INVESTIGATING THE IMPACT OF FAITH ON THE DESIGN OF PERSONAL HEALTH INFORMATICS TOOLS: UNPACKING MUSLIM MENSTRUATORS' HEALTH AND TRACKING PRACTICES

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Submitted to the faculty of the Graduate School

in partial fulfillment of the requirements

for the degree

Doctor of Philosophy

in the Luddy School of Informatics, Computing, and Engineering,

Indiana University

June 2025

Accepted by the Graduate Faculty, Indiana University, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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To my lovely parents (Alhaji and Hajiya Ibrahim) and my brothers —

Thank you for the prayers and support throughout my Ph.D

ACKNOWLEDGMENTS

Alhamdullilah- an expression of thanks to the Almighty Allah (God). I am grateful to God for the good health, opportunities, and strength to go through my PhD program and for the support structures that Allah placed in my life throughout this journey. I find myself undeserving of these opportunities and thus immensely grateful for the blessings throughout my life till this moment and beyond. Next, I express my deepest gratitude to my advisor, Dr. James Clawson, for his guidance and support throughout this long PhD journey. I am especially grateful for his unwavering support in situations where I felt I had little control. He challenged my thinking process and took the time to discuss research, life, and faith with me. I also appreciate the accommodations I received during the multiple Ramadans that coincided with academic semesters. Thank you, Dr. Clawson for taking a chance on my PhD application and for ensuring that I stayed on course through the pandemic and the final stages of my PhD journey.

I must thank my awesome mentor, Dr. Katie Siek for the immense support and guidance throughout my PhD. I admire Dr. Siek's passion for research and for indulging my research ideas, collaborating with me on research projects, and supporting most of my conference travels to present my work. I could not have imagined many of the opportunities that came my way without the support of Dr. Siek's funding support for my travels and conference logistics. Thank you to my committee members for helping me steer my PhD research into what is now presented in this document: Dr. Chia-Fang (Christina) Chung, Dr. Selma Selma Šabanović, and Dr. Elizabeth Kaziunas. I appreciate Dr. Chung's support and mentorship on other side projects that have been published. I am also grateful to Drs. Kaziunas and Šabanović for being open to bouncing ideas off with me. I am immensely thankful for the support I have received from each of you, both individually and collectively.

Thank you to Dr. Mary Gray at Microsoft Research, Cambridge, for first offering me two internship opportunities at Microsoft Research. I am grateful for the intellectually stimulating research that helped me develop new skills while allowing me to think critically and push beyond the limits of my PhD training. I learned so much at Microsoft Research—from the incredible mentors to my fellow intern peers. I must also thank the mentors and friends who

supported me throughout my PhD program, providing practical support, guidance, and feedback on my writing. I am grateful for Dr. Novia Nurain, PhD, for being an incredible collaborator, mentor, and support system in both research and faith—I not only gained a collaborator in Novia, but also a sister and a friend.

Thank you to Dr. Jacob Abbott, Arash Zakaresfahani, Dr. Juan Fernando Maestre, and Dr. Ben Jelen, PhD, for helping me navigate the first year of my PhD journey. And to my colleagues who journeyed with me through the rest of my PhD—Aswati Panicker, John Osario, and Isioma Nwayor—thank you. To present and past ProHealth members, with whom I have collaborated and traveled—Seung Wan Ha, Michaela Krawczyk, Colin Lefevre, and Sitha Vallabhenani—thank you for being a part of this journey! Navigating my PhD journey would not have been easy without great friends (Chiamaka Maimouna, Lina and Madinah) who have stood by me and with me through all the highs and lows of the PhD. Special gratitude to Aunty Shade of EducationUSA Abuja.

Finally, to my parents—thank you for your firm support throughout my many years of academic sojourn, for your prayers, and for sharing in my joys, tears, and challenges. And to my brothers, for being the best siblings one could ever have—I am truly grateful. I pray that Allah grants you all the best in this world and the next. Ameen.

Zaidat Ibrahim

INVESTIGATING THE IMPACT OF FAITH ON THE DESIGN OF PERSONAL HEALTH INFORMATICS TOOLS: UNPACKING MUSLIM MENSTRUATORS' HEALTH AND TRACKING PRACTICES

Menstrual technologies are becoming increasingly pervasive, allowing menstruating individuals to track their cycles, manage symptoms, and access educational resources. Despite notable advancements in the capabilities and designs of many of these tools, they are not designed to meet the needs of diverse cultural and religious users. In particular, Muslim women's experiences have been largely overlooked and traditional Human-Computer Interaction (HCI) research typically has not studied these groups. As a result, many solutions fail to meet the unique needs and risk alienating those who require more tailored and culturally responsive support. This lack of inclusivity and culturally responsive support is especially concerning given the global Muslim population of roughly 1.6 billion, half of whom are menstruating individuals. For Muslim women, religious principles include detailed guidance on menstrual and intimate health management. For example, Muslim menstruators are exempt from certain religious practices, such as daily prayers and fasting during Ramadan, when menstruating, necessitating precise menstrual tracking to plan religious observances.

In my dissertation, I investigate the complex relationship between menstruation and Islamic religious practices through three (3) empirical studies employing mixed-methodological approaches. These studies systematically examine tracking motivations, management practices, and information-seeking behaviors surrounding menstruation for Muslim women of faith. In my research, I uncover the strategies developed and challenges encountered as Muslim menstruators navigate the dual-considerations of physical health and spiritual obligations, often without adequate technological support. My work makes the following pri-

mary contributions include: First, it illuminates how health and religious perspectives intersect in menstrual health management, secondly, it uncovers the challenges Muslim menstruating individuals face in integrating religious obligations with technological tools, and third, it offers design recommendations for culturally aligned and responsive menstrual and personal health informatics solutions. Inspired by the Bronfenbrenner's Ecological Systems Theory (EST), I present the Muslim Menstruator Ecological Model in highlighting how individuals' experiences of menstruation are shaped by interconnected factors operating at multiple levels: interpersonal relationships, technological environments, institutional structures, and broader socio-cultural contexts. I provide a holistic and nuanced understanding of how technological interventions can be thoughtfully designed to support Muslim women across these various systems of influence. To conclude, I advocate for more inclusive approaches to menstrual health technology that recognize the inseparability of physical, religious, and cultural dimensions of sensitive health experiences.

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CHAPTER 1

Introduction

Menstruation represents a fundamental biological process that significantly influences women's lived experiences. Healthcare technologies have evolved to support menstrual tracking and symptom management, while ongoing research explores conditions such as Polycystic Ovary Syndrome (PCOS) and Endometriosis. The clinical significance of menstruation as a health indicator is evidenced by its prominence in medical assessments—healthcare providers routinely begin consultations by inquiring about a patient's most recent menstrual cycle, highlighting its diagnostic importance. Researchers continuously study menstruation in populations to try to better understand menstruation, and to design personal health tools to support menstrual health journey.

Despite significant exploration of menarche and menstruation within HCI research, a substantial gap remains in the study of menstruation as experienced by faith-based individuals. This deficiency necessitates immediate scholarly attention to foster a comprehensive understanding of menstruation's multidimensional significance in women's lives. Such an understanding is essential for the development of integrated menstrual technologies that seamlessly incorporate both health and religious perspectives, thereby adequately supporting individuals who navigate these intersecting domains.

My dissertation presents an exploratory research endeavor comprising three methodologically distinct studies. The initial investigation employed survey methodology complemented by semi-structured interviews to elucidate the menstrual tracking practices of Muslim women in the United States (US). In this study, I examined how participants currently

engage with existing menstrual tracking technologies and assessed the extent to which these technologies provide adequate support for their specific needs. Findings emerging from this investigation included participants frequently engaged in tracking behaviors specifically to facilitate adherence to religious guidelines pertaining to prayer and fasting obligations and individuals encountered challenges with existing menstrual tools. While conducting this study, legislative changes in the US prompted a follow-up survey to understand how these changes affected the use or disuse of menstrual apps. Building upon this discovery, my second study implemented diary studies to investigate menstrual experiences within the specific religious context of Ramadan—a sacred month identified as particularly significant in the first study. This methodological approach allowed for the documentation of experiences of tracking menstruation, health and religious practices within this religiously significant but temporal timeframe.

The culminating or third study, synthesized insights derived from the preceding investigations to design and implement a participatory research methodology utilizing Asynchronous Remote Communities (ARC). This approach engaged female participants in reflective activities concerning three critical domains: (1) preparation for menarche, (2) adaptation to menstruation as an integral component of lived experience, and (3) continuous acquisition of menstrual knowledge from both health and religious epistemological frameworks. Additionally, the study incorporated a speculative design activity, prompting participants to envision and design technologies for menstrual experiences—ones that simultaneously respect their health requirements and religious observances.

The tripartite research studies (Chapters 3, 4, and 5) presented in this dissertation establish a foundation for understanding the complex interrelationship between faith-based practices and menstrual experiences, and could inform future technological interventions and culturally responsive personal informatics tools for menstrual health support.

1.1 Research Questions

In my dissertation, I present the following thesis: *Menstrual experiences are often intertwined with religious values, especially for practicing Muslim women who track both religious and health goals through digital tools. While many Muslim women use tracking technologies to monitor both their health and religious obligations, current digital health and personal informatics tools fail to address this intersection. This gap presents a critical design opportunity for sociotechnical systems to create tools that support Muslim women's holistic health and religious experiences of menstruation.* To this end, I employed qualitative research methods, I explored the complex dynamics between religious practices, menstrual health management, and technology use. This investigation was designed to inform the development of socio-technical systems that better align with Muslim women's integrated religious and healthcare needs during their pregnancy journey. The following research questions guided this exploration:

Aim 1: Exploring the dynamics between religious practices and menstrual tracking among practicing Muslim women.

Research Question 1: How do practicing Muslim women in the US track their menstrual cycle and engage with menstrual applications?

- What are the commonalities between Muslim menstruators and other menstruators?
- How do religious experiences and practices influence menstruation?
- What challenges do Muslim menstruators encounter with menstrual tracking applications?

Aim 2: A deeper understanding into menstrual tracking practices within a situated religious context

Research Question 2: What are the tracking experiences of practicing Muslim women within a religious context (e.g., Ramadan)?

- What are the religious and health-related goals and motivations for Muslim Menstruators, especially in the context of Ramadan? How are these goals tracked?
- How do Muslim menstruators balance disruptions to religious goals as a result of menstruation?
- How might we design (or expand Personal Informatics Tools) to support religious and health goals for Muslims Menstruators?

Aim 3: Understanding how Muslim women learned about Menarche, navigate menstruation and to co-design technologies for menstrual support

Research Question 3: How did Muslim women learn about menarche and how could we design to support their educational experiences around menarche and menstruation?

- How did practicing Muslim women approach menarche experience (first experience with menstruation)?
- Based on their personal experiences, in what ways do practicing menstruating Muslim women perceive technology could have enhanced their menstrual experiences from menarche through adulthood?

1.2 Research Overview

My dissertation research comprises three empirical studies (Table 1.1) examining the intersection of health and religious perspectives on menstruation among Muslim women. The first study explores religious practices and menstrual tracking, particularly the use of menstrual apps, among individuals in the United States. To investigate this, I conducted a preliminary survey, a series of semi-structured interviews, and a post–Roe v. Wade survey. The findings illuminate the complexities of menstrual tracking within Muslim communities, perceptions of the Roe v. Wade overturns, and how it influenced menstrual app usage. Based on the findings from this study, I propose practical recommendations for designing more inclusive menstrual tracking applications. In addition, the menstrual tracking study contributes to the broader HCI discourse on "othering," illustrating how attention to culture, religion, and identity can help mitigate exclusionary practices in the technologies we create (Chapter 3).

As a follow-up, I conducted a diary study to explore menstrual tracking practices within the religious context of Ramadan, a month of fasting observed by Muslims worldwide. This study revealed a variety of tracking motivations—spanning both health and religious considerations—along with socially constructed tracking practices. It also highlighted tensions arising from simultaneously managing religious and health-related tracking needs, as well as using multiple tracking tools at once. Drawing on these findings, I offer perspectives on designing for long-term tracking needs, integrating Islamic values and concepts, and providing educational support (Chapter 4).

