($15 Amazon e-gift card), and completion of the semi-structured interview ($20 Amazon e-gift card). We present a visual representation of our study design in Figure 1. We split the compensation to allow participants to withdraw from the study at any point rather than wait until its conclusion.

3.1 Pre-Intake Survey, Eligibility, and Recruitment

We distributed our recruitment announcement and pre-intake survey link through e-mail invitations to Muslim slack channels, WhatsApp groups, Facebook groups, and word of mouth. The pre-intake survey was divided into the following categories: demographic information, tracking history, Ramadan plans, and contact information section. In demographic information, we asked about participants' age, gender, ethnicity, highest level of education, faith identity, self-reported practice of faith, and country of residence. In tracking history, we asked if they tracked their Period, why they tracked it, how frequently they tracked it, and other things they tracked beyond their periods. We also asked if they intended to observe the fast/Ramadan and, if they track acts of worship, how frequently they track faith-related information. We asked respondents of the pre-intake survey to provide their e-mail addresses if they were interested in participating in the diary study. We sought to understand the tracking habits of practicing Muslim women who actively tracked their menstrual cycle. Therefore, eligible participants met the following criteria: (1) actively tracked their menstrual cycle, (2) intended and planned to observe Ramadan, (3) resided in the US, and (4) opted in to receive more information about our study and provided their contact information. We received a total of 121 responses to the survey. Of the 121 responses, 80 fully completed the survey. Out of the 80 fully completed responses, 7 indicated a preference not to be contacted about the study, 1 reported a non-USA location, one did not provide an e-mail address or contact phone number, and eight reported not currently tracking their menstrual cycle. The remaining 63 participants were contacted through the phone number and e-mail they provided in the survey. In the e-mail, we attached an informed consent document and study overview. We invited each participant to a 20-minute, 1:1 introductory video call through Zoom, where we described the study in detail, answered any questions or concerns, and officially enrolled them into the study. Several survey participants who chose not to continue in the study reached out to inform the team that they were interested in participating but chose not to engage in more activities during

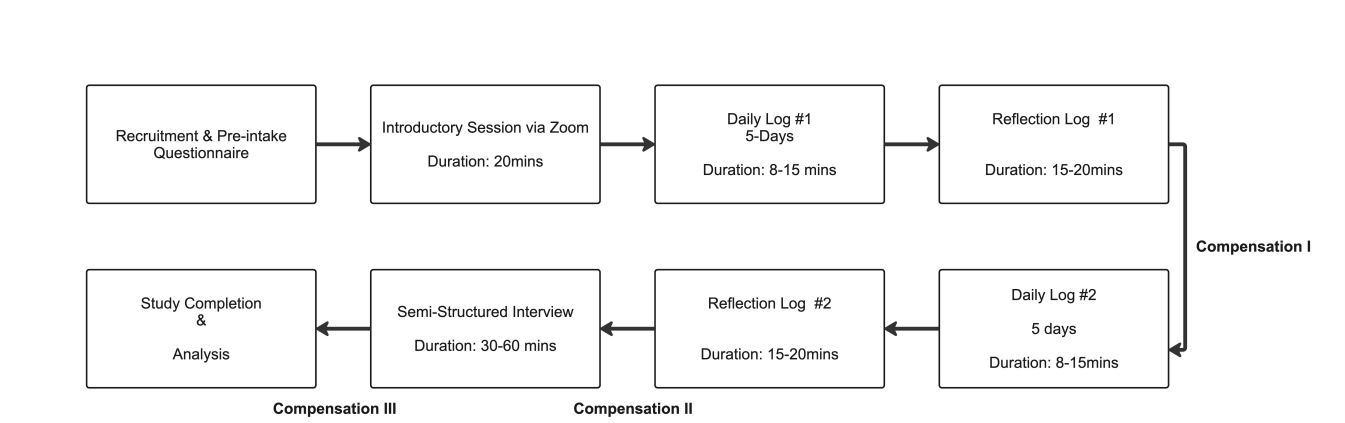

Figure 1: Study Design and Compensation

Ramadan. Among the survey respondents who provided their e-mail addresses, twelve (12) signed up for introductory calls, and ten (10) eventually accepted to take part in the diary study, with nine (9) (Table 1) completing the study in its entirety. One participant withdrew from the study midway, attributing the withdrawal to commitments related to balancing motherhood during Ramadan.

3.2 Introductory Call

The introductory call took approximately twenty minutes and served two purposes: First, we introduced the study to participants, addressed their questions, and ensured they fully consented and were comfortable participating in our study. Crucially, the introductory call served a secondary purpose of building comfort and familiarity between the research team and participants. By having a short video call with participants, we were able to start building trust and a comfort level in advance of the study, which we believe facilitated communication with participants throughout Ramadan. Introductory calls were conducted via Zoom and were not recorded as we did not collect any data. Instead, it was an opportunity to provide more information about the study to eligible and interested participants. Upon completion, we allowed participants to e-mail us consenting to enroll in this study.

3.3 Diary study

Diary study has been proven to be a suitable method for capturing religious [12] and spiritual experience, and it has been used to study spiritual user experience in older adults [5]. We made the following considerations in the design of the diary study: We decided to collect 10 Daily Logs (DL) instead of having participants log all 30 days to minimize participant burden. Though participants could complete daily logs consecutively, we suggested completing one every 2-3 days. Encouraging participants to space out their ten DLs allowed us to capture experiences throughout participants' menstrual cycles. We reminded participants via e-mail every three days to complete a daily log for the previous day. This design allowed us to stagger recruitment throughout the months of Ramadan. We also designed a Reflection Log (RL) that captured participants' reflections midway through the daily log (i.e., after the completion of the 5^{th} DL) and at the end (after the completion of the 10^{th} DL). Therefore, each participant collected 12 logs (10 DL and 2 RL).

3.3.1 Daily Logs (DL) and Reflection Logs (RL). The Daily Log (DL) and Reflection Log (RL) entries comprised open-ended text entry questions and were collected via Qualitrics, an online data collection tool. A Daily Log (DL) entry took eight to fifteen minutes to complete. In the DL, we asked participants if they fasted, what they tracked, what religious goals they tracked and why, what health goals they tracked and why, how they tracked each spiritual and health goal, and to describe the challenges they encountered. Each participant completed two (2) Reflection Logs. The Reflection Log (RL) was designed to take fifteen to twenty minutes each to complete. The first RL was completed after the 5^{th} DL; the second RL was completed after the 10^{th} DL. The questions in the RL prompted participants to think about the previous five entries– specifically prompted them to reflect on their tracking motivations, how the Ramadan experience influenced what they tracked, what tools they used for religious tracking, health tracking, or both, with whom they discussed their religious tracking experiences, and if they experienced menstruation, how it influences what they choose to track. We also encouraged participants to share photos or screenshots of their tracking experiences within the DL and the RL, which were used to elicit more details in the semi-structured interview. Upon completing the diary study, two authors analyzed the log data to finalize the participant-specific questions for the semi-structured interviews.

3.4 Semi-Structured Interview

Before conducting semi-structured interviews, we analyzed each participant's DL and RL (a participant had 10 DL and 2 RL). We used the entries and photos in the diaries to probe further in-depth information from participants. Interviews ranged from 21 minutes to 68 minutes, with an average of 46 minutes. We collected a total of 410 minutes of interviews. The semi-structured format consisted of two categories of questions – questions we asked every participant and questions specific to each participant based on their DL and RL entries. The first and second authors conducted interviews through Zoom video calls; each interview was recorded. In the interview,

Table 1: Participants who enrolled (N=10) and completed the diary study (N=9) Demographics & Tracking Methods. All Participants tracked the menstrual cycle and observed the fast.
***Note that P8 dropped out halfway through the diary study**

ID	Age	Ethnicity	Forms of Worship Tracked	Aspects of Health Tracked
P1	22	Asian or Pacific Islander	missed fasts	Food, Exercise, Skin and Personal care
P2	22	White	missed prayers, missed fasts, chapters of the Quran memorized	Missed prayers, missed fasts, Chapters of the Quran memorized
P3	21	Self-describe (Middle Eastern)	Mandatory prayers (on time or late), voluntary prayers, days fasted, chapters of Quran read	Period and symptoms
P4	31	Asian or Pacific Islander	Fasts in Ramadan consistently, Prayers	Days of exercise, Step count, food I ate
P5	45	Asian or Pacific Islander	# of Missed Fast	Food log, water intake, period/ovulation
P6	38	Asian or Pacific Islander	# of Missed prayers, # of Missed Fast, Chapters of Quran read, Charity/donations the family gives on an annual basis	Exercise, Step count, food
P7	39	Asian or Pacific Islander	Fasting, nightly prayers in Ramadan	Insulin dosage, mood tracking, weight
P8*	38	Self-describe (South Asian)	# of Missed Fast	Step Count
P9	29	Black and African	Chapters of Quran read	Period, exercise
P10	28	Self-describe (Hispanic)	# of Missed Fast	Period, step count, weight gain

we asked all participants about their experience of diary study, the experiences of tracking in Ramadan, their tracking goals and motivations, what they learned about themselves, their tracking experiences, how they balanced monitoring health and religious goals, and how they could be better supported. Entries in the daily and reflection logs prompted questions tailored to individual participants. For instance, if a participant mentioned tracking with her child, we incorporated probing questions to gather additional details about that particular experience.

3.5 Data Analysis

We transcribed the interviews and compiled all the log data for each participant. We then utilized inductive coding as described by Merriam and Grenier [85]. The first and second authors familiarized themselves with the full scope of the data set and separately coded two interviews. After individually coding two interviews, the first two authors met and discussed the codes. Once we obtained consensus on our codes, we created a codebook, which we used to code the rest of the interviews deductively. The interviews were split between the first two authors, with the first author coding four interviews and the second coding the remaining 3. Upon completion of coding nine interviews and through multiple iterative rounds, we analyzed the codes to identify the themes. Then, the codebook for the interviews was adopted to deductively code the DL and RL for the diary portion of the study (in total, from all 9 participants: 18 RL and 90 DL entries). The 108 log entries were split between the first two authors by participant. In our analysis, we discovered themes such as *"religious purpose"*–to depict tracking that is formed around religious motivations, *"tracking challenges"*–to describe challenges of tracking for religious purpose and health purpose, etc. Through further iterative rounds, we reduced overlap and redundancy among the themes. After all the interviews and diary entries were coded, all three authors met to discuss the emerging themes we presented in our findings section.

4 POSITIONALITY AND SELF-DISCLOSURE

All of the authors conduct HCI research and strive to co-design inclusive technologies for vulnerable populations. Of the three authors, the first two identify as female and practicing Muslims, while the third identifies as a non-muslim male. The first two authors were born and raised outside the US, though the first author has lived in the US for most of her adult life (over a decade). Our motivation for this research stems from our lived experiences as Muslim women who menstruate. We acknowledge exploring the role that practicing our faith plays in shaping how we engage with health, wellness, and technology.

5 FINDINGS

We organize our findings in three sections. First, we present the motives and goals that are supported by tracking. Next, we discuss socially crafted practices resulting from participants' religious motives. Finally, we present tensions and challenges participants experienced while trying to accommodate their religious and health motives.

5.1 Tracking Motives during Ramadan

Participants had two prominent motives for tracking during Ramadan, which we broadly categorized into religious and health motives. These motives lead participants to track using a variety of tracking artifacts that were either physical (e.g., wall calendars, journals) or digital (e.g., phone applications)

5.1.1 ***Religious Motives.*** Participants articulated diverse religious objectives or intentions during Ramadan. In this section, we emphasize two specific goals: (1) maintaining personal consistency and accountability in fulfilling obligatory Islamic rituals and (2) engaging in reflections on one's religious growth to identify areas or facets for improvement. Participants shared how their Islamic values and concepts structure their tracking practices during Ramadan.

Ensuring Consistency and Accountability:

Participants bolster their faith by self-monitoring their daily prayers, fasting (especially missed fasting days), and daily recitations or readings of the holy book (Quran). This tracking aids in maintaining **consistency and self-accountability in their Islamic rituals**. Below, we highlight instances from P3, P6, and P10 that illustrate how their pursuit of consistency and personal accountability in their worship was facilitated through tracking. In P3's case, in her quest to maintain regularity and consistency in performing her daily obligatory prayers, she turned to tracking to sustain her commitment and responsibility. She mentioned experimenting with various apps before ultimately settling on one that met her requirements:

> *I started praying consistently two years ago. Before that, it was more like once a day or once a week. I wasn't religious back then. I was teaching myself how to pray. I learned how to pray using YouTube videos. When I learned how to pray, I was like, "I need to get it on. I need something to remind me...", so I started trying various apps. And this was the only app Pillar App*[1] *that was effective and had all these features... And it's been since 2021. So, I have almost three complete years of tracking.*–P3

In addition to her drive for upholding consistency in worship, P10, a recent convert to Islam (mostly referred to as "revert"), monitors her prayers and any missed fasting days. She emphasized that tracking fasting days, both completed and missed, served to eliminate any uncertainty in remembering the number of fasting days she needed to compensate for later. She voiced the following :

> *My motivations are the mandate of the discipline that I should attend to my salat/prayer times as soon as I can and within the periods for consistency. So that's one of my motivations to be held accountable for the days I missed my fasts during Ramadan. Also, it would be nice to know what other days I fasted during Ramadan, but as a revert, I think it's essential that I am going through this space of trying to figure it out. Another positive thing would be not having the unknown, not having any ambiguity about how many days I miss Ramadan* –P10

In the last example below, P6 explains that she monitors her recitations of the holy text (or the Quran) using two different tools: a physical journal and the notes app. Although she doesn't display or disclose the tracked data to others, she utilizes it as a means to enhance herself by assessing her religious growth or journey through reflecting:

> *... I tracked my Quran (recitation) so I could make sure that it brings accountability... I don't need to show it to anyone except myself. So, I would use it to better myself.*–P6

The practice of keeping a record of prayer time, fasting days, and the Quran recitation assisted participants in upholding regularity and consistency in their worship, thereby contributing to the enhancement of their religious well-being.