In the third and final empirical study, I employed Asynchronous Remote Communities (ARC), an emerging design research method in HCI. For 10 weeks, participants completed weekly activities—including scenarios, surveys, design tasks, reflection prompts, and draw-

ing exercises—to explore how they learn about menarche and integrate menstruation into their daily experiences. The findings revealed that mothers and other female figures often use storytelling to prepare young Muslim girls for menarche, providing foundational knowledge that these girls then refine and expand as they grow older. Despite these supportive practices, there remains significant potential for technological innovation to provide holistic care for menstruating Muslims. Through this study, participants envisioned ways technology could better address their needs. Based on these insights, I offer recommendations to fostering and supporting menarche education and suggest strategies for improving religious information ecosystems (Chapter 5)

Table 1.1: Dissertation Summary and Contributions

Chapter	**Study Name**	**Motivation**	**Methods**	**Findings**	**Status**	**Contribution Type**
Ch.3	Menstrual Tracking Study	Exploring the dynamics between religious practices and menstrual tracking among practicing Muslim women	Surveys (Pre- & Post-) Semi-Structured Interviews	1. Menstrual tracking to adhere to Religious Practices. 2. Tensions between religious values and period tracking applications. 3. Roe v. Wade and implications for menstrual tracking.	Complete Published CHI'2024	Empirical
Ch. 4	Ramadan Study	A deeper understanding into menstrual tracking practices within a situated religious context	Diary Study Onboarding Call Semi-Structured Interview	1. Religious and health tracking motives during Ramadan 2. Socially crafted religious tracking practices 3. Tensions and challenges around tracking practices in Ramadan	Complete Published CHI'2024	Empirical & Methodological
Ch. 5	ARC Study	Reflective experiences on menarche experiences and co-designing to support menstruation for Muslim women	Asynchronous Remote Communities with 15 Activities (e.g., Design Prompts, Advice Columnist) Circle Diagram, Usability Testing, Scenarios	1. Role of female figures and using storytelling in preparing for menarche. 2. Experiences of navigating religious menstrual education through curation, self-learning, and refinement of previously learned knowledge. 3. Participants generated design concepts and ideas for supporting menstruation	Submitted to ACM Health Special Issue	Empirical
3–5	Dissertation	Combining Ch. 3–5	Qualitative research methods	An empirical exploration of Muslim menstruators' experiences, tracking practices, and efforts to balance religious and health needs in menstrual management. An ecological model of Muslim menstruators	–	Theoretical Opinion

1.3 Dissertation Contribution

My dissertation research explores menstruation among practicing Muslim women in the United States and highlights their experiences with menstrual tracking, education, and learning from both health and religious perspectives. By unpacking the motives, needs, and challenges these women face in their lived experiences, I aim to provide empirical insights for researchers and designers. Ultimately, my goal is to inform the development and design of digital health technologies that respect deeply embedded values, ensuring they promote rather than undermine the beliefs and practices of the communities they serve. To exemplify my contributions, I draw upon Wobbrock et al.'s [1] framework for HCI contributions, which encompasses seven categories: A) Empirical, B) Artifact, C) Methodological, D) Theoretical, E) Dataset, F) Survey, and G) Opinion. The contributions of my dissertation are as follows: **Empirical Contributions**– the three (3) studies in my dissertation research examine the intersections between menstruation and Muslim women's religious experiences, revealing how these interconnected aspects shape their interactions with technology. The empirical findings provide design implications and recommendations for developing personal health informatics tools tailored to Muslim women's needs, while also informing future research in this area. **Methodological Contribution**– while diary studies are well-established in HCI research, my dissertation makes a novel methodological contribution through its adaptive approach to data collection. I developed a two-tiered diary system consisting of daily reflections, and reflection logs (mid-study and end-of-study) reflection logs. This structure was carefully designed to capture experiences throughout the menstrual cycle while minimizing participant burden. The methodology also introduced an innovative compensation system that empowered participants with flexibility in choosing their preferred form of compensation. Importantly, this system was structured to ensure

that compensation did not become a coercive factor, allowing participants to withdraw from the study at any time without financial pressure to continue. **Theoretical Contributions**– my dissertation introduces the *The Muslim Menstruator Ecological Model*, a theoretical framework derived from the three studies presented in Chapters (3, 4 and 5) The model offers a comprehensive view of the complex social, cultural, religious, and technological ecosystems that shape the lived experiences of Muslim menstruators. It identifies and maps the roles of key stakeholders—such as religious authorities, family members, healthcare providers, and designers—as well as sociocultural and institutional factors that influence menstrual practices and self-tracking behaviors. By foregrounding these multilayered influences, the model provides a foundation for rethinking how menstrual technologies can be designed to better support the needs of Muslim menstruators. It serves not only as an analytical lens but also as a guide for the development of culturally responsive, faith-informed personal informatics tools that align with users' values and contexts. **Opinion Contribution**– collectively, my dissertation research findings present a compelling case for broadening the scope of personal informatics to thoughtfully integrate faith and religious values into the design of personal health technologies. This approach of considering values will help foster more inclusive, tools that resonate with the diverse needs and beliefs of their users. This integration is important as religious beliefs and practices significantly influence how individuals interact with and utilize health technologies, particularly in communities where faith plays a central role in daily life and health management practices.

CHAPTER 2

Background

2.1 Menstruation and HCI

In this section, I present a structured review of relevant literature. First, I outline the established body of work concerning menarche, menstruation, and HCI. Subsequently, I narrow the focus to examine the scholarly discourse surrounding menstruation and religion, highlighting the existing research gaps that my work aims to address. Finally, I culminate in a targeted review of literature pertaining specifically to menstruation within the context of Islamic religious practices, providing a foundation for the empirical investigations presented in this dissertation

2.1.1 Menarche, Menstruation, and HCI

Menarche is a pivotal time of transition in the lives of menstruating individuals. Menarche is the first occurrence of menstruation. It is recognized as a milestone of puberty and indicates the onset of reproductive capability. It typically occurs between the ages of nine (9) and fifteen (15) [2, 3]. At puberty, individuals undergo bodily changes such as breast/chest development, pubic hair growth, widening hips, etc [4]. To culminate these physical bodily changes from puberty is menarche, the first menstruation. Menarche is a bodily-rooted and socially-experienced life transition, that can affect how individuals perceive themselves or engage in social activities, such as participation in sporting activities [5, 6]. In some cases, menarche may be seen as a disruptive event and can lead to the destabilization of an individual's established sense of normalcy [7], as a result, this experience not only impacts an indi-

vidual's immediate response to the sight of blood from their first menstruation but could also have a long-lasting impact on their perception of menstruation and overall self-esteem [6, 7]. Menarche experiences have not been well-researched in HCI. The few research works that explore menarche have mostly explored the potential of educational tools to support menarche experience [8, 9, 10, 11]. An example of studies exploring education support for menarche is seen in *menarche bit*- a prototyping kit for young adolescents to create body-worn technologies that support their experiences of menarche [6], and *Menstrupedia*- a digital platform for menstrual health education designed for the Indian community [8]. In addition to fostering menarche education, another body of literature has explored how inadequate health education can lead to a negative perception of menstruation [12]. In their research exploring how parents support children for menarche and the use of technology for this support, Rai et al [7] mention how mothers particularly play an influential role in providing initial menstrual guidance, and that the accuracy of information is often dependent on the parental level of education [7]. Rai et. al [7] further identify key values such as an appreciation of a holistic approach to menstrual education that parents prioritize when sharing information with their children at the onset of menarche. However, they also recognize the necessity for further investigation into how differences in parents' needs and preferences—shaped by gender and cultural background—might influence a holistic approach to menstrual education and communication effectiveness during this critical period [7]. Technology has the potential to support holistic menstrual health education while addressing gaps in parental knowledge about menstruation and helping individuals be better prepared for both menarche and menstruation. Against this backdrop, there is still a need for a more thorough investigation of menarche education within different contexts, such as parents who value religious teaching and upbringing in their children. My research seeks to expand the understanding of preparation for menarche and holistic menstrual health within the HCI

field, particularly when religious beliefs and values play a significant role in approaches to the upbringing of children and everyday life.

While menarche remains a relatively underexplored topic in HCI, menstruation research has been well-documented within the field of HCI. HCI researchers have explored a wide range of aspects related to menstruation, reflecting the multifaceted nature of this experience in individuals' lives. Key areas of focus have included information-seeking behaviors and educational interventions, highlighting how people gather and utilize information about menstrual health [9, 13, 8]. Additionally, there has been significant attention given to tracking practices, where studies have explored how individuals monitor and manage their menstrual cycles using various tools and technologies [14, 15, 16, 17, 18, 19, 20, 21]. Another noteworthy dimension of this research is menstrual data exploration, which involves analyzing the data collected through tracking practices to gain insights into patterns and health implications [22, 23]. The privacy practices associated with menstrual apps have also been scrutinized, emphasizing the importance of protecting sensitive personal data in the digital age [17]. Moreover, the development of technologies specifically designed for the menstruating body has been a growing area of interest, focusing on innovations that address individuals' unique needs and challenges during menstruation [24, 25].

One particularly insightful study by Lin et al. [18] examined menstrual experiences, tracking, and data-sharing practices among individuals with minimal menstrual education. This research highlighted the role that cultural foundations play in shaping how people engage with menstrual health. Factors such as cultural backgrounds, access to menstrual health education and care, menstrual stigma in both school and home environments, income, and education levels all contribute to how individuals approach menstrual tracking and management. Lin et al. [18] emphasize that these cultural perspectives can profoundly impact the mechanisms and technologies participants use for tracking their menstrual cy-

cles, thereby stressing the need to consider and integrate cultural and religious values in the menstruation experience to foster a more holistic health experience. To better design technology that would support menstrual health within a religious context, my current research further explores the intersection of menstruation, experiences of menarche and menstruation, and the identity of being a practicing muslim. My work contributes to the growing body of knowledge on menstruation, offering insights into how religious beliefs intersect with personal health management. In the subsequent section, I will explore the complex relationship between menstruation and religion.

2.2 Menstruation and Religion

Many religions around the world, including Islam, Judaism, Christianity, Buddhism, and Hinduism, impose specific restrictions, exemptions, or guidelines on menstruating individuals, with Sikhism being a notable exception [26, 27]. These religious practices often reflect firmly established cultural beliefs and vary widely across traditions. In particular, Islam and Judaism have well-defined rituals that menstruating individuals must observe [26]. For instance, both religions require a purification process, such as a ritual bath (*Ghusl* in Islam and *Mikveh in Judaism*), to be performed upon completion of menstrual bleeding. This ritual purification is essential before the individual can resume participation in religious activities, such as prayer, fasting, or entering places of worship [14]. These practices illustrate how religious values impact everyday behavior. Understanding these religious practices is essential for appreciating how menstruation is integrated into the broader fabric of religious life and how these practices influence the lived experiences of individuals within these religious communities.

Several HCI scholars have explored the intersection of religion and technology design,

highlighting the importance of incorporating religious considerations into HCI practices [14, 28, 29, 30, 31, 32]. Within this broader discourse, some researchers have particularly emphasized the need to integrate religious needs and values into health-related HCI design [15, 28, 29, 33, 34, 35]. These scholars argue that by understanding and embedding religious beliefs and practices into health technologies, these tools can become more relevant and effective for diverse user groups. For example, Al-Naimi [28] advocate for leveraging Islamic concepts into the design of technologies that support women's health, thereby promoting religious wellness and overall well-being. However, much of the existing literature on health technologies for women's intimate health overlooks the design for early menstruation (menarche) and how religious values are cultivated in young girls' preparation for this key milestone in their transition to womanhood. My existing work contributes to this unfilled gap and expands upon designing for women.

Religious upbringing, religious laws, and values can influence how individuals navigate the menstrual experience, how education around menstruation is sought, and how support structures are built to navigate the menstrual experience. Building on this body of work, my research further explores how muslim women navigate menarche education and self-learn to accommodate menstruation as part of daily life. This population represents a minority group that, while often overlooked, is highly diverse, encompassing a wide range of ethnic, national, and educational backgrounds. By examining this specific group, I aim to uncover the nuanced ways in which religious, and social contexts influence education before menarche, menstruation experiences, and support systems. My research seeks to contribute to a more inclusive understanding of menstruation within HCI, recognizing the importance of this intersectionality in shaping health behaviors and experiences.

2.2.1 Menstruation and Islam

Researchers have called for the inclusion of faith, religion, spiritual practices, and values in the design of technology and HCI discourse, arguing that the lack of inclusion of these values has resulted in the secularized nature of HCI [36]. In her work with people facing critical life illnesses, Estelle et al. [37] argue that for a genuinely human-centered approach, we, as researchers must account for the spiritual values and that an individual's spiritual values form a core part of their human identity [37]. Furthermore, studies by Oguamanam et al. [38] highlight that participants in their research resorted to religious and spiritual-based strategies–*"activities such as seeking assistance from a higher power, praying, or attending church"*–for coping with stressors in their pregnancy journey. By recognizing the impact of human values on identity, behavior, and health, HCI researchers have the unique opportunity to truly address the most profound challenges and serve the needs and values of users [37]. Some examples of research that offer the inclusion of faith and religious importance in HCI include– the study of the intersection of Islamic values and sustainable living, which could help inform the design of sustainability practices [39], religion and intimate health [33], multidimensional approach to wellbeing in faith communities [40], and the study of online worship workshops to help inform the design of technology-mediated religious experiences [41]. Given my research, I discuss menstruation and Islam to explain the relevance of considering the impact of Islamic values on menstrual health. The Islamic faith is guided by a set of beliefs and ritual practices or obligations, e.g., five daily prayers (*'Salat'*) and fasting (*'Sawm'*). While these ritual practices are core aspects of Islam and of being a Muslim, there are times when specific individuals are exempted from adhering to these obligations. Menstruating women are not permitted to observe obligatory fasting during the lunar month of Ramadan. This exemption also extends to voluntary fasting, ob-

serving the daily prayers, and participating in aspects of religious pilgrimage. Menstruating women are also required to abstain from sex during their periods. While the obligatory fasting days that were missed due to menstruation have to be made up later, the days of prayers missed do not have to be made up. Simultaneously, the Islamic faith exhibits diverse implementations and practices across various regions worldwide; nevertheless, the fundamental principles that most Muslims uphold remain unchanged [33]. Research on religion and intimacy in three Muslim-majority countries by Mustafa et al. also highlights a central value regarding how Muslims consider their body as an *Amaanah* (an entrusted loan) that demands to be taken care off [33]. These values and beliefs–the essence of being a Muslim woman and the core value of modesty and ensuring trust–are central to Muslim women's identities and how they interact with their health and wellness [33].

A significant component of being able to engage in prayers is purification or cleanliness, which is an integral value of Islam. Ablution (*'Wudhu'*) (pronounced woo-doo) is a ritual washing or purification process to ensure cleanliness before prayer or touching the holy book [42]. It involves washing body parts - the face, hands, mouth, and feet. A fuller version of this purification process that involves washing the entire body is called *'Ghusl'*. *'Ghusl'* (pronounced gu-sul), which loosely translates into "Ritual bath" or "Major ablution" [43] and is a form of Islamic purification that takes place under certain conditions - after sexual intercourse or discharge of semen, after menstruation, or after post-natal bleeding [43]. For practicing Muslims, Ghusl is required before recommencing praying, fasting, or pilgrimage upon completing the menstrual cycle. Therefore, it is essential to know when a period phase is considered complete to perform the ritual act of Ghusl. Each of these purification processes (Wudhu and Ghusl) uses water to cleanse specific parts of the body (Wudhu) or the entire body (Ghusl).