Reflection and Self-Assessment:

Participants shared that tracking aided them in contemplating or **reflecting upon their ritual practices and obligatory worship**. They assessed their current level of worship fulfillment by comparing it to the previous day's performance. This self-assessment enables participants to identify areas of their faith that could be enhanced and areas where they didn't meet their daily religious goals. To reflect on their daily worship, participants engage in self-inquiry. We provide two instances from P1 and P6. P1, who tracks her daily prayers, mentioned that she asks herself reflective questions like, *"Which prayers did I complete today, and which ones did I miss?"* She voiced how she self-reflects in the following quote:

> *I track my prayers; at the end of each day, there are five prayers in a day, and I am not good with praying five times a day. So, at the end of the day, I ask myself, 'Okay, which ones* (referring to prayers) *did I do?' 'And then, which ones did I miss?' So that I know, 'Okay, those are the ones that I will need to make up,' and 'I need to be better about doing those.'*–P1

Participants also emphasized that their self-evaluation process is deeply rooted in Islamic values and concepts, specifically *Muraqabah* (mindfulness and meditation) and *Muhasabah* (self-evaluation or reflection). P6, who tracks her prayers, fasting days, and the Quran readings, utilizes tracking to assess her progress. In the following quote, she shares the questions she uses as prompts for her daily self-evaluation, utilizing the information to enhance her religious commitment. She highlighted integrating these reflective concepts of the Muraqabah and Muhasabah into her role as a teacher in an Islamic school:

> *[...] Muraqabah is an Islamic way of reflecting on oneself continuously...that's why I'm huge on reflection... Muhasabah, it's like you're accounting for your deeds daily. So for children, when I teach children, I tell them, 'Before going to bed every night, I want you to think of three things that you could improve on, three things they did well, and three things you can improve on a nightly basis' that's the accountability. Muraqabah is the reflection: 'Why did I do those three things that were not so great? And how can I go back and improve on those three things?' That's the reflection piece. So I do both. Accountability is big for me, and reflection as well, because it comes directly from Islam...So every day should be better than the other day that you just had...That's how I've tried to live my life. And that's why I tried to build in reflection over and over again in so many parts of my life.*– P6

In summary, participants are driven by religious motives to strengthen their faith and establish a sense of consistency and accountability in their worship. Tracking various aspects of their religious practices, such as prayers, fasting, and chapters of the holy text they have read, enables them to fulfill these goals. The participants engage in reflective practices, drawing insights from their tracked information to enhance their spiritual and religious well-being.

5.1.2 ***Health Motives.*** Our research revealed that participants were motivated to engage in health-related tracking to stay informed about their health and well-being during Ramadan. Participants emphasized that monitoring their health played an essential

[1]Pillar App: https://pillar-app.com/

role in identifying when they might be exempt from certain religious obligations. For instance, tracking their menstrual cycle enabled them to prepare for days when they were exempt from fasting and praying. This tracking behavior demonstrates the interaction between health and religious tracking practices. In this regard, participants expressed their dependence on mobile applications to cater to their specific tracking needs. To attain their health objectives, they relied on applications that aligned with their tracking needs. For instance, P9 employed various tracking tools for distinct yet sometimes complementary purposes, as illustrated in Figure 2. For her health-related tracking, she utilized both the Clue and Aavia apps. While Clue was dedicated to menstrual tracking, Aavia facilitated the monitoring of hormonal changes, enriching her understanding of her body and reproductive cycle. She articulated her experience as follows:

> *I use an app called Aavia [2]. And it's an app where women can track their hormone cycles. So, since we have four phases, depending on your last period, it will let you know if you're in a Follicular phase if you're in the menstruation phase, the Ovulation phase, and the Luteal phase. And then it gives you advice on what you should eat and shouldn't be doing during these times. And it's very spot-on. I could say that it's probably still being developed because it updates all the time. But, for the most part, all my friends and I started using the app, and we love it. Because, you know, when we started educating ourselves on our bodies, we needed to follow our female cycle...*–P9

Another instance involves P5, who discussed her commitment to health goals through a combination of tracking methods. She used a period tracker app to monitor her menstrual cycle and utilized the notes feature on her iPhone to keep tabs on her water and carbohydrate intake. In the following quote, she elaborated on the health objectives and explained the relevance of period tracking in aiding her compliance with religious fasting obligations. Keeping a record of the start and end dates of her fasting and her menstrual cycle allowed her to calculate the number of fasting days she missed and needs to make up later.

> *I use the period Tracker app because I know my period days, which are my missed fasts. So I could just easily look at that and know [...] I'm already charting, on the notes section[in iPhone], what my water intake that you know, my period is it's getting kind of funky. So, some days, I'll think I'm not done [with my period]. And that did happen this year. I was fasting, and I thought it [referring to period] was done. And then it turned out, No, I was. I spotted it and had to break my fast and make it up later. So, I think the notes section helped in that situation. I could have done that on the period tracker, but it just was easier since I was typing every day on the other one to just put it in there*–P5

In summary, we encapsulate our first finding concerning two overarching tracking motives: religious motivations and health motives. Specifically, we highlight the underlying reasons driving these motivations, the tools used in tracking, and how tracking practices contribute to realizing these motives.

[2]Aavia: https://aavia.io/

5.2 Socially Crafted Religious Practices

We found that social roles are shaped by societal norms and influenced by religious practices. We present two lenses of viewing these socially crafted roles influenced by religious practices: (1) The Maternal Perspective– exploring how mothers support their children in accomplishing their religious rituals. (2) The Child's perspective–teasing how children perceive and elaborate on their parents' support in achieving their religious goals.

5.2.1 The Maternal Perspective. The social roles shaped by societal norms significantly influence participants' tracking and structuring of their religious goals. In particular, motherhood plays a central role in shaping the tracking practices of muslim women. During Ramadan, the approach to tracking as an individual differs from the tracking approaches taken by the mothers in the study, as the latter involves aiding their children in tracking their religious observances. In this context, P5 and P7 emphasized how their tracking responsibilities evolve as they adapt to different stages of parenthood. Both participants point out that supporting their children's tracking efforts has strengthened their parent-child relationships. P5 noted that her tracking experiences had evolved, citing that when her children were younger, she was responsible for tracking the number of fasting days to help them gain more experience until they could fast for the entire duration of Ramadan. However, now that her children are older and more experienced with fasting, she pointed out that they have taken on the responsibility of fasting and tracking their fasting for themselves. P5 also alludes to transitioning the responsibility of tracking her children once they hit puberty, explaining that at this point, accountability to self for fulfilling religious rituals becomes personal and upon each individual

> *..when they* (referring to her children) *were little, we did track together, but because my kids are 'older fasters'* (more experienced at fasting), *they're responsible for tracking their own and knowing what they've missed and what they need to make up. I tell them. I'm like: 'Well, now that you guys have hit puberty, this is between you and Allah (God), so you are now responsible. And I'm not babysitting you here'* –P5

P7, on the other hand, emphasized that she not only tracks her own religious goals but also tracks religious goals for her children. Given that her children are still young, she taught them to make specific prayers (or duas). She emphasized that these social responsibilities have helped develop her relationship with her family. In her words:

> *During Ramadan, my son and I were tracking together, and I was teaching him different Duas and prayers we could do for different nights in Ramadan and tracking that [...] So, my husband is a muslim. He was also there. But he saw how much it took me to teach my son and track it. It brought my husband and me closer; we can talk about: 'what you are doing. How are you teaching?', and we're all learning. He was learning some of the duas. I was learning too, so it was a good learning experience for us to come together* –P7

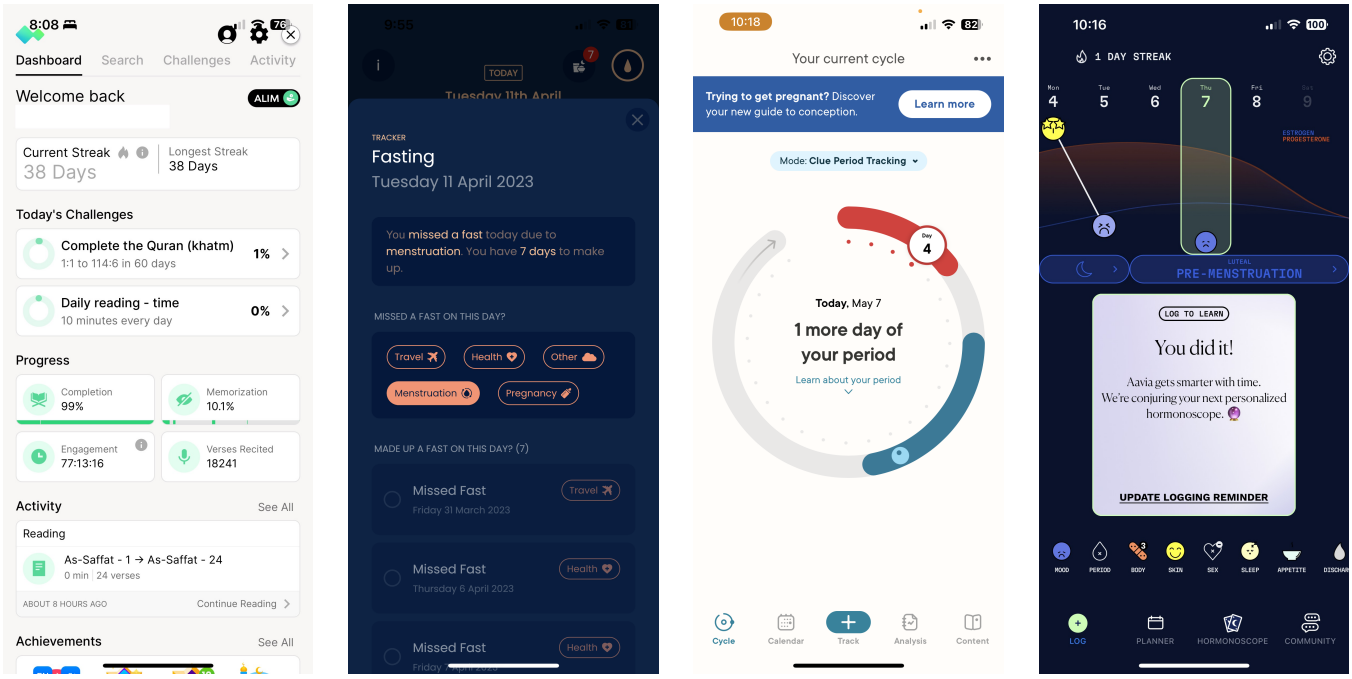

Figure 2: Tracking Practice of P9 in Ramadan. L-R: (1) Tracking Chapter of Quranic Text Read using Tarteel App, (2) Tracking Days of Fasting and Missed Fasting using Pillar App, (3) Tracking Menstrual Cycle using Clue App. (4) Hormonal tracking using Aavia

Additionally, P2 shared that she and her mother worked together to devise food menus for Ramadan, using a whiteboard calendar as a tool. This physical calendar was useful for planning meals for each day's predawn and breaking of fast meals during Ramadan. Through their collaborative efforts in constructing the Ramadan food schedule, She constructed a mental chart of fasting days, organizing them according to the meals they had scheduled for each day of fasting. She elaborated on this experience in the following quote:

> *... we started this thing we bought like little whiteboard calendar that has the days of the week. Before Ramadan, my mom and I brainstormed what we wanted to eat in Ramadan. So that she knows what to cool. So, instead of the day of the month, I wrote Ramadan Days 1...2...3...4* (Islamic lunar-based calendar). *On the other corner, I would put what day of the month that was* (Gregorian calendar). *For each day, I would record what we had planned to eat. If we deviated from that plan, I would update it on the calendar. So I knew what day of Ramadan it was because of what my mom was cooking. And so that was one of the ways that I also like to track my fast. It's like, okay, yesterday, we ate burritos. And we were supposed to eat burritos on the fourth day of Ramadan. And we didn't change that. So it's been four days. I like to have a physical copy of things, especially regarding Ramadan. Things that I will see. I have this whiteboard calendar; I mounted it to a wall by the dining table. So it's always there...* –P2

5.2.2 The Adult Child's Perspective. Conversely, participants provided detailed insights into how their parents supported their religious goals. P1 and P2 received support from their parents to pursue their religious objectives. P2 additionally emphasized her reliance on her mother as a resource for maintaining a record of missed fasts during Ramadan due to menstruation.

> *...I use the Flo app to track my period. Exclusive to Ramadan, another resource is my mom because if I forget when my period started. I forget to put in the app; I'll ask her, 'Do you remember when I had mine because she's really good about remembering hers, and she'll say something along the lines of: 'I know you got yours like the day after I got mine or the week after I'm pretty sure it was a Tuesday so then I'll go back and check the calendar with 'Oh yeah, that sounds about right,' and then that's when I'll log in. This way, I know what days of fasting missed* –P2

P1 indicated that her father offered assistance in distributing the money she had set aside for charitable purposes or donations, known as "Sadaqah" in Islamic tradition.