Moreover, religious law *'Fiqh'*(pronounced fee-k) guides menstruation in Islam. The

Fiqh of menstruation defines the duration of the menstrual phase. Different Muslim schools of thought (similar to varying sects of Christianity) adhere to different Fiqh. In the largest sect of Islam, there are four schools of thought. For example, for people who adhere to the *'Shafi'i'* interpretation [44], the Fiqh states that menstruation does not exceed 15 days. Suppose a woman menstruates for more than 15 days. In that case, the legal ruling is that the menstruation days exceeding the 15^{th} day are regarded as non-menstrual vaginal bleeding [45]. Once a woman is considered to no longer be menstruating according to her religious legal jurisprudence, she is no longer exempted from the obligations of praying and fasting and can resume her daily rituals. These laws, principles, and guidelines influence Muslim women's behavior regarding menstrual, intimate health, and religious participation. It is, therefore, essential to consider religious identity as a Muslim when designing menstrual health technologies.

2.3 Religion, Technology, and HCI

In this section, I first explore research on various religious traditions and HCI, followed by a focused subsection on Islam-specific HCI research.

2.3.1 Other Religions and HCI

Recent statistics have shown that approximately 85% of individuals globally adhere to organized religions. Religious rituals directly influence individuals' religious needs, goals, values, lifestyle, norms, and aspirations [46]. 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 [47]. Bell et.al [48]and Muller et.al [49] have theorized that there may be underlying tensions between religion and technology [48, 49]. 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 [48]. Bell further speculates that religious systems and values impact how technologies are created, consumed, and possibly rejected. For instance, research [50] explored ways technology may support or collide with the Christian priority of cultivating human relationships. Claisse et al. [31] studied supportive digital technologies for the community practice of Buddhism and provided recommendations for designing a meaningful spiritual experience. Hammer [51] 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 Jewish way of life. Emerging research has also begun to explore the intersection of religion and gaming [52, 53, 54, 55].

Bjørn et al. [56] emphasize that, given the widespread use of technology, it is crucial for researchers and designers to 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 the integration of a digital compass into smartphones, now a standard feature in most phones, was inspired by muslim prayer practices (p. 89) [56]. Today, instances exist where technology mediates and facilitates religious practices and rituals [48]. 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) [48], religious use of technology by American Christian Ministers [57], a prayer companion for cloistered nuns [58], BibleCell, a tool that supports personalized reading plans, scripture reading, and social sharing [59]. Other studies have highlighted the use of technology in Buddism [60, 61], the intersection of race, religion, and community in exploring how technology can promote well-being in churches with historically Black memberships [62, 40]. Kaziunas et al [29] 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 [63]. Ahmad et al. [64] speculated that older adults become more spiritual as they age; therefore, there is a need to study user experiences from the point of spirituality.This exhaustive list of research efforts indicates the increasing demand and focus on studies exploring the intersection of religion, technology, and HCI.

Thus far, HCI Researchers [33, 37, 39, 40, 50, 57, 65] 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 [36, 37, 39, 66] and that we, as HCI researchers, have fallen short of the goal of achieving "truly human-centered design" [37]. Estelle [37] argues that for a *"truly human-centered approach, we must account for the spiritual values that form a core part of the human identity"* [37]. With this objective in mind, researchers have initiated speculation and proposed emerging design principles [67] specifically tailored for religious and spiritual contexts. Undoubtedly, the intersection of religion and HCI will continue to grow. In the next section, I focus on ongoing efforts and initiatives at the intersection of Islam and HCI.

2.3.2 Islam and HCI

The scope of Islam and HCI is relatively nascent resulting in a limited amount of research literature available. The existing research supports that the practices of the muslim population are heavily influenced by Islamic teachings and beliefs [68, 69, 70, 71, 72]. Relevant examples of existing research with and for the muslim population that centers their faith include: the perception of privacy in the use of technology [73], incorporating faith in substance abuse recovery [74], creating a mobile app with Islamic prayer-text on pregnancy for muslim women [75], designing to support US-based muslim women who experienced domestic violence [76, 77], expanding privacy principles to take into account privacy of muslim women [78], designing to support muslim women's spiritual coping as they experience miscarriage and loss [79]. Furthermore, researchers have studied using technology for faith-based purposes- including using TikTok to provide Islamic religious learnings [80, 81], selfie-taking practices during the muslim pilgrimage of Hajj as a means of expressing religious identities [82]. This highlights the limited but ongoing research at the intersection of Islam, HCI, and technology, which I aim to contribute to through my research work. Beyond the HCI literature, it is evident that various technologies, particularly mobile technologies, are designed with a focus on serving the muslim community. Instances of this include the creation of an application aimed at educating Muslims about the fundamental principles of inheritance laws and the equitable distribution of wealth [83], as well as a mobile app designed to offer information catering to the needs of muslim travelers [84]. Fewkes [85] examined the intersection of mobile technology and food practices, investigating the influence of mobile app technologies on the religious practices of American Muslims. These research endeavors demonstrate that research at the intersection of religion, technology, and HCI is an expanding field within the greater HCI research community. Collectively,

I draw upon the existing body of literature and the prior contributions of the researchers I have spotlighted thus far to guide my research and gain valuable insights into how Islamic expectations, values, and norms intersect with technology usage. My current work adds to this body of literature by specifically exploring and trying to understand the personal informatics needs of muslim women in the Western world in the context of Ramadan. Expanding on the existing research, I aimed to investigate the experiences of muslim women during Ramadan and their use of personal informatics tools.

2.4 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 [86, 87] health-focused games [88, 89], online health communities [90], menstrual health tracking [20], physical activity [91, 92, 93], mental wellness [94, 95, 96], and chronic disease management [97, 98, 99]. Considerable research effort has been invested in building models for self-tracking (e.g., the Stage-based model [100] and lived informatics model [101]), understanding self-tracking, and the attributes of self-tracking apps people consider when selecting a tracking tool [102]. However, there is a notable gap in research regarding specific populations. Neiss et al. [103] pointed out that marginalized groups, who are often ethnically diverse, have been largely unexplored when it comes to studies on self-tracking, particularly in the context of fitness. In alignment with this perspective, my work is geared towards amplifying the voices of these understudied populations. Doing so aims to enhance the understanding of the motivations and values driving self-tracking in these communities. Ultimately, my research contributes to the design and development of culturally and faith-inclusive tracking tools and experiences.

Self-tracking involves *"practices in which people knowingly and purposively collect information about themselves, which they then review and consider applying in their lives"* [104]. Rooksby et al. [105] observed that self-tracking practices are intricately enmeshed into the fabric of 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. [106, 107] coined the concept of 'self-tracking cultures', urging the broadening of personal informatics research to encompass social, cultural, and political aspects and emphasizing the importance of recognizing social inequalities within the realm of self-tracking. As self-tracking becomes more prevalent, it is relevant to examine this practice's social, cultural, and political implications. This growing trend of "quantifying oneself" [104] through self-tracking, in pursuit of "self-knowledge through numbers," raises concerns about the potential for further marginalization and socioeconomic disadvantage of groups that have not been adequately studied. Lupton [108] emphasizes that a significant portion 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.

My research aims to provide an understanding of self-tracking practices within a religious context (Ramadan). Specifically, I am interested in exploring religious tracking among individuals who actively track aspects of their health, such as menstruation. Research on self-tracking for women's health encompasses menstrual tracking [18, 20, 21], fertility tracking [109, 110, 111, 112], pregnancy [75, 113, 114, 115, 116] and menopause [117, 118]. In some communities, especially faith-based communities, menstruation tracking is relevant for planning for the "break" (or exemption) in performing religious rituals [33],

Terminology	Meaning
Alhamdullilah	Praises to God
Eid	Islamic Festival/Holiday
Ghusul or *Ghusl*	Purification done after Menstruation
Imam	A religious leader, typically one who leads prayers at a mosque
Hadith	The collective body of traditions relating to Prophet Muhammad and his companions.
Halaqa	A religious gathering for studying religious text e.g., Quran
Isnad	Credible Chain of Knowledge Transfer
Khutbah	Sermons–These are typically done before Friday congregational prayers
Masjid	Mosque
Muslimahs	A term describing a group of muslim women
Seerah	Historical biographies (typically of the Prophet) but sometimes of significant people in Islamic history
(SW) or Sallallahu Alaihi Wasallam	Peace be Upon Him– Salutations typically said whenever Prophet Muhammed is mentioned
Ustadha	A title for a female graduate from a higher Islamic institute of learning

Table 2.1: A summary of various religious terminology along with their meanings

highlighting the need to plan for these breaks. Prior research [33, 119] has uncovered the connection between religion and health. However, the intersection of personal informatics for health and religion is relatively underexplored. Through my research, I sought to address this gap by contributing to the empirical understanding of menstruating Muslims tracking practices and behaviors, particularly during Ramadan.

2.5 Terminologies and Their Meanings

For terminologies and their meanings, see Table 2.1.

2.6 Research Team and Positionality

My dissertation comprises three collaborative studies, each conducted with researchers from diverse cultural, religious, and gender backgrounds. The collective identities and lived experiences of the research team involved in each of the three studies, shaped the way we approached data collection, analysis, and interpretation, ultimately enriching the nuanced interpretations, inclusivity and depth of our findings. In **Study 1** (Chapter 3), the research team comprises of four U.S based scholars with diverse cultural, religious, and gender identities. Three members identify as female and one as male. The team includes individuals who identify as African Muslim, Hindu and Asian American, Muslim from a Southeast Asian developing country, and a non-practicing Protestant white American. Members have varied experiences of being born and raised outside the U.S., with differing lengths of residency in the country. All researchers conduct HCI work with vulnerable populations—three focus on women's health, while one specializes in aging and older adults. The diversity of our faiths, genders, and cultural experiences enabled us to critically engage with the data and contribute inclusive perspectives throughout our analysis. In **Study 2** (Chapter 4), the research team consists of three HCI researchers committed to co-designing inclusive technologies for marginalized communities. Two of the authors identify as female and practicing Muslims, while one is a non-Muslim male. Two authors were born and raised outside the U.S., although one of them has lived in the U.S. for the majority of her adult life. In **Study 3** (Chapter 5), the research team includes mostly cisgender women from diverse religious and cultural backgrounds, including Islam and Hinduism, alongside one cisgender white male. Team members bring experiences from both developing and developed regions, and their durations of residency in the U.S. vary. This diversity fostered a critical, multifaceted analysis of the data. During the development of activity

prompts and throughout data analysis, the cisgender women researchers openly discussed their menarche experiences. These formative moments were not seen as distant memories but as significant personal events that informed the empathetic and culturally sensitive lens applied throughout the study.

CHAPTER 3

Menstrual Tracking in Muslim Women in the US

3.1 Motivation

Approximately 50 million individuals worldwide use mobile applications to track their monthly menstrual cycle [120]. Menstrual tracking affords individuals the ability to plan and prepare for their upcoming cycles, enables individuals to map their contraception and fertility, provides insight into mood management, helps individuals better understand their bodies, and can be used as a learning resource for sexual health and wellness [21]. Menstruating individuals use several methods to track their periods, such as mobile apps, calendars, birth control pills, etc. [20]. Many popular menstrual tracking apps are available on the Apple AppStore and Google Play Store, including Period Tracker, Flo, Clue, Eve, etc. [21, 121]. These apps include symptom logging, period logging, notes, reminders about periods, pattern visualizations, community forums, health-related articles, and contact with health experts [21]. While applications and technologies for tracking the menstrual cycle continue to increase, they are not without their challenges. Some of these challenges include prediction accuracy, allowing sensitive data to be sold or leaked [122], relying on non-validated approaches to tracking menstrual pain (or Dysmenorrhea) over established pain management [123] and under-serving new menstruators [122, 123]. Existing menstrual apps have been shown to embed certain assumptions based on societal norms, thus presenting users with an idealized normativity of the reproductive body (gendered and heterosexual contexts) [124, 125]. One such assumption is categorizing an average menstrual cycle length of 28 days [20, 124, 126], eliminating those with irregular periods. While

many research studies explore the challenges of existing menstrual tracking technologies and menstrual tracking practices of women in the global south, situated within particular cultural contexts [8, 13, 21, 33, 127], our work focuses on exploring the perception of menstrual tracking technologies (particularly apps) within a population whose 'faith' centers as a core value and whose engagement in faith practices are entangled with their menstrual cycle. I build on the work of prior research [18, 20, 125, 128] exposing the unintended inequities brought about by menstrual tracking technologies and suggesting solutions for charting the way forward. To our knowledge, HCI research on menstruation in the Muslim population has almost exclusively focused on the global south and on the cultural stigma associated with menstruation. Considering the in-depth menstruation work done in HCI, we decided to engage with Feminist HCI's quality of advocacy to study a population that has been long overlooked (i.e., Muslim Women) within the literature of HCI and CSCW research, especially in the Western world.

I set out to explore the following two research questions.

- **Research Question 1:** How do Muslim women track and manage their menstrual cycles, particularly in relation to their religious practices?
- **Research Question 2:** What are Muslim women's perceptions, needs, and challenges when using existing menstrual tracking applications, and how do these applications align with their religious and cultural requirements?
- **Research Question 3:** How has the overturning of Roe v. Wade influenced Muslim women's trust, privacy concerns, and overall engagement with menstrual tracking applications?

This research was conducted collaboratively with Pallavi Panchpor, Dr. Novia Nurain, and Dr. James Clawson. The use of "we" in this chapter refers to me and these researchers.

Figure 3.1: Study Design and Timeline

3.2 Methods

Our methodology had three phases: a preliminary survey (total N=164, sampled dataset N=133), semi-structured interviews (total N=22, sampled dataset N=20), and a post-Roe v. Wade survey (total N=121, sampled dataset=77). All parts of this study were approved by the Institutional Review Board (IRB). The preliminary survey was launched in March 2022, with interviews conducted from March 2022 to early June 2022, and the post-Roe v. Wade survey was launched in May 2023 (see Figure 3.1 for our study design).