> *... I like to give Sadaqah with my hand each day, or I tried to, and what that looks like is I do it in cash. From whatever personal money I have, e.g., pocket money that my parents give me, the savings that I have, or gift money that people give me, even if it's something as small as $1, I will take it out with my hand and put it*

> *in a designated pile of money that is only Sadaqah. I don't touch it for anything else... And it's in dollars... And then what I'll do is when it gets to $200 or more, I'll take it and give it to my dad. And then he will send it back to Pakistan because dollars are worth a lot more there. And then I'll give it away as a charity over there... Once that has been accounted for, I can start over with like giving every day* –P1

In summary, in section 5.2, we present the socially crafted roles expressed by the participants and describe how they influence their religious practices. We underscore two significant perspectives–maternal and child–elucidating the intricate interplay between social roles and religious practices within family dynamics.

5.3 Tensions around Tracking Practice during Ramadan

The participants experienced tensions and challenges around their tracking habits during Ramadan. The themes we uncovered in our study include (1) challenges with managing disruptions to religious goals resulting from natural health cycles, such as menstruation, (2) challenges with balancing health and religious goals simultaneously, (3) maintaining tracking habits post-Ramadan and (4) the trade-offs of engaging with multiple tracking tools.

5.3.1 Managing Disruptions to Religious Goals. Participants underscored the emotional struggle of reconciling menstruation with the interruption of their religious obligations during Ramadan. Some participants described how they had to adopt an alternative perspective regarding their menstrual cycle, viewing it as an *"opportunity to take a break"–P4* from religious rituals, a time for self-care, or even as a "rewardable" act of obedience to God due to adhering to the exemption. In the quote below, P1 offered how she viewed these disruptions, describing her menstruating days as a break, an opportunity to observe her faith differently by practicing self-care. She referenced that adhering to these exemptions was rewardable. Hence, it helped change her perspective from seeing it as a disruption to her faith-related goals to the lens of another act of worship (Islamically referred to as *Ibadah*).

> *Menstruation limits the kinds of worship you can do. I try to practice [my] faith differently during those days [...] We have been told that you are rewarded for neither fasting nor praying when you are on your period during Ramadan. And I read somewhere that self-care is also an act of Ibadah* (or worship). *I try to do whatever I'm doing, whether it's resting, sleeping, showering, or anything; I try to start these acts with the intention that I am doing this act as self-care* –P1.

One strategy that some participants took to manage these interruptions in their daily faith routines was to utilize the opportunity to engage in further acts of religious education. According to these participants, these disruptions opened up more time in the day to learn more about their faith.

> *My spirituality dips are always aligned with my menstruation. Because I'm feeling my lowest at menstruation, I have hormone imbalances [...] My health suffers because of that. So, I know all of those things are connected. And we have to make sense of all of that [...] I know there are ways to connect with God in those times, certainly, but it's just not the same as fasting like everyone else. But I think what helps me is when I listen to some scholars talk about or discuss how there are other blessings for women who are not fasting because of their menstrual cycle when they're in their period. So I think that helps me through the process.* –P6

Although participants put up a brave face on the challenges of being exempted from some acts of worship, menstruation during Ramadan is perceived as a challenge that can be both hard and isolating.

5.3.2 Managing Conflicting Health and Religious Goals. Especially during Ramadan, participants voiced their difficulties in managing their health and faith objectives simultaneously. The struggle often led to substantial alterations in their daily routines, affecting their exercise routines, water intake, and sleep patterns. The most notable conflicts and lifestyle adjustments were predominantly centered around alterations to daily exercise routines. In the quote below, P4 described that observing Ramadan conflicts with her daily exercise goals as she found herself doing less exercise during fasting.

> *[...] I know some people do an excellent job exercising during Ramadan, but I'm not one of them. When I'm outside Ramadan, I exercise more, maybe not to the level I'd like, but more than in Ramadan*–P4

Participants sought to maintain exercise habits even while fasting. P2 sought external support through YouTube videos to try and find a balance. The Youtuber specifically creates exercise regimens for fasting individuals. However, she expressed that there is still a considerable need for more support in this area. P2 preferred maintaining full body covering and added that she sought out female Muslim fitness instructors on YouTube.

> *It's also tough to go to the gym, as a woman, much less a Muslim woman, because you have to cover up head to toe, but then you get hot, and it's uncomfortable. It isn't easy. I know that there are Muslim ladies who exercise at home. They'll hold little groups. One woman said: "Oh, these are exercises you can do during Ramadan." And she has a whole YouTube channel [that one can access if one subscribes to] her mailing list. And that way, she maintains [control over] who sees her videos. Having guided exercises for Muslims would be good because it's hard to be active at home when you don't know what to do. And if you see a Muslim woman leading these kinds of exercises, you feel encouraged like, "Okay, I can do this too. "Instead of, you know, those ripped men, leading those cardio exercises on YouTube"*–P2

Similarly, P10, in her diary entry, also sought out a female instructor and chose to pay for the fitness app EvolveYou[3], which offered tailored exercises specifically for Muslim women observing Ramadan. She quoted as follows:

> *The iPhone also has a paid fitness app called EvolveYou. I bought this app for $100 for a yearly subscription but have only recently been using it. I found a Muslim*

[3]EvolveYou: https://www.evolveyou.app/

> *instructor and fitness plan within the app when I typed in Ramadan. The workouts have been shorter and doable while fasting. This has been the other health-related tracking app I have been using lately. It keeps track of the workouts I've done and the ones I need to do, along with a schedule for the Ramadan workout plan I signed up for.*–P10

5.3.3 Maintaining Long Term Religious Goals Post-Ramadan. Participants talked about the challenge of sustaining their religious goals post-Ramadan. Participants aimed to sustain these goals consistently throughout the year. However, upon reflection, they acknowledged their challenges in maintaining these goals as the year progressed. P4 described that the goals she set during Ramadan are habits or behaviors she would like to do all year round but that she struggled to maintain her religious goals outside of Ramadan. Considering that she would need to make up missed fasts outside of Ramadan, she described the challenge of maintaining the same heightened goals.

> *[...] I only like doing these things during Ramadan and not outside of Ramadan. But it's nice to do it all around the year [...] I will make up my fasts at other times* (outside Ramadan). *I would like to give charity throughout [the year]. I'm not going to give it the way I do Ramadan, but I would like to throughout the year. I want to be mindful of my prayers throughout the year. I want to listen to Islamic content throughout the year. I want to be mindful of my diet. Throughout the year, I want to exercise. So, I think a lot of it is longitudinal [...]*–P4

Additionally, P6 emphasized her commitment to a longitudinal approach to her religious goals, mentioning that she creates annual religious objectives and endeavors to build upon them yearly. She noted in the following quote that her goal for the current year was to establish a more consistent reading of the Quran to strengthen her connection with its teachings. Subsequently, the following year, she planed to extend her goal by adding another religious goal, indicating her continuous efforts to build upon her religious aspirations.

> *So every year, I try to think of one thing I can do spiritually [...] So one of the things that's always been nagging me is I've never really had a relationship like a really strong relationship with the Quran [...] I'd like to maintain the relationship I have or the status I have with the Quran. So that would be a goal. I probably would set another goal on top of that. Maintaining this is great, but, 'how do I go beyond what I just did this year?' 'How do I make it even better?' In the education world, we call it the spiral curriculum where you have a building block, and you build on top of that [...]*–P6

P6 also highlighted that the same strategy she employed for her religious goals applies to her planning for other aspects of her well-being, including, but not limited to, exercise and nutrition. We found that P6, in thinking about how to build upon her goals, negotiated with questions that helped determine when it's a good enough time to add a goal. For example, she queried: *"I've maxed out the gym. What do I do now?"* and then reflected that ways to build upon it is *"Okay, add a personal trainer"*

> *[...] we call it the spiral curriculum where you have a building block, and you build on top of that so you reach the highest potential that you have as a person.[....] I have a personal trainer. Just this year, for the first time, I added nutritionists to my plan. So, in the past, I've always gone to the gym; I then added a trainer to get even better. I thought to myself, 'I've maxed out the gym. What do I do now?' 'Okay, add a personal trainer.' 'I've been using a personal trainer for about three or four years. Now. What do I do?' 'Oh, add a nutritionist,' right?' "*–P6

5.3.4 Trade-off of Engaging With Multiple Tracking Tools. Many participants described using various tracking tools to help them manage their health and religious goals during Ramadan. These tools included (1) menstrual tracking tools for tracking periods and accounting for days in which they would need to adhere to guidelines of not participating in certain Islamic rituals (examples were the Flo App and Clue App), (2) specific faith-based trackers for tracking their prayers (examples were Muslim Pro [4] and Tarteel app [5]) and (3) physical tracking artifacts, such as wall calendars and reflection journals/notebooks. While these tools supported distinct religious and health goals, participants encountered challenges where these goals intersected. For instance, tracking menstruation also facilitated the monitoring of missed fasting days. P3 described the challenge of juggling her tracking habits across four apps– the Flo app, the Apple Notes app, the Pillars app, and the Tarteel app. (She shared photos of 3 of these apps on her diary entries. See Figure 3). She described how she uses these apps in her daily lived experience.

> *I tracked my symptoms daily using the Flo app. This is by filling out the daily log of symptoms, which allows the app to predict when my period will arrive. The Pillars app is what I use five times a day to check off my five daily prayers...The app also has a new feature, which tracks fasting and menstruation days and checks off all of the five daily prayers as they cannot be completed. I only insert ['insert' refers to ticking Y/N on the Pillars app] if I have missed a prayer on the feature, and the days where I do not click anything are assumed to be a day that I fasted. If I forget which dates I did not fast, I can always go back to the dates on both Pillars and Flo to figure out when my period was, how long it was, and how many days I did not fast so I can easily make them up. On my notes app, I have a log of the dates and the Juz (or chapter of the Quran) that I read. I also use Tarteel to bookmark the chapter* –P3

However, participants voiced difficulties and trade-offs when managing multiple tracking applications. Two prominent challenges that arose from our data include (1) menstrual apps not catered towards Muslim women and (2) data ownership and privacy for Muslim apps that track religious goals. Despite these tensions, participants persist in using these applications, primarily driven by

[4]Muslim Pro : https://www.muslimpro.com/
[5]Tarteel :https://www.tarteel.ai/

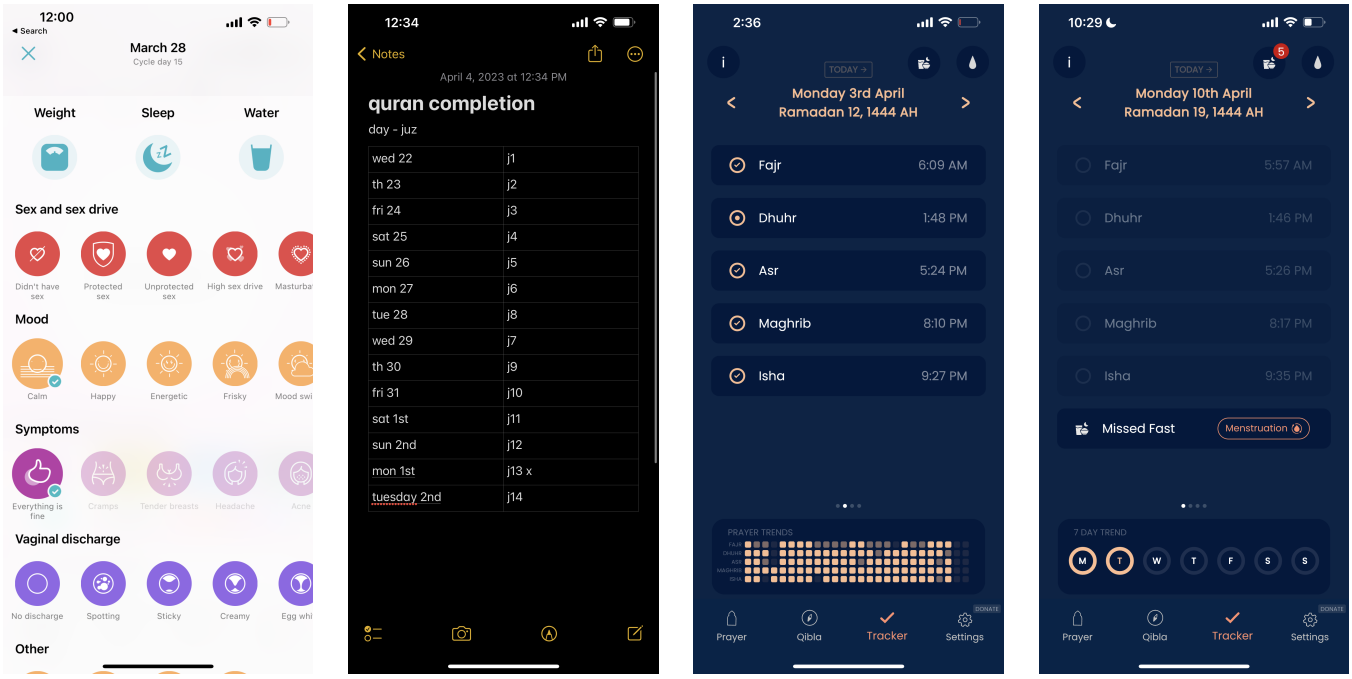

Figure 3: Tracking Practice of P3 in Ramadan. L-R: (1) Flo app for tracking her symptoms (2) Apple notes app for tracking chapters of the Quran read daily (3) Pillars app indicating prayer tracking (4) Pillars app indicating missed fasting due to menstruation

convenience and the absence of alternative tools designed to meet their unique requirements. In the quote below, P2 highlighted that she used the Flo app and didn't find it to cater to the needs of Muslim women whose periods interfere with their faith practice and goals. On the other hand, Muslim Pro–a mobile-based app that offers details on prayer time and the Islamic call to prayer (or *Athan*)–doesn't offer a menstrual tracking feature. She rationalized that maybe the exclusion of period tracking in Muslim Pro is basically because the app is used by both men and women, which leads her to question why men aren't educated on menstruation. She believed that menstrual education should not be limited by gender but should be inclusive and accessible to both Muslim men and women.