3.2.1 Phase I: Preliminary Survey

The preliminary survey (Phase I) allowed the research team to collect demographic information from a broad sample of Muslim women living in the U.S. It was used as a recruitment instrument for the interview portion of the study. Participants were recruited through multiple channels. The first author e-mailed Muslim student organizations in the U.S., contacted Muslim influencers on Instagram, and reached out to Muslim women Slack communities to share our recruitment flyers. As a result, recruitment flyers were posted on Instagram stories, Facebook groups, mailing lists, and Slack channels. Summary of preliminary survey respondents is presented in Table 3.1. Participants who completed the preliminary survey and provided contact information were contacted and invited to participate in semi-structured interviews (Phase II). The survey contained open-ended questions asking about

respondents' tracking motives, practices, and tools. In addition, we asked about their menstruation cycles and irregularities. Twenty-six participants stated they were willing to be contacted for follow-up interviews and provided their contact information. We reached out to all 26 individuals, however only 22 responded to our e-mail.

3.2.2 Phase II: Semi-Structured Interviews

We interviewed a total of 22 participants, two of whom (P6 and P9) were interviewed to pilot our interview protocol (their data were not included in our findings). Interview participant demographics (N=20) are summarized in Table 3.2. Given, the sensitive nature of the subject under investigation, we ensured that two of the female authors of this paper conducted the interviews to facilitate participant engagement throughout the study. The interviews allowed us to gain deeper insights into the experiences of Muslim women in America who use menstrual tracking apps. During the interview, we started with a brief introduction to the study and then asked questions about the participants' period-tracking habits, their experiences with period-tracking applications, their attitudes toward their periods, and their feelings about period-tracking. We also asked them to describe if/how their religious practices were impacted by their periods and reflect on how menstruation and religion impacted their daily lives. The semi-structured interviews lasted between 20 and 40 minutes (mean=27.2 minutes, standard deviation= 9.2) and were conducted and recorded using Zoom to minimize participants' costs (e.g., travel costs) During Phase II of our study, the US Supreme Court overturned the constitutional right to abortion access. This development sparked widespread discussions about the potential implications for menstrual tracking apps and surveillance [129, 130, 131, 132] and a broader conversation on faith and abortion [133]. Consequently, our research team sought to investigate how this decision might impact our study population, particularly in light of the possibility that abortions

may still be permissible under certain religious laws. As such, we launched Phase III (the post-Roe V. Wade survey).

3.2.3 Phase III: Post-Roe V. Wade Survey

We launched Phase III of our study in March 2023 (nine months after the Supreme Court's decision) to investigate the potential impact of this decision on participants' menstrual tracking behaviors and opinions. At the time of the Roe v. Wade overturn, there were widespread concerns about the privacy of menstrual tracking apps [134]. Therefore, it was important to explore how this decision affected our Muslim participants' use—or discontinued use—of such applications. We contacted previous participants who had provided e-mail address information in Phase I. To reach out to new participants, we again shared our recruitment materials with Muslim Facebook groups, Muslim women's Slack channel, and the first author's WhatsApp contacts and groups. The survey asked the following questions: *"Has your decision to use technologies to track your menstrual cycle changed post-Roe v. Wade?"*, *"Please explain your response to the previous question (Has your decision to use a period tracking app changed post-Roe v. Wade?)?"* and *"What are your concerns post-Roe v. Wade?"*. We report 77 responses to this survey.

3.2.4 Data Analysis

Phase I: Preliminary Survey Data

We received 164 survey responses, with a 98.5% completion rate. We discarded incomplete surveys, from participants in countries outside the U.S., had no location data specified, had no age specified, and were from individuals younger than 18 years old. We removed 31 responses, leaving 133 survey responses in our dataset (see Table 3.1). Survey participants'

(N=133) average age is 29.1 years; the minimum age is 18 years, the maximum is 49 years, and the standard deviation is 8.5 years. To ease the reporting of our findings, we assigned the Phase I survey participants labels S1 through S133.

Phase II: Semi-Structured Menstrual Interview

From the twenty participants, we collected 544 minutes of audio-recorded interviews. All interviews were transcribed using otter.ai, an online text transcription tool. The first and second authors coded twenty interviews using Braun and Clarke's thematic analysis methodology [135]. We began by familiarizing ourselves with the full scope of the data and generated an initial set of codes. When we reached alignment in our coding, we independently coded the complete set of interviews. The authors met frequently to discuss the codes and resolve conflicting codes we had in our analysis. After generating codes, the research team reviewed them and utilized affinity diagramming [136] to categorize the codes into themes. We discovered themes such as *"Tracking Methods"*, *"Motivations For Period Tracking in Muslim Women"*, which support the findings of other menstruation work in non-Muslim individuals. We also find unique themes on *"the relationship between Menstrual Tracking and religious practices"*, and *"Implications for Designing for Muslim Menstrual Tracking"*. These later two themes are the core findings of our work and contribute to expanding the existing research on menstruation. We discuss the full scope of these themes in our findings section. The mean age of our Phase II semi-structured Interview is 29.4 years; the minimum age is 21 years, the maximum age is 49 years, and the standard deviation is 8.6 years. See Table 3.2 for interview participant demographics.

Phases III: Post-Roe V. Wade Survey Data

We treated phase III survey data (total N=121, sampled dataset=77) as completely distinct from survey respondents in Phase I. We discarded 44 incomplete responses, including participants who neither reported their age nor their location. We assigned each respondent in Phase III identifiers labeled R1 through R77. The mean age of our Phase III survey participants is 28.4 years; the minimum age is 18 years, the maximum age is 45 years, and the standard deviation is 6.2 years.

3.3 Results

In this section, we report the findings from Phase I (N=133) preliminary survey data (S1, S2, S3...), Phase II (N=20) interview data (P1, P2, P3....), and Phase III (N=77) post-Roe v. Wade survey (R1, R2, R3...R77). Tables 3.1 and 3.3 represent summary data from our preliminary and post-Roe v. Wade surveys. Our Phase I survey and Phase II interviews uncovered several reasons Muslim women in the United States are motivated to track their menstrual cycles. Our participants track their monthly menstrual cycles to increase their understanding of how their periods affect their mood, fertility, and menstrual health. They track for the practical purposes of improving their communication with healthcare providers and ensuring they are prepared with sanitary products for their period. For the most part, and unsurprisingly, our findings on tracking motivations and methods align with previous work investigating menstrual tracking in western populations [20], indicative of the commonalities in tracking methods and motivations that transcend cultural or faith beliefs. However, a unique finding from our participants that differentiates them from findings from previous studies is the intimate link between menstrual tracking and adhering to religious practices (sections 3.3.1). We present the challenges in tracking with apps (sections 3.3.2). In our

findings, we draw from Luptons' work to highlight connections to previous literature on technology and the body [104, 108, 137].

3.3.1 Relationship Between Menstrual Tracking and Adhering to Religious Practices and Guidelines

For participants, an added motivation for menstrual tracking is to help support their adherence to religious practices and guidelines that exempt them from adhering to certain religious rituals, e.g., fasting and prayer (subsection 3.3.1), consider implications for times when the duration of the period is unusually long (subsection 3.3.1) and plan social activities that do not clash with timings for religious rituals (subsection 3.3.1). Our finding highlights a central discourse in Lupton's self-tracking cultures [137], where she highlights that *'self-tracking has no meaning in itself, but is endowed with meaning by the wider discourses on technology, selfhood, the body and social relations that circulate within the cultural context in which the practice is carried out'*.

Adherence to Islamic Guidelines or Practices Our participants mentioned that one motivation for tracking is to help prepare for adhering to the religious guidelines of times when they would be unable to participate in certain forms of religious worship–prayers and fasting–and knowing when they would need to perform the purification process or ghusl. In addition, in Islam, engaging in sexual intercourse during one's period is prohibited, and Muslim women and their partners strive to adhere to plan on adhering to this prohibition.

Observation of Fasting and Prayers. Participants talked about having a close link between period tracking and religious observance. For instance, S23 mentioned while experiencing menstruation she followed guidelines that involved abstaining from specific religious practices, such as the mandatory five daily prayers, voluntary prayers, and any obligatory

or optional religious fasting. Once her menstruation period concludes, S23 performs the cleansing ritual (ghusl), after which she can resume these religious practices:

> *"I track for religious reasons, to know when to fast and pray and to know when to take the ritual bath to purify myself after my period." -S23*

The statement from our survey participant above illustrates the close link between period tracking and religious observance for most Muslim individuals who menstruate. While experiencing menstruation, S23, along with other Muslim menstruating individuals, follows guidelines that involve abstaining from specific religious practices, such as the mandatory five daily prayers, voluntary prayers, and any obligatory or optional religious fasting. Once her menstruation period concludes, S23 performs the cleansing ritual (ghusl), after which she can resume these religious practices. Interview participant P18 expressed she mentally prepares for exemptions from praying and fasting, explicitly highlighting the prayers on celebratory religious holidays or *Eids*. P18 reveals that even during the celebratory religious holidays, menstruating individuals are still not allowed to participate in the special congregation prayers on that day, based on the assertion that the conditions for participation in these special prayers are the same as those for regular daily prayers. Therefore, menstrual tracking and predictions help her mentally prepare for the feelings of exclusion that may occur from their exemption from participating in these prayers.

> *"...Our period is significant because we can't pray, we can't fast... especially during Ramadan; in the month of fasting, it was essential for me to know when I would get my period and if I would get it, say, twice during Ramadan, like at the beginning or the end. So it was just essential for planning. Also, when we have the Eid prayer at the end of Ramadan, it was helpful to know if I could pray or if I wouldn't so that I could mentally prepare myself so I wouldn't be*

upset. Spoiler: I was upset. But, it's beneficial to know when I should expect not to be able to pray" -P18.

Other participants track their periods to know how many days of fasting they need to make up for due to missing the obligatory fast in the holy month of fasting (*Ramadan*). Unlike the obligatory five daily prayers, missed days of fasting due to periods would need to be made up outside of Ramadan. Therefore, these individuals need to track the number of days of fasting that they missed while menstruating. We present an instance of this from P15, quoted below:

".. it's just good to know when Ramadan is coming and you're going to fast, which days of the month, you're going to be missing..." -P15

Therefore, from these quotes, we see that the motivation for tracking is to help prepare for adhering to Islamic guidelines and exemptions on prayers and fasting.

Prohibition of Sexual Intercourse. Participants also reported tracking to prepare for prohibition from sexual intercourse during menstruation. We present an example in the quote below by P8, a married woman who monitors her menstrual cycle and communicates this information to her husband to ensure their compliance with religious restrictions on sexual intercourse. She conveyed her thoughts as follows:

"... you know, abstaining from sexual intercourse during my period is based on religion, although it's not something I didn't think I would want to do, it just seems messy..." -P8.

Exemptions From Religious Pilgrimage. Participants also reported tracking to help plan for certain religious rites such as Islamic Pilgrimages(*Hajj* and *Umrah*). As with the five

daily prayers, menstruating individuals are exempted from performing certain rites if they find themselves menstruating during the pilgrimage. This provides extra motivation for the tracking period to help plan pilgrimage travels and activities. This is illustrated in the quote by P15 below. P15 emphasizes that, because of these exemptions, organizing her pilgrimage plan is of utmost importance, and she even contemplates using medications to halt her menstrual cycle to ensure she does not menstruate during the pilgrimage

> *"It just helps to know when it is coming...When you go on the pilgrimage, you cannot participate if you are menstruating. So I wanted to make sure that if I was going and we were planning that I would know whether I needed to take any medication to stop my cycle.." -P15*

Implications For Periods Longer Than "Normal" Duration From our participants, we teased another intimate connection between tracking one's period and religious practices, which is the implication for what is considered to be the "normal" length of period. The implication is that participants whose period exceeds the "normal" length must perform ghusl and recommence their forms of worship even if she is still bleeding. The guidelines for menstruation duration and how bleeding is defined vary based on Fiqh interpretations (mentioned in Section 2.2.1). In these instances, the Fiqh of menstruation–the interpretations and diversity in implementing and practicing Islamic beliefs– becomes more apparent. We present two examples from the survey response, S66, and the interview response, P10. S66, quoted below, highlights that the Fiqh she adheres to does not consider any period longer than ten days a "normal period." Therefore, she recommences the obligations of prayer and fasting even if her period extends beyond ten days.

> *"I follow the Fiqh opinion that the minimum duration for a period is three days and its maximum duration 10, as well as that there must be at least 15 days of*

purity between the end of one menstrual cycle and the start of the next. I keep track for the sake of maintaining ritual purity." -S66.

P10 mentions further this implication for longer than average period length in the quote below:

"...I follow the belief/opinion that your period can only last ten days. And if it lasts longer, it's irregular, not defined as a period longer than ten days. Second, one needs 14 full days of purity or non-bleeding between two periods. And anything outside these defined time slots is not considered a period...For Muslim women, this is relevant because when you're on your period, you can't engage in certain aspects of worship, such as praying and fasting...for example, if during the month of Ramadan, I have a period where I'm physically bleeding for 11 days, I would still fast the final, the 11th day, because Islamically I'm no longer on my period. I try to make sure that I can worship or engage in these acts when I can. And because I have very long periods, that was my reason for starting to track." -P10

These quotes describe participants' attempts to balance menstruation's medical and religious aspects, especially when menstruating days are longer. While we didn't specifically ask participants with irregular periods about the complexity that comes with determining what is or is not "normal," this finding reveals that menstruating individuals with longer than "normal" periods have increased challenges when balancing their adherence to religious guidelines within a complex and emotionally fraught condition.