> *[...] The problem with the Flo app is that it includes aspects that do not apply to muslim women. So there's that. And then also, the muslim Pro app – having [period tracking] as an option for muslim women would be nice, but I still feel like it's still there for everybody [men and women]. Which I guess isn't necessarily bad because I think men should be educated on what women go through, too [...] But we have an app that's explicitly for women; it may be much more helpful* –P2

Other participants were concerned about data ownership and privacy in tracking. Below, P4 described the tension and trade-offs between data privacy versus convenience of use. In 2020, several published reports (one example is seen here [59]) announced that Muslim Pro sells user data to the US military, prompting many muslims to uninstall the app and stop tracking.

> *[...] This whole thing about using multiple apps, there has been this concern that they're kind of, I guess, they were selling our information, I don't know if selling is a good word. But basically, they were collecting information, and because whatever information we track, like, that is available to the public [...] Muslim Pro was one of the big ones; it was the only Muslim app named among all these apps transmitting this information. And I know personally many people stopped using Muslim Pro after that. I remember at that point, I was wondering whether or not I should continue to use Muslim Pro. But at the end of the day, it was a super convenient app [...] So I continue to use Muslim Pro. But it did make me pause because I know many people were concerned, and some people, including friends, stopped using certain apps because they were concerned about this breach of personal information [...]* –P4

In this section, we have presented the several tensions inherent in tracking health and religious behaviors during Ramadan. These tensions or challenges encompass managing disruptions to religious goals, conflicts between health and religious goals; goal transitions after Ramadan, multitudes of tracking tools used simultaneously, and the trade-offs resulting from engaging with multitudes of tracking tools.

6 DISCUSSION

Designing for religious wellbeing is an essential but challenging task. Part of the challenge is the diversity in religious and belief

systems. We encourage the HCI research community to consider designing personal informatics technologies that are value-sensitive and culturally responsive to individuals' religious wellbeing and health.

6.1 Expanding the Domain of Tracking Technologies

The findings uncover an interwoven connection between health and religious tracking motives. Participants rely on tracking applications and practices to support their religious goals. We find that these tracking practices encompass both their health and religious goals and indicate participants' need to support holistic health, including their religious wellbeing. This need for holistic health aligns with findings from researchers who studied Muslim individuals outside of the US and found that in addition to their medical support, they also leaned towards spiritual and religious practices to support their pregnancy journey [91, 92, 112]. Moreover, researchers [75, 91] have highlighted the significance of including religion in the discourse for designing personal health informatics systems. Based on our findings, it is evident that menstruating Muslim individuals are already actively pursuing various personal tracking goals in order to better understand, engage with, and improve their health, physical activity, and religious wellbeing. They encounter challenges when searching for tracking tools that effectively support both their health and religious wellness together, particularly in cases where these goals complement each other, e.g., monitoring menstruation to keep track of missed fasting days or tracking food plans to record the number of fasting days observed. The challenge is: "How do we design culturally responsive and religiously inclusive self-tracking technologies that support both health and religious wellbeing?".

We propose two approaches for consideration. Firstly, as researchers, we can evaluate existing wellness self-tracking technologies and envision potential redesigns or customizations [24, 58] to align with people's religious beliefs, thus enhancing faith-related support. Illustrative examples could draw upon concepts similar to those found in Omnitrack [66] or KeepTrack [62]. OmniTrack [66] affords flexible self-trackers the ability to construct a tracking tool with customized tracking items that meet their unique needs and preferences. KeepTrack allows users to utilize multiple data sources as inputs to create visualizations that support awareness and self-reflection [62, 66]. These customizable trackers can prove useful in socially constructed religious practices that involve parent-child co-tracking behaviors or for individuals monitoring their charitable donations for example. The advantage of these customizable trackers lies in their adaptability to the diverse stages of individuals' religious wellbeing, necessitating tools tailored to their specific requirements. Users can define their religious wellbeing indicators using these trackers and choose to represent them on a Likert scale, numerical scale, textual format, or a combination customized to their preferences. The benefit of this approach is the provision of insights derived from their data, aiding them in reflecting on their personal journey and progress. These customizable trackers would support Muslim individuals in tracking their goals and providing visualizations to support their reflective practices. Secondly, we recommend facilitating conversations and collaborations between researchers and faith-based stakeholders to encourage supporting faith-related goals and religious wellbeing in the design of interactive technologies. Researchers have begun pursuing these collaborations; a good example can be seen in the recent ACM Designing Interactive Systems (ACM DIS) 2023 workshop focused on Crafting Tangible Interactive Artifacts for Spiritual Endeavors [6]. We recommend a call to action to increase collaborative work with religious leaders, community leaders, and experts in health and wellbeing in order to collectively advance the development of self-tracking technologies that are culturally responsive and inclusive of religious contexts.

In addition to managing and self-tracking personal health and religious goals, participants also take on additional tracking activities to help support and track the religious goals of their family members (e.g., children). Researchers [27, 74, 102, 103, 113] have discussed the benefits of considering and designing beyond personal informatics to focus on family-centered health tracking. A comparable strategy could also be applied to promote family informatics within a religious context. In our findings, the discovery of collaborative religious tracking within family contexts presents an intriguing avenue for investigating and designing joint tracking of religious goals within familial contexts and creating solutions tailored to the family dynamic. It also provides an exciting challenge to navigate when children become teenagers, where the accountability for religious goals shifts from the family to the individual (as described by P5 in section 5.2). We encourage future research that explores how family dynamics and relationships cater to individuals' religious practices and how religious practices can be integrated with health goals in the context of family. Designing PI tools to include religious wellbeing to support physical, social, and mental wellbeing will help foster more equitable and holistic health.

6.2 Design Considerations

In this section, we reflect on participant's experiences and offer potential considerations for designing personal informatics tools to support Muslim individuals within Ramadan and beyond. We mainly highlight three promising directions.

6.2.1 Leveraging Islamic Values and Concepts in Design. Participants in our study are very strongly motivated to reflect upon their tracked information, asking critical questions to generate insights on areas needing improvement. We envision that health and wellness apps could support this desire to frequently reflect on one's spiritual wellbeing. For example, Apple Health summarizes daily workouts, exercise minutes, and, more recently (on iOS 17), logging emotional wellbeing. We envision similar systems, where individuals could be supported to track and reflect on their religious wellbeing. For example, it may be helpful to provide participants with options to set their religious goals for the day or the week and then prompt them daily or weekly to self-assess and reflect on their goals. In our study, the participants highlight "Muhasabah" and "Muraqabah," indicative of the deeply connected ways religious values and norms shape how they think about the world. These principles/values can support the transition from gathering data to engaging in sensemaking, reflection, and action, encompassing

[6] W.09: Designing Tangible Interactive Artifacts for Religious and Spiritual Purposes

their health-related goals and religious aspirations. When contemplating applying self-tracking practices to assess religious worship and ritual activities, it may be helpful to emphasize enhancing the quality of worship rather than focusing solely on quantity–an idea supported even within Islam. Here, we can draw inspiration from the "Slow Technology" [47, 98, 99] design philosophy, which promotes the development of interactive technologies tailored to slower, more contemplative practices. Islamic concepts of reflection (Muraqabah) encompass a holistic approach that includes spiritual, moral, and intellectual dimensions, often drawing insights from religious texts like the Quran and the Hadith. Although the reflective practices in Islam also include individual pursuits and achievement of goals, its central focus revolves around an individual's connection with God. In contrast, reflection in design research [13, 39, 114, 115] often concentrates on individual pursuits, such as achieving goals or problem-solving within the design process. Similarly, the notion of privacy in Islam draws heavily from religious texts which emphasize privacy of different forms, individual privacy, privacy in the home, and privacy for gender-exclusive spaces and gatherings [1, 3, 4]. We see these forms of privacy when P2 describes her 'individual privacy' in using the Muslim Pro app and her preference for 'privacy in the home.' She also highlights privacy associated with 'gender-exclusive spaces' when she discussed her preference for working out at home watching tailored YouTube videos over working out in a gym which lacks gender-secluded areas [4, 126]. As HCI researchers, when designing for Muslim individuals, it is important to consider these forms and perspectives on privacy. By respecting the values of the Muslim population in our designs, we can create culturally sensitive self-tracking tools that not only align with their beliefs but also encourage continuous engagement.

6.2.2 Designing for Long-Term Tracking. As participants expressed, a need exists for sustained monitoring that extends beyond the month of Ramadan. Of even greater significance is the observation that participants utilize Ramadan as a time for establishing annual religious goals, which they intend to pursue throughout the entire year until the next Ramadan cycle. Consequently, Ramadan serves as the foundation for establishing and advancing existing goals. This presents an opportunity to devise a long-term self-tracking system that accommodates the annual reassessment of goals, enabling users to build upon their accomplishments. In this regard, we can draw inspiration from the model for long-term self-tracking presented by Epstein et al. [34]. The long-term self-tracking model [34, 86] delineates two tracking orientations: *purposeful tracking*, which stems from users' specific needs, such as tracking for weight loss, and *incidental tracking*, where users engage in tracking as part of their everyday use of technology or through passive data collection. It may be beneficial to consider both tracking directions to provide better support for Muslim individuals. We recommend that a goal-based (purposeful) tracking system allow Muslim individuals to set goals and then, based on their overall tracking practices over time, provide feedback or suggestions on how to achieve their goals or how to build on their goals further. For example, if the system has noted that a user has consistently added one or more religious goals yearly, it may offer feedback on what goals to include or which were left behind. This approach enables users to generate religious data and gain insights from visualized trends of those data over time. Utilizing compelling visualizations can enhance their reflective practices. As researchers, we need to strive to mitigate potential tensions associated with long-term tracking. Our research findings have demonstrated that participants harbor concerns about data ownership. One participant, in particular, highlighted her reluctance to share her information with anyone, preferring to use it solely for personal self-awareness, reflection, and religious well-being. This issue about data ownership and sharing practices is essential, especially when designing self-tracking tools to facilitate extended monitoring for Muslim individuals. Indeed, as highlighted in [86], it is imperative to give due attention to data ownership, privacy, and security concerning data amassed over extended periods; as such, data accumulation carries ethical, legal, and societal implications.

6.2.3 Designing for Educational Support. Participants' experiences point toward the need for educational resources to support them in pursuing their health and religious goals. As indicated in our findings, participants expressed needing more help and education on maintaining their health and religious goals simultaneously. Questions such as *" How do I exercise as a fasting Muslim woman? How do I balance my nutritional (water intake) while fasting? What sort of health exercises are recommended in Islam?"* points towards an education gap. Providing tailored exercise content that aligns with user preferences (e.g., being led by a female instructor) and principles (grounded in Islamic ideas) of Muslim individuals or offering educational resources on alternative forms of worship to accommodate menstruation-related breaks could be helpful. Our findings indicate a growing tendency among participants to turn to YouTube and enroll in training programs led by other Muslim individuals. This trend highlights the desire to connect with individuals with similar life experiences to guide them in pursuing health and religious wellbeing. We envision tracking technologies that support a community forum that promotes experiential learning among its members where participants can ask each other questions, learn from scholars and health experts, and share resources they use to balance their health and religious goals.

7 CHALLENGES AND LIMITATIONS

Using a digital diary as a data collection method (Qualtrics link) allowed the research team to recruit and enroll participants across the United States. However, this also meant that our participant pool included participants familiar with and having access to technology to access Qualtrics. Additionally, participants were not enrolled at the same time; thus, it may have been challenging for participants to manage our study and the demands during the final days of Ramadan when religious activities typically peak. This challenge could have led to drop-out from studies or could have affected the participation rate. In our study, enrolling participants at various stages could burden the researchers, necessitating reminders to each participant and diligent tracking of their involvement. We recommend researchers consider demands from both participant and researcher perspectives when executing studies during Ramadan. We did not specifically inquire about the duration of participants' religious practice, except for one participant who mentioned having converted to Islam and practiced for a little over two years. The duration of individuals' practice may vary, depending on factors

such as whether they were born into the religion or converted to Islam. Future research could explore whether the duration of religious practices impacts religious tracking, health tracking, or both. In applying our findings to Muslim populations outside the United States, we recommend considering their cultural and familial context, which may affect the socially crafted religious practices.

8 CONCLUSIONS

We investigate the tracking motives and practices of Muslim women in the US (N=9) during the month of Ramadan. We utilize a diary study consisting of 10 daily log entries and 2 reflection log entries per participant and interview participants upon completing the diary study. We uncover the religious and health motivations that drive self-tracking practices. We shed light on how social roles influence tracking practices and also highlight the challenges that arise from tracking practices during Ramadan. Our contribution lies in providing an empirical understanding of the motivations and challenges faced by Muslim women in their tracking practices. In our discussion, we advocate for expanding personal informatics and self-tracking to promote religious well-being and provide design considerations for designing tracking tools that are faith-inclusive. In conclusion, our research extends the scope of personal health informatics beyond conventional health and wellness tracking, offering a perspective where faith is intertwined with health and wellness objectives.

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