Planning Social Activities In our study, participants illustrate that exemptions from mandatory prayers create chances to organize social activities that would otherwise clash with the

prescribed schedules of the five daily prayers. Consequently, these participants take advantage of their menstrual days, and thus the days of exemption, to engage in pursuits that may disrupt prayer timing or affect the acceptability of their prayers. P18, a 21-year-old college student who tracks her period using the Flo app, prioritizes her daily prayer schedule and finds that sometimes social activities with her friends, especially her non-Muslim friends, conflict with the stipulated times of one or more of the five daily prayers. Therefore, she plans social activities with her friends around her period since she does not have to worry about prayer times clashing with her social activities. In her case, period days are opportunities to engage in activities with her non-Muslim friends.

> *"...Many of my friends will complain about when they're on their period, especially non-Muslim friends. But I see it sometimes as an opportunity if somebody wants to go out to do something. I say, 'Okay, perfect. Let's go out. I'm on my period. So I don't need to worry about prayer.'... that's one of the reasons why I want to know when my period was coming, just because sometimes people wanted to plan things or there were assignments we had to do where we'd have to go out. So, I would prefer to do those on my periods. I don't need to worry about praying in a public place that is not as accessible..." -P18.*

Similarly, P15 utilizes the exclusions from religious activities as a time to plan other social activities that they would not otherwise be able to participate in. According to P15, quoted below, wearing nail polish invalidates the ablution, a purification process required before prayer. Therefore, during her period days, she can freely apply nail polish without concern for its impact on her prayers.

> *"... It's good to know... if you want to plan like a pedicure and a manicure, because, as a Muslim, I have chosen, or you know, to my understanding is that*

I cannot pray when I have nail polish on, so I try to plan accordingly" -P15

3.3.2 Tensions Around Religious Values & Period Tracking Applications

Self-tracking technologies face limitations acknowledging the influence of various aspects of individuals' lives, such as their belonging to minority ethnic groups and religious communities [104]. Research remains scarce on how different subgroups engage with these technologies [93]. Here, we detail the religion-related challenges our participants faced using period-tracking apps for menstrual cycle tracking.

Community Forums Clash With Value for Modesty.

Several period tracking applications have community boards or educational interface elements that allow users to discuss and learn more about topics relating to their sexual and reproductive health. While this is a relevant feature on a period tracking app, it sometimes clashes with the Islamic values for modesty (or 'Haya'), which frowns upon open conversations about sex, sexual partners, dating, or intimacy, even more so with strangers. These values became apparent in how our participants engaged in period conversations within virtual settings, such as community features within menstrual tracking apps or social media groups. The initial enthusiasm for the forums waned amongst participants due to their unmoderated nature and unfiltered content, ultimately causing them to lose interest and stop engaging.The tensions between wanting to seek knowledge but through the lens of Islamic guidelines becomes a significant challenge, resulting in non-engagement with these features on menstrual tracking applications. P8 emphasized how she received a negative comment on her discussions within a Facebook group that encouraged engaging in sex during one's period. As a result, she finds it uncomfortable to engage in community conversations on social media or within the community portions of tracking apps.

"[...] I try to filter anything that I say, do, or think...through the lens of Is-

lam—so I participate in community conversations where there's a variety of religions or beliefs. It sometimes becomes weird [...] On Facebook, there was a post about having sex during your period. And I said, 'Well, that's something we don't believe in doing.' And the comments I got were: 'Oh, that's outdated,' 'You can't prove that that's harmful,' and blah, blah. And even though I went, I found studies online that demonstrated that it is harmful to women. Others debated it; some debates are just not worth it. So I stay away" –P8.

P8 here highlights the importance of filtering the information received in menstrual communities/groups on Facebook through the Islamic lens, as religious values are deeply tied into the lived experience of menstruation and sexual, intimate health. However, these filters are currently non-existent in menstrual tracking technology and, therefore, not aligned with the faith-based lives and values for modesty in Muslim women. P11, a 25-year-old Asian practicing Muslim woman in America, uses the Flo app for tracking. She finds that the community aspect of the app is both Western and not geared toward her, given her cultural background and religious beliefs. As a result, she does not consider the community a safe space to learn and discuss her menstrual health.

"I feel like the community chat or the community aspect is not geared toward me... We (referring to Muslim women)*don't take part in the Western dating aspect as a Muslim woman. And most of, a lot of the questions are kind of about their intimate partners. And if someone sexually active describes their problems, I think those are some things that I don't find very geared toward me. And a lot of people ask questions about that. I mean, at least from my app, I could see that. So... I'm not active at all in the community aspect. As a single woman who is not sexually active, there are not a lot of safe places in the Flo*

app...” –P11.

Similarly, P7, who also uses Flo for tracking her periods, considered that the conversations within the community section of the app felt very open and almost like a violation of the faith-based value of modesty and, to a larger extent, a violation of privacy. It is essential to highlight that while the participant is not opposed to discussing these topics, she felt it would be more important to discuss them within guidelines.

> *“Okay, well, I used to go the questions part of the app. And some of the questions and concerns are very provocative. It’s, of course, not for Muslim women... And some things that the ladies discussed, I wouldn’t feel that they’re appropriate to be discussed on such a platform. Of course, for the modesty that we have as Muslim women. But for them, it’s normal. So sometimes, answers [to questions] would be very open, which I wouldn’t say I like because it feels like it is a violation of privacy. I don’t believe that whatever they’re discussing is sealed by the developers of this app, and I feel like everything is out in the open. So this is one of the things that I don’t like...the discussions on the app.” -P7.*

P5, a user of the Flo app who sometimes takes a peek at the community center within the app, talks about how she feels that the app doesn’t represent her identity. To her, representation is significant, and she finds these to be lacking within the community features of the menstrual tracking app. She expressed:

> *”...Something that jumps out at me is that in the community engagement center. And I’ve noticed that there are a lot of Barbaras and Karens and not many Hibah...But it doesn’t seem like this is an app for Muslim women. I would feel*

differently and more supported if I felt like this is an app for Muslim women... It's still women; women still go through similar issues. you don't have to be Muslim to experience a specific kind of issue. But seeing that kind of representation (Muslims) makes you feel comfortable. And it makes me feel more open to opening up about certain things...Sometimes I find myself not saying what I want actually to say, or over-explaining certain things" -P5.

The Multiple Calendar Challenge

Participants in our work with two calendar systems: the Islamic Hijri calendar (based on the lunar system) and the Gregorian calendar. The former is used primarily for identifying religiously significant days and months, e.g., celebratory holidays, fasting, and pilgrimage months. P18 utilizes an analog tracking system to track her period during Ramadan. While P18 has tried using period-tracking apps, she was not satisfied with the experience because they couldn't accommodate her specific religious needs. Many practicing Muslim women share similar challenges, as current apps fall short of meeting their specific needs. She particularly stressed the importance of a feature that notifies her of the precise start and end times of her period. This is crucial because if her period begins before sunset during fasting, she must compensate for the entire day's fast. Conversely, if her period ends by mid-day, she cannot continue fasting for that day and must make up for it later. These considerations are highly relevant to the daily lives of Muslim women, necessitating seamless integration of dates, durations, and calendars in tracking apps.

"[...] for instance, during Ramadan, we need to keep track of the days we can't fast because we can't pray or fast when we're on our periods. So I have a dry-erase board where I write the dates I couldn't fast and then track them that way... I had my period for five days [...] from this day to this day, and I'll have

to make those up." - P18

On the other hand, P4 uses a period tracking app to track her periods and Muslim Pro[1] – a fasting tracker application based on the lunar calendar to track missed fasting days resulting from menstruation – to ensure that she correctly takes note of the number of days of fast that she had missed. Then, she matches these dates with her Gregorian calendar as well.

"[...] I also use the Muslim Pro app which it says: 'Did you fast today?' So I track it like that. Just so I make sure, I have the number of days correct." -P4

Survey respondent, S79 chooses to swap between the Hijr and Gregorian calendars to keep track of the days of fasting that she has missed.

"..It helps me track the days to pay back my fasts or make the nearest prayer before I get my period...I write it on the calendar or sometimes swap between the Hijri and Gregorian calendar to try to make a guess" -S79.

These experiences of working with both calendars can be burdensome tasks to keep track of amidst other life responsibilities.

Gaps in Knowledge and Guidance for Navigating Menstruation

Participants in our study highlight the knowledge gap in trying to balance connections to their faith during menstruation. Mainly the participants were concerned that they needed more Islamic knowledge in navigating the disconnect that comes from the inability to engage in some forms of worship while on their period. We present an instance in the quote below. P3, a 21-year-old, emphasized that period conversations are still taboo within her Muslim community and are frequently not talked about. As a young woman, she finds that

[1] https://www.muslimpro.com/

some areas of her knowledge are still missing– for example, what should she do with the ”time off” from prayers? How should she know when and how to purify herself or perform a ghusl? These conversations would be helpful to features within community groups/online forums embedded in tracking apps; there are gaps in education around faith and periods for individuals who identify as Muslim women.

> *“..When we do have our period, we can’t pray. And it’s just a week of ’what do I do with my time?’[...] And then, like, when? Do you do Ghusl or purify your body?”–P3*

To recap, within this section, we have outlined the difficulties associated with religious values and menstrual tracking practices. These challenges encompass issues related to discussions within community forums, the management of multiple calendar systems for period tracking, and gaps in education concerning menstruation in Islam.

3.3.3 Roe v. Wade and Implications For Menstrual Tracking Technology

Of the 77 responses we received 87% (N=67) of the survey respondents said they track their menstrual cycle. Of those who currently track their menstrual cycle, 81% (N=54) reported that their decision to use technologies to track their menstrual cycle had not changed post-Roe v. Wade (see Table 3.3). Though the majority of the participants, their tracking behaviors had not changed, many participants shared that the Court’s ruling did not affect them due to their commitment to the religious value of sexual abstinence before marriage. Additionally, participants shared a variety of concerns that surfaced in light of the court ruling, such as disclosing marital status, data privacy, bodily autonomy, and surveillance, that may impact their perceptions of the ruling. For instance, R8 expressed concern that the overturn was unjust to women’s reproductive health:

"I feel terrible that a decision that should be in the hands of women and women alone is in the hands of government officials. Unfair doesn't feel like a heavy enough word. Roe v. Wade being overturned is an injustice." –R8

Another participant R59, a 39-year-old mother with a daughter, expressed concerns, mostly looking into the future. She mentioned that she continues using a period tracker but worries that women's rights are being removed.

"That women won't have the right to make their own decisions over their bodies. I have a daughter now, and even though I'm done having children, I worry about her and the following generations. I used a period app tracker before Roe v. Wade and will continue to do so "- R59

Survey participants also mentioned the tensions between abortion permissibility within the confines of the faith versus a complete abortion ban. For instance, R48 expresses a viewpoint that supports the concept of "pro-choice," which entails allowing the pregnant individual to decide on abortion while adhering to Islamic principles. They do so while adhering to Islamic principles that permit the choice of abortion under certain circumstances. Their quotes are provided below:

"Everyone should be able to decide what they do to their bodies. Islam has guidelines and even allows it (abortion) in certain circumstances. So I am pro-choice." –R48

"[I'm worried about what happens] if I have a life-threatening pregnancy that my religion allows me to end but the state will not" –R56

Participants who avoided menstrual tracking applications were concerned about privacy and surveillance. These concerns resonated with the broader discourse on "dataveillance,"

[104] in which digital data is collected and often utilized by third parties without sufficient user transparency. Notably, developers frequently fail to adequately inform users about how their data may be collected, shared, and used, further exacerbating privacy anxieties [138]. It's crucial to emphasize that when it comes to personal choices like adopting an app, our participants expressed worries about their data privacy, bodily autonomy, potential infringement on reproductive rights, and concerns that such decisions might intersect with religious rights, particularly regarding the permissibility of abortion under specific circumstances. For instance, R18 described her concerns around reproductive rights and potential data breach: We present example quotes from survey responses of participants who avoided using menstrual tracking apps following the Roe V. Wade overturn below.

> *"I'm very much concerned about Post-Roe v. Wade because it has resulted in the loss of reproductive rights. I feel I'm not safe"* – R41
>
> *"I am concerned about reproductive issues. I know that medications are frequently outlawed for people because they might cause miscarriage without regard to the patient's health, concerns, or needs. I feel bodily autonomy is significant [...] I am a bit scared to use apps now because companies can track and sell your data."* – R18.
>
> *"Restricted bodily autonomy and access to safe abortions for me and fellow women...Paper [tracking] is just better—less concern of surveillance and data breaches"*–R71

In summary, while most of our participants continue to engage with period tracking technology post-Roe v. Wade, they voiced concerns and tensions regarding the broader implications for women's health and decision-making.

3.4 Discussion

Our research uncovers two key themes: (1) the intertwining of menstruation and the religious practices of Muslim women, and (2) the obstacles faced by menstruating Muslim women when utilizing current period-tracking technologies. We discuss considerations of religious identity in HCI studies on menstrual tracking, advocate for intersectionality in HCI research to foster inclusivity of individuals' values in the design of technologies, especially those values rooted in religion and faith, and we amplify the voices of underexplored populations. Additionally, we offer recommendations for designing inclusive menstrual tracking technologies.

3.4.1 Considering Religious Identity in The Design of Personal Health Tracking Technologies

Researchers [139] have emphasized the pivotal role that individuals' identity, including factors like age, gender, ethnicity, and religion, has in shaping their worldview [140, 141, 142, 143]. While previous HCI studies have explored ways in which various aspects of identity impact users' experience and the design of technologies [142, 144], religion remains relatively unexplored or "othered", particularly in contexts where religious practices intersect with health. In the context of self-tracking, Lupton, argues that identity is important to consider when conducting critical sociocultural analysis of different perspectives in self-monitoring. Lupton [104] advocates that designers and researchers should "situate design within social and political contexts" as a means of challenging social inequalities, fostering critical reflection and creating design interventions that are different those offered by the existing dominant representation. Importantly, re-imagining self-tracking beyond self-improvement presents us with the opportunity to critique and reshape dominant narra-

tives of selfhood and embodiment, thus enabling the emergence of new possibilities [104]. We endorse this call to action in rethinking our designs beyond dominant representations, by encouraging the community to consider the religious aspects of individual's lives and explore how adherents of faith practices interact with technology for health.

Feminist HCI and Value Sensitive Design (VSD) offer a nuanced approach to addressing challenges. Feminist HCI emphasizes pluralism over universalism in design, advocating for artifacts that embrace diverse perspectives [145]. In the context of menstrual tracking apps, a pluralist approach could facilitate customized community features for women with similar values, fostering shared learning without compromising privacy. VSD encourages consideration of designs constrained by existing technology [146, 147, 148, 149, 150]. Its tripartite methodology prompts researchers to question whose values are prioritized in the design process. Ignoring these questions, particularly in health-related technologies, risks promoting "othering" and straying from equitable research. Our work aligns with the voices of researchers [151, 152], advocating for diversity in HCI studies. A content analysis by Himmelbach et al. [151] highlighted the underrepresentation of religion in HCI work. Essential to promoting justice and inclusivity is intersectional work [151, 152, 153, 154, 155, 156] that considers marginal identities and addresses the dimensions of identity and health.

To et al. [157] proposes expanding HCI design beyond problem-solving to "designing for flourishing" - amplifying goals and identities through creative collaboration. Designing for advancing empowers understudied groups to express their needs and ensure designs reflect their unique identities. We suggest applying this approach to religious identity, creating opportunities for Muslim women and other faith groups to share their stories, highlighting the values that they hold important for us as researchers to design solutions that align with their values. As researchers, it is crucial to design solutions that align with these

values to prevent "othering". For instance, the Jewish faith values modesty and utilizes the Hebrew calendar and the Hindu faith uses the lunar calendar to keep track of festivities, such as the Karva Chauth. To achieve inclusivity, researchers must identify common values within different faith groups (i.e., modesty, alternative calendar systems use, etc.) and navigate potential clashes. Design solutions need to incorporate these commonalities across different faith groups, and when values clash, multiple design options may be considered to cater to diverse user groups. Participatory design, involving collaboration with Muslim women and faith-based groups, ensures that design approaches are inclusive and aligned with their needs. Designing with the goal of "advancing" contributes to a better balance between health and faith practices. As researchers, we must consider how to utilize methods (e.g., participatory and co-design approaches) that include the experiences of under-studied groups. We may need to produce a set of design objects (similar to Period Packets [128] or Curious Cycles [158]) that invite Muslim women to explore ways in which technology could better support their menstrual health while upholding their preference for religious and faith values. A good example of inclusive design incorporating faith values into technology for women's health is the application Baby+ [34] created for pregnant women in Pakistan. Baby+ app [34] was designed to include prayers and verses from the Quran for a healthy pregnancy. Several participants in that study expressed that the prayers feature was their favorite part of the experience, indicating the relevance of inclusively designing technologies that consider people's values. That paper is one of the few works we have found that has successfully contributed to the intersection of faith and personal health informatics. We hope our work can serve as a call to action for HCI researchers to collaborate on investigating, supporting, and designing for under-served religious and faith-based communities to improve health and wellness while respecting these communities' priorities, norms, and values. To this end, in the subsequent subsection, we present design recommendations that

could advance the unique goals and values of muslim women.

3.4.2 Implications For Design

Our research reveals a desire among participants for religious accommodations within general-purpose apps, necessitating customizations in existing menstrual tracking tools. While this approach offers the potential to support women of faith, it raises concerns about potentially alienating non-Muslim users who might disapprove of the changes. In designing new menstrual trackers or modifying existing technologies, we recommend the following design considerations. Our recommendations extend to other faiths, especially in areas with shared values like modesty and privacy. We encourage designers to engage in collaborative design practices with individuals from diverse faiths. Taking a collaborative approach enables designers to uncover subtle conflicts in values and work towards developing inclusive solutions.

Designing For The Faith-Inspired Value of Modesty.

First, our research indicates that modesty is a key motivator for behavior in practicing Muslim women. To cater to these values, menstrual tracking apps should offer options for users to opt out of features conflicting with their beliefs. Allowing users to choose participation in community features and resources empowers them. Apps could include content filters based on user preferences, enabling individuals to avoid objectionable material while engaging in comfortable conversations. Designers might explore the creation of user-monitored communities within the app, fostering relationships among like-minded individuals who share similar values. This approach aligns with users' modesty values, potentially enhancing engagement and promoting discussions on health and well-being within a secure, faith-aligned environment. This design recommendation will support other faith groups and empower individuals with the opportunity to create their own faith-centered communities. This area

holds exciting opportunities for future HCI research, utilizing participatory and user-centric design [159, 160, 161] principles to investigate how design decisions in menstrual tracking technologies can resonate with the value of modesty. The emphasis would be on creating designs tailored for the Muslim population and other religious groups with similar modesty-aligned values. Future research work could explore how values from different faiths inform design choices.

Educational Resources Geared toward Muslim Women.

Designers could integrate Muslim-specific educational materials into future period tracking technologies. Addressing knowledge gaps at the intersection of faith and menstruation, these resources can offer guidance on managing the spiritual disconnect Muslim women often feel during their periods, along with articles from faith experts versed in menstrual cycles and reproductive health. Providing information on Islamic laws related to menstruation, purification rituals, and maintaining spiritual connection during menstruation can be challenging but valuable. For individuals with extended menstrual duration, navigating religious practices and guidelines that define menstruation differently than medical terms can be challenging (mentioned in Section 3.3.1). For example, many individuals need help identifying when to determine the end of a menstrual cycle based on patterns of bleeding and performing the ritual bath process. Educational resources provide crucial support in this context, helping them determine when they can resume participation in their faith practices and ultimately reducing the potential for stigma. To accomplish this task requires designers to design within the patriarchy [162]. To adopt this orientation, researchers need to collaborate with religious figures to create educational content for Muslim women [33]. In addition to modifying existing technologies to support menstruating muslim individuals, the critical and speculative design enables designers to imagine alternative futures of

self-tracking technologies that foster inclusivity and destigmatization, aligning with calls to accommodate all menstruators [163]. In the US context, where abortion laws impact everyone, irrespective of religious beliefs, there's an opportunity to develop educational resources addressing the religious considerations surrounding the permissibility of abortion.

Designing for Multiple Calendars.

Coordinating multiple calendars for period tracking proved error-prone and frustrating in our study. Menstrual tracking apps can address this by integrating various calendars to capture cycle details. Our findings suggest an opportunity to design apps supporting Muslim women in tracking both menstrual and faith-related aspects efficiently. For instance, enabling tracking of religious obligations like fasting alongside menstrual information is crucial. Designers could incorporate features allowing users to log missed fasting days due to menstruation. Adopting multiple calendar features, similar to those available for iPhone users with lunar and Gregorian options, can broaden app accessibility not just for individuals practicing Islam, but also for those of various faiths and cultures who rely on alternative calendar systems. Beyond mobile apps, designers should explore alternative methods for period tracking, such as the Islamic Geometry-Based Moon-Period Calendar [164], a physical artifact offering a non-app-based approach.

Designing For Privacy.

Despite the post-Roe v. Wade decision retention of menstrual tracking applications by many participants, there's a notable surge in concerns regarding data privacy, bodily autonomy, and surveillance. Redesigning menstrual tracking technologies to address these concerns is both a challenge and an opportunity. Researchers advise transparency in data-sharing practices, emphasizing user awareness of collected data and its usage [130, 165]. They

also propose regular privacy check-ups for better user understanding of data sharing, security, and privacy policies in period tracking apps [165]. To promote bodily autonomy in menstrual tracking, Tuli et al.'s [21] concept of "designing for self" is recommended, urging a shift away from smartphones and empowering users to shape and personalize their relationship with menstrual trackers [21]. Dong et al [166] suggest a method to protect users' privacy by allowing app access without logging in or sharing health data, enabling users to keep their period data local and confidential. Design researchers could explore opportunities beyond mobile apps for designing various menstrual tracking artifacts.

3.5 Limitations

We also contacted Muslim women's slack channels, WhatsApp groups, and word-of-mouth to distribute our post-Roe v. Wade survey. We attempted to reach a diverse group of Muslim women; however, we acknowledge that our recruitment methodology may have been biased toward practicing Muslim women, particularly those from the Muslim Student Organization bodies. Our recruitment flyers did not specify whether we wanted Muslims actively practicing their faith. However, the preliminary survey (Phase I) asked participants to self-identify their religion and to select whether they considered themselves practicing or not practicing. 96% of our preliminary survey participants self-identified as practicing Muslims. Our participants were US-based; therefore, careful consideration must be taken in applying our findings to Muslim women from other backgrounds, especially those who live in non-western environments (e.g., Muslim women in the Arab world or the Middle East). One limitation of our work is that our recruitment led to an overwhelmingly large proportion of practicing Muslim women. Therefore, our findings may not apply to individuals who identify as Muslim but do not actively practice their faith. Our preliminary survey did

not provide the option to self-identify race/ethnicity. In all phases of the study, we did not ask participants to identify their religious sect within Islam. Also, while there are different ways in which faith practices in Islam are observed in different regions and cultures of the world, the underlying principles and guidelines are the same. Another limitation is that we did not specifically research our participants' perceptions of privacy in the menstrual apps, though we are interested in pursuing this investigation in future studies.

3.6 Conclusions

Menstrual tracking applications are widely used today and offer users the opportunity to track their periods, understand their bodies, engage with other women on topics relating to health and well-being, and learn about their overall health and wellness. However, for Muslim women, menstruation is also tied to their spiritual practices, offering an added layer of motivation for tracking that extends beyond health. To investigate how Muslim women in the United States track their periods and understand the impact that menstruation has on their religious practices, we deployed a preliminary survey (N=133), conducted semi-structured interviews (N=20) and a post-Roe v. Wade survey (N=77). We briefly touched on the similarities of Muslim menstruators with other menstruators, supporting the findings from prior research. Then, we detail the intimate link between menstrual tracking with apps and upholding religious practices. We present recommendations for designing a faith-inclusive period-tracking app for Muslim women. We highlight the need to support their faith-inspired values, design for complex calendaring and long-term tracking of religious obligations, and provide educational resources to increase understanding of how menstrual health relates to their faith. We discuss how we, as researchers, can engage with religion and spirituality in our designs by adopting a pluriversal design framework and advocate

for moving past ”othering” religious identity into a more inclusive research design. Ultimately, our research highlights a need to design health technologies that are responsive to religious beliefs and values. We also encourage designers to extend personal health tracking technologies to address specific challenges and needs of women of faith.

3.7 Summary of Contributions

The research work presented in this chapter contributes to HCI and CSCW Literature in three ways:

- We expand on previous menstrual tracking work to include the *experiences* of Muslim women and explore how they engage with menstrual tracking applications, exposing the intimate link between menstruation and religious practices. We uncover *challenges and shortcomings* that arise as Muslim women engage with period tracking apps and identify gaps between the design of existing tracking apps and the tracking needs of faith-based Muslim women.
- We present *design implications* and provide recommendations to inform the design of future period tracking applications that are inclusive of the needs and values of Muslim women.
- We advocate for a *call to action*, that eliminates ”othering” (e.g., religion) and embraces an alternative design approach that centers the religious identity in designing intimate technologies to promote equity for Muslim women and improve menstrual health.

Table 3.1: Summary of Phase I Preliminary Survey (N=133)

	Did not Disclose (N=1)	Non-practicing Muslim (N=4)	Practicing Muslim (N=128)	Total (N=133)
Observe Fast				
Yes	1 (0.8%)	2 (1.6%)	124 (97.6%)	127 (100.0%)
No		1 (50.0%)	1 (50.0%)	2 (100.0%)
Sometimes		1 (25.0%)	3 (75.0%)	4 (100.0%)
Race				
Asian		2 (3.0%)	64 (97.0%)	66 (100.0%)
Black or African American	1 (2.95%)	1 (2.95%)	32 (94.1%)	34 (100.0%)
Multi-racial		1 (3.1%)	31 (96.9%)	32 (100.0%)
Did not disclose			1 (100.0%)	1 (100.0%)
Length of Cycle				
24 days		1 (4.8%)	20 (95.2%)	21 (100.0%)
38 days			7 (100.0%)	7 (100.0%)
24–38 days	1 (1.0%)	3 (3.0%)	95 (96.0%)	99 (100.0%)
Did not respond			6 (100.0%)	6 (100.0%)
Period Length				
less than 4.5 days		1 (8.3%)	11 (91.7%)	12 (100.0%)
4.5–8 days	1 (0.9%)	3 (2.8%)	104 (96.3%)	108 (100.0%)
8–15 days			9 (100.0%)	9 (100.0%)
greater than 15 days			3 (100.0%)	3 (100.0%)
Did not disclose			1 (100.0%)	1 (100.0%)
Using Birth Control				
No	1 (0.8%)	2 (1.7%)	118 (97.5%)	121 (100.0%)
Yes		2 (16.7%)	10 (83.3%)	12 (100.0%)
How They Track Period				
App	1 (1.2%)	3 (3.6%)	80 (95.2%)	84 (100.0%)
Calendar			10 (100.0%)	10 (100.0%)
Memory/"I simply remember"		1 (5.3%)	18 (94.7%)	19 (100.0%)
Paper system			7 (100.0%)	7 (100.0%)
Multiple methods			13 (100.0%)	13 (100.0%)
Did not disclose			2 (100.0%)	2 (100.0%)
Devices Personally Owned				
Smartphone	1 (0.8%)	4 (3.0%)	128 (96.2%)	133 (100.0%)

Table 3.2: Phase II: Interview Participant (N=20) Demographics & Tracking Methods

Interview ID[a]	**Age**	**Profession**	**Ethnicity**	**Tracking Method**	**Apps Used**
P1	29	Insurance Adjuster	Black/A.A	App	P-Tracker, Flo
P2	21	Student	Asian	App	Clue
P3	21	Student	Asian	App	Apple Health
P4	25	Student	Black/A.A	App	Flo
P5	26	Therapist	Asian	App	Flo
P7	31	Teacher	Other	App	Flo
P8	37	Family Business	Black/A.A	App	Ovia
P10	24	Student	Two+ Races	App	Flo
P11	25	Student	Asian	App & Journal	Flo
P12	22	Student	Black/A.A	App	Flo
P13	35	Homemaker	Asian	Journal & App	Apple Health
P14	22	Student	Black/A.A	Calendar	N/A
P15	49	Childhood Educator	Asian	App	Fitbit,Apple Health
P16	26	PhD Student	Asian	App	Flo
P17	44	Student	Asian	Calendar	Flo
P18	21	Student	Asian	App	Flo
P19	22	Student	Asian	Calendar	N/A
P20	39	Doctor	Asian	App	Period Tracker
P21	28	Pharmacy Manager	Asian	App	Flo
P22	42	Global Logistics Manager	Asian	App	Fitbit

Note: P6 and P9 are omitted as they were pilot participants in the study.
A.A = African American.

Table 3.3: Summary of Phase III Post-Roe v. Wade Survey (N=77)

	Survey Respondents (N=77)	
	No.	**%**
Do you track your menstrual cycle?		
No	10	13.0%
Yes	67	87.0%
Frequency of Period Tracking		
Did not disclose	10	13.0%
Always	63	81.8%
Other	4	5.2%
Ethnicity		
Asian or Pacific Islander	21	27.3%
Black or African American	28	36.4%
Prefer not to respond	1	1.3%
Prefer to self-describe	11	14.3%
White	16	20.8%
Changed tracking use post-Roe v. Wade?		
Did not disclose	2	2.6%
No	62	80.5%
Yes	13	16.9%
Educational Background		
Regular high school diploma	3	3.9%
Some college credit (¡1 year)	5	6.5%
1+ years of college, no degree	7	9.1%
Associate's degree	4	5.2%
Bachelor's degree	31	40.3%
Professional degree	4	5.2%
Master's degree	18	23.4%
Doctorate degree	5	6.5%

CHAPTER 4

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

4.1 Motivation

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, encompassing their physical activity, mood, location, (social) media usage, productivity, and finances [167, 168]. 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 [105, 169, 170], the accuracy of tracking tools [171], tracking for varied goals [172, 169], user experience and barriers for tracking [173, 174], and why people abandon their tracking devices [175, 176]. Epstein et al. [168] 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 [168, 177, 178] 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 work that explores the intertwined relationships between religious tracking and health tracking. In my work, I 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 when menstruating [119]. As such, tracking for religious needs becomes inexorably linked with tracking their periods. This underexplored opportunity inspired and motivated my research, which aims to investigate the religious tracking practices of menstruating Muslims in the US. I 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 [78], and muslim women in America comprise the most diverse and heterogeneous population in Islamic history [179]. 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 [179]. Approximately, 65% US Muslims who were born outside the United States come from at least 68 different nations (35% are born in the US) [180]. The affordance of heterogeneity offers several advantages: first, it provides the opportunity to gain insights into various approaches to implementing the underlying beliefs 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. The findings, therefore, reflect various traditions and beliefs within the muslim faith.

The muslim faith is characterized by rituals, beliefs, guidelines, and religious laws, which influence how people see and interact with the world. While the muslim population

accounts for 18–25% of the world population and is estimated to be approximately 1.1–1.5 billion people worldwide [181], there has not been an abundance of technologies designed to support the lived life experience of practicing Muslims - fundamentally, their religious, cultural, or social lives that may need tracking support [95]. To this end, my research contributes to expanding understanding of how the use of personal informatics tools is currently used to support religious and faith-based aspects of people's lives. I 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?

My work situates itself at the intersection of personal informatics, religion, and women's health within the domain of HCI. This research was conducted in collaboration with Dr. Novia Nurain and Dr. James Clawson. The use of "we" in this chapter refers to myself and these collaborators.

4.2 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 served as 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 upon completion of the semi-structured interview ($20 Amazon e-gift card). We present a visual representation of the study design in Figure 4.1. We split the compensation intending to provide participants the flexibility to withdraw from the study at any point rather than have to wait until its conclusion.

4.2.1 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, whether or not they plan to observe the Ramadan fast, 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 data points. 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) reported that they 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 responses that were fully completed, 7 indicated a preference not to be contacted about the study, 1 reported a non-USA location, 1 did not provide an email address or contact phone number, and 8 reported not currently tracking their menstrual cycle. The remaining 63 participants were contacted through the phone number and/or email 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 of the 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 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 4.1) completing the study in its entirety. One participant withdrew from the study midway, attributing the withdrawal to commitments related to balancing motherhood during Ramadan.

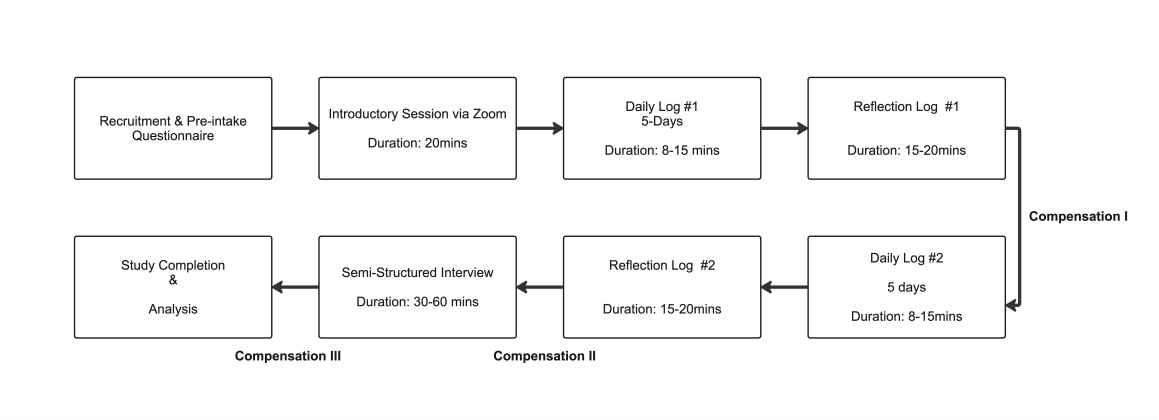

Figure 4.1: Study Design and Compensation

4.2.2 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 gave participants the opportunity to e-mail us consenting to enroll in this study.

4.2.3 Diary study

Diary study has been proven to be a suitable method for capturing religious [81]and spiritual experience, and it has been used to study spiritual user experience in older adults [64].

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 that they try to complete one every 2-3 days. Encouraging participants to space out their ten DLs allowed us to capture experiences over the course of participants' menstrual cycles. We reminded participants via e-mail every 3 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 mid-way through the daily log (i.e., after the completion of the 5th Daily Log) and at the end (after the completion of the 10th Daily Log). Therefore, each participant collected 12 logs (10 DL and 2 RL).

Daily Logs (DL) and Reflection Logs (RL)

The Daily Log (DL) and Reflection Log (RL) entries were comprised of 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 5th DL; the second RL was completed after the 10th 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; tools 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.

4.2.4 Semi-Structured Interview

Before the semi-structured interview, we analyzed each participant's DL and RL (in total, 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, 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 for health and religious goals, and how they could be better supported. Questions tailored to individual participants were prompted by entries in the daily and/or reflection logs. For instance, if a participant mentioned tracking with her child, we incorporated probing questions to gather additional details about that particular experience.

4.2.5 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 [182]. The first and second authors familiarized themselves with the full scope of the data set and jointly coded two

interviews together. After individually coding two interviews, the first two authors met and discussed our codes. Once we obtained consensus on our codes, we created a codebook, which we then used to deductively code the rest of the interviews. 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.

4.3 Results

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.

4.3.1 Tracking Motives During Ramadan

Participants had two prominent motives for tracking during Ramadan, which we broadly categorized into religious and health motives, respectively. 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)

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 as a means of sustaining 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*

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

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 the practice of tracking fasting days, both those completed and those 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. And 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 participant's holy text (or the Quran) using two 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 con-

tributing 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 highlights 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.

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 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 4.2. 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 when your last period was, 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 discusses her commitment to health goals through a combination of tracking methods. She uses a period tracker app to monitor her menstrual cycle and utilizes the notes feature on her iPhone to keep tabs on her water and carbohydrate intake. In the following quote, she elaborates on the health objectives she monitors and explains 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, as well as her menstrual cycle, enables her to calculate the number of fasting days she missed and needs to make up later. She particularly cites that using.

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

I use the period Tracker app because then I know my period days, which are my missed fast. 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 objectives. Specifically, we highlight the underlying reasons driving these motivations, the tools used in tracking, and how tracking practices contribute to realizing these motives.

4.3.2 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.

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 emphasize 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, 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

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 elaborates 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

The Adult Child's Perspective

Conversely, participants provided detailed insights into how their parents supported their religious goals. P1 and P2 receive support from their parents to pursue their religious objectives. P2 additionally emphasizes 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 (charitable donations). 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 4.3.2, we present the socially crafted roles expressed by the participants and describe how they influence their religious practices. We highlight two significant perspectives–maternal and child–elucidating the intricate interplay between social roles and religious practices within family dynamics.

4.3.3 Tensions Around Tracking Practice During Ramadan

The participants experience 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.

Managing Disruptions to Religious Goals

Participants emphasized the emotional struggle of reconciling menstruation with the interruption of their religious obligations during Ramadan. A few 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 offers how she views 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 disruption opens 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 prohibited from practicing their faith, menstruation during Ramadan is perceived as a challenge that can be both hard and isolating.

Managing Conflicting Health and Religious Goals

Especially during Ramadan, participants have voiced their difficulties in managing their health and faith objectives simultaneously. This struggle has 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 describes that observing Ramadan conflicts with her daily exercise goals as she finds 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 regimen for fasting individuals. However, she expressed that there's still a considerable need for more support in this area. P2 prefers to maintain full body covering and added that she preferentially 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 un-

comfortable. 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 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

Maintaining Long Term Religious Goals Post-Ramadan

Many of the participants cited the challenge of sustaining their religious goals post-Ramadan. Participants aimed to sustain these goals consistently throughout the year. However, upon

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

reflection, they acknowledged their challenges in maintaining these goals as the year progressed. P4 described that the goals she sets during Ramadan are habits or behaviors she would like to do all year round but that she struggles 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 plans to extend her goal by adding another religious goal, indicating her continuous effort 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 employs for her religious goals applies to her planning for other aspects of her well-being, including, but not limited to, exercise and nutrition. We see that P6, in thinking about how to build upon her goals, negotiates with questions that help determine when it's a good enough time to add a goal. For example, she questions: *"I've maxed out the gym. What do I do now?"* and then thinks that a way 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

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 describes 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 4.2). She describes 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 daily five 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

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

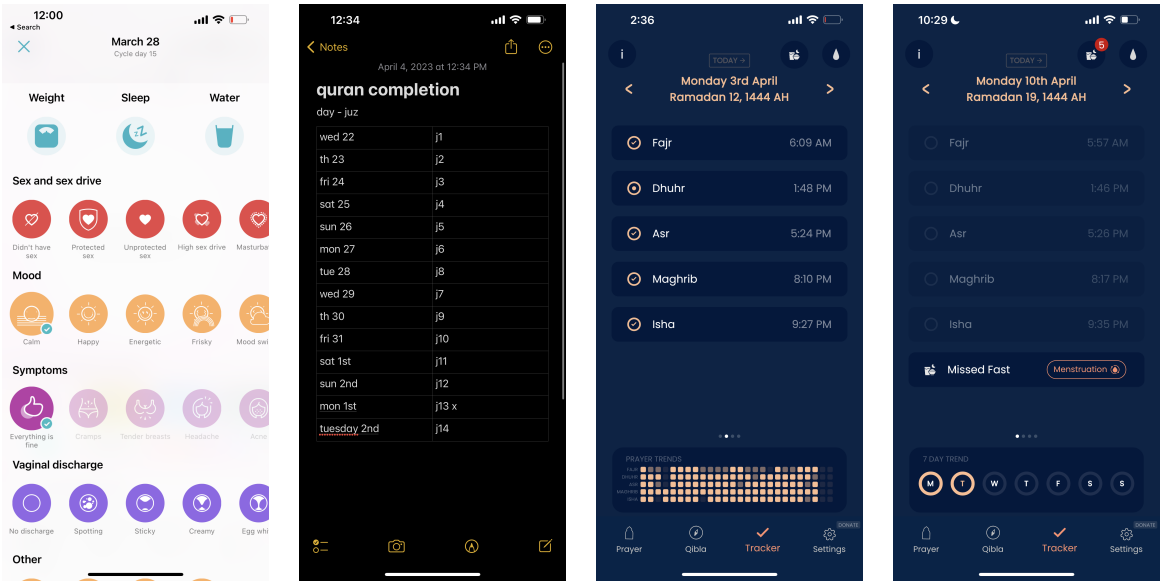

Figure 4.2: Tracking Practice of P3 in Ramadan. L-R: (1) Flo app for tracking her symptoms (2) Apple notes app for tracking chapters of the Quran read daily (3) Pillars app indicating prayer tracking (4) Pillars app indicating missed fasting due to menstruation

apps that track religious goals. Despite these tensions, participants persist in using these applications, primarily driven by convenience and the absence of alternative tools designed to meet their unique requirements. In the quote below, P2 highlights that she uses the Flo app and doesn'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 rationalizes 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 believes 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 describes the tension and trade-offs between data privacy versus convenience of use. In 2020, several published reports (one example is seen here [183]) 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 reli-

gious 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.

4.4 Discussion

Designing for religious well-being 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 well-being and health.

4.4.1 Expanding the Domain of Tracking Technologies

The findings uncovered 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 well-being. 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 [33, 184, 75]. Moreover, researchers [184, 107] have highlighted the significance of including religion in the discourse for designing personal health informatics systems. Based on our research findings, it is evident that menstruating Muslim individuals are already actively pursuing various personal tracking goals to better understand, engage with, and improve their health, physical activity, and religious well-being. 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 encompassing health and religious well-being?".

We propose two approaches for consideration. Firstly, as researchers, we can evaluate existing wellness self-tracking technologies and envision potential redesigns or customizations [92, 185] to align with people's religious beliefs, thus enhancing faith-related support. Illustrative examples could draw upon concepts similar to those found in Omnitrack [186] or KeepTrack [187]. OmniTrack [186] supports flexible self-trackers to construct their tracking tool with customized tracking items to meet their unique needs and preferences. KeepTrack allows users to amalgamate multiple data sources as inputs for visualization to support awareness and self-reflection [187, 186]. 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. The advantage of these customized trackers lies in their adaptability to the diverse stages of individuals' religious well-being, necessitating tools tailored to their specific requirements. Users can define their own religious well-being indicators using these trackers and choose whether 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 both tracking their goals and providing visualizations to support their reflective practices. Secondly, we recommend facilitating conversations and collaborations between researchers and faith-based stakeholders through

participatory design toward designing for supporting faith-related goals and religious well-being. Researchers have begun to explore this research collaboration; 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]. Therefore, we recommend a call to action for collaborative work with religious leaders, community leaders, and experts in health and wellbeing 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 their family members' (e.g., children) religious goals. Researchers [188, 189, 190, 191, 192] have discussed the benefits of considering and designing beyond personal informatics into family-centered health tracking. A comparable strategy could also be applied to promote family informatics within a religious context. The discovery of collaborative religious tracking within family contexts, in our findings, 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 becomes very much personal to the individual (as described by P5 in section 4.3.2). We encourage future research to explore 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 well-being to support physical, social, and mental well-being will help foster more equitable and holistic health. Toward that goal, we discuss design considerations to support individuals' religious tracking practices.

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

4.4.2 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.

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 well-being. For example, Apple Health summarizes daily workouts, exercise minutes, and, more recently (on iOS 17), logging emotional well-being. We envision a similar idea, where individuals could be supported to track and reflect on their religious well-being. 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 their health-related goals and religious aspirations. When contemplating the application of self-tracking 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" concept [193, 194, 195] design philosophy, which promotes the development of interactive technologies tailored to slower, more contemplative practices. Islamic concepts of reflection (Muraqabah) encompasses a

holistic approach, emphasizing spiritual, moral, and intellectual dimensions, often drawing insights from religious texts like the Quran and the Hadith. These reflective practices within Islam primarily revolve around the individual's connection with God. In contrast, reflection in design research 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 [73, 78, 196]. We see these forms of privacy when P2 emphasized her *'individual privacy'* in using the Muslim Pro app and her preference for *'privacy in the home'* the 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 [78, 197]. As an HCI researcher designing for muslim individuals, keeping these forms of privacy values in Islam is crucial.

Designing for Long-Term Tracking

As participants expressed, there exists a need for sustained monitoring that extends beyond the month of Ramadan. Of even greater significance is the observation that participants utilize Ramadan as a foundation 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. [198]. The long-term self-tracking model [199] 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 of these tracking directions to provide better support for muslim individuals. We recommend that this goal-based (purposeful) tracking system allow muslim individuals to set goals and then, based on their overall tracking practices over the years, offer feedback or suggestions on how to achieve their goals or 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 what goals were left behind. This approach enables users, including muslim individuals, to generate their own data and gain insights from visualized trends over time. The latter aspect of visualization can also enhance their reflective practices. As researchers, it is also vital for us 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 [199], 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.

Designing for Educational Support

Participants' experiences point toward the need for educational resources to support them in 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 the 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, offering educational resources on alternative forms of worship to accommodate menstruation-related breaks. Our findings indicate a growing tendency among participants to turn to YouTube and enroll in training programs led by fellow muslim individuals. This trend highlights the desire to connect with individuals with similar life experiences to guide them in pursuing health and religious well-being. We envision a community forum promoting 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.

4.5 Limitations

Using the digital diary method (Qualtrics link) afforded the research team, the opportunity to recruit and enroll participants accross the United States. However, this also means that our participant pool had some participants' familiarity with and access to technology. 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 pose a burden on the researchers, necessitating reminders to each participant and diligent tracking of their involvement. We recommend researchers consider demands from both the participant's and researchers' perspectives when executing studies during Ramadan. We did not specifically inquire about the duration of participants' reli-

gious 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.

4.6 Conclusion

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.

4.7 Summary of Contributions

Our research addresses 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.

Table 4.1: Participants who enrolled (N=10) and completed the diary study (N=9): Demographics and Tracking Methods

ID	Age	Ethnicity	Forms of Worship Tracked	Aspects of Health Tracked
P1	22	Asian/Pacific Islander	Missed fasts	Food, exercise, skin and personal care
P2	22	White	Missed prayers, missed fasts, chapters of the Quran memorized	Same as worship tracked
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/Pacific Islander	Fasts in Ramadan consistently, prayers	Days of exercise, step count, food eaten
P5	45	Asian/Pacific Islander	Number of missed fasts	Food log, water intake, period/ovulation
P6	38	Asian/Pacific Islander	Missed prayers, missed fasts, annual charity/donations	Exercise, step count, food
P7	39	Asian/Pacific Islander	Fasting, nightly prayers in Ramadan	Insulin dosage, mood tracking, weight
P8	38	Self-describe (South Asian)	Number of missed fasts	Step count
P9	29	Black & African American	Chapters of Quran read	Period, exercise
P10	28	Self-describe (Hispanic)	Number of missed fasts	Period, step count, weight gain

Note: All participants tracked their menstrual cycles and observed the fast. P8 dropped out halfway through the diary study.

CHAPTER 5

Unpacking Muslim Women's Menstrual Education and Experiences

5.1 Motivation

For individuals who actively practice a religion, their religion profoundly shapes how they experience and respond to life transitions (e.g. pregnancy [75] or menstruation [33]) and navigate health crises [35, 200, 201]). For billions of religious adherents [202], these religious influences extend beyond personal beliefs, are deeply intertwined with broader health behaviors and practices, and play a pivotal role in shaping communal and public health strategies. Yet, the intersection of religion and health is often overlooked in efforts to address health inequities. Faith-based interventions, in particular, have emerged as essential tools to address health inequities within these communities [40]. For example, in the United States, churches have long served as hubs for community-based health promotion initiatives and interventions [203, 204, 205, 40]. Despite the growing recognition of faith-based interventions in public health, intersections between religious beliefs and intimate health, particularly menstruation, remain under-explored. This oversight is especially pressing in the context of Islam, a religion practiced by 1.7 billion people globally (23% of the global population) [202], where specific religious guidelines around menstruation greatly influence Muslim women's experiences. For example, Muslim women are exempted from praying, fasting, sexual intercourse, and fulfilling religious pilgrimage rites when they are menstruating [14]. While previous research has explored the menstruation experience in Muslim women [14, 15, 28, 33], there is a notable lack of literature exploring how Muslim girls prepare for menarche (the first occurrence of menstruation) and integrate menstruation into

their daily lives within the context of their religious practices. Therefore, in this paper, we aim to deepen the understanding of menstruation in Muslim women by providing empirical insights into Muslim women's reflections on preparing for menarche and religious knowledge acquisition about menstruation. This understanding is critical for developing menstrual technologies tailored to the unique needs of Muslim women.

Some women's health in HCI scholarship have explored and investigated the influences of religion and religious practices on women's experiences of menstruation and sexual health [14, 15, 28, 33]. These investigations address various challenges, such as designing technologies that align with religious, non-secular beliefs and values to enhance intimate health practices among Muslim women [33], self-discovery regarding sex and women's intimate health among Arab women [28], Muslim women's engagement with menstrual tracking applications [14], and personal informatics tools for tracking menstruation while observing a religious fast/Ramadan [15]. Despite the HCI research community beginning to investigate the design and use of technology at the intersection of religion and the menstrual health of Muslim women, there remains a dearth of literature that explores religious information-seeking practices around menstruation to inform technology better design for muslim women's menstruation experiences. In response to this need, our research seeks to understand better the support Muslim women require for religious information seeking related to menarche and menstruation. To achieve this, we investigate muslim women's reflective experiences of menarche and menstruation to understand how they integrate menstruation into their lives. By doing this, we gained insight into how religious information-seeking forms the foundation for understanding the dynamics of menstrual education in muslim women.

Building on this, we investigate how religion influences individuals' menstrual education approaches. Particularly, we investigated Muslim women living in the United States,

a minority population characterized by significant diversity, encompassing various cultural, ethnic, and national backgrounds. Despite this diversity, these women share common religious beliefs, laws, and guidelines concerning menstruation and their lived experiences as practicing women of faith. By studying this population, we gain broad and multifaceted perspectives on their experiences, allowing researchers to observe the diverse interpretations of religious laws without privileging one interpretation over another. We leveraged Macleod et. al's Asynchronous Remote Communities (ARC) [206] method and created a private, closed Facebook group where 14 cisgender Muslim menstruators were invited to participate in a 10-week-long study that involved weekly prompts and design activities to unpack Muslim women's menstrual education and experiences. Our study aimed to answer the following research questions:

- **RQ1:** How did practicing Muslim women approach menarche experience (first experience of menstruation) and incorporate the menstruation experience into their lives?
- **RQ2:** How can technologies be redesigned to better support Muslim women's menstrual experiences from menarche to adulthood?

This research was conducted collaboratively with Dr. Novia Nurain, Sitha Vallabhenani, Priya Jain, and Dr. James Clawson. "We" in this chapter refers to me and these researchers.

5.2 Methods

We employed the Asynchronous Remote Communities (ARC) method [206], to unpack how US Muslim women's menstruation experiences and education have been shaped by religious values, practices, and attitudes. Prior research using the ARC method has established that ARC is an effective way to remotely study the lived experiences and challenges of groups who are marginalized, stigmatized, living with chronic illness, or are hard-to-

reach populations [206, 207, 208, 209]. To conduct our ARC investigation, we utilized Facebook to create a private online community of menstruating Muslim individuals. Creating this group enabled us to have a private online space to connect participants and facilitate group discussions and other activities. The ARC method helped us to overcome barriers to access and recruitment by allowing individuals to participate remotely regardless of location or time zone [206]. Using ARC afforded the research team the ability to interact with participants in a convenient and low-burden manner, allowing the participants time to reflect on prompts posed by the research team. We were able to gather participant perspectives and feedback in a way that suited their convenience, especially as they needed to provide reflective and in-depth responses to various activities. All parts of this study were approved by the Institution Review Boards (IRB) at [redacted institution] on the first day of February 2024. The study was conducted from March through April 2024.

5.2.1 Asynchronous Remote Communities (ARC) Using Facebook

We opted for Facebook for several reasons. First, its ease of use and widespread familiarity among individuals made it a convenient choice. Additionally, it allowed us to engage with a broader range of participants, overcoming geographical limitations, and facilitating asynchronous study activities. However, Facebook has drawbacks and challenges, including privacy concerns and the risk of data breaches. We communicated these challenges to our participants and explained how we addressed them to the best of our ability as researchers. Importantly, we highlighted to participants our lack of control over how Facebook utilizes the data on its platform.

Before the start of the ARC study, we outlined rules for engagement, emphasizing the significance of participants providing thoughtful responses to researcher prompts or each other rather than merely liking a response or commenting with a few words. We com-

menced the ARC study on the first Sunday of March 2024. The ARC study lasted for 10 weeks (including 15 activities) with a 2-week break to accommodate religious obligations and the Islamic holiday of Eid. This break was scheduled as the study coincided with the holy month of Ramadan, during which participants were fasting from dawn to sunset. Each week, we shared Activity A on Sunday and Activity B on Wednesday [1]. Our activities include surveys, scenario-based questions, reflection-based activities, and design activities [2]. Following the posting of each activity, we sent a reminder email approximately 24 hours later, containing unique links to the corresponding Facebook posts referencing the activity. Please see the supplementary materials for full details of each activity's prompt. Participants received $5 compensation for each completed activity. However, given that on week 8, we canceled the second activity to give participants more time to complete Design Activity I, we offered every participant a bonus $5 for the canceled activity (See Table 5.2). With a total of 15 activities, participants had the potential to earn up to $80 ($75 for completing all 15 activities and $5 extra for the canceled activity) for full engagement in the study.

5.2.2 Recruitment and Onboarding

Recruitment of participants took place throughout February 2024. We began the recruitment process by first contacting individuals who had previously participated in our earlier studies. We also recruited through social media through Facebook groups, Slack channels, Instagram stories, word of mouth, WhatsApp groups, and GroupMe groups. Individuals who were interested in joining the study either responded to members of the research team via e-mail or completed the short survey used in the social media call. The survey asked

[1] Except week 8 which only had one (1) activity [6A] and therefore participants had 1 week to complete 6A. On week 10, Activities 8A and 8B were posted together

[2] For detailed descriptions of our study activities, survey instruments, and screenshots of Facebook posts of activities, please refer to the supplementary material

Table 5.1: Participants demographics in the ARC Study. All participants identified as cisgender women.

PID	**Age**	**Ethnicity**	# of Completed Activities (N=15)
P1	25	Black or African American	15 (100%)
P2	37	Asian	3 (20%)
P3	23	Asian	15 (100%)
P4	22	White/Caucasian	13 (86.7%)
P5	29	Asian	11 (73.3%)
P6	39	Asian	11 (73.3%)
P7	28	White/Caucasian	15 (100%)
P8	33	Black or African American	11 (73.3%)
P9	19	Black or African American	14 (93.3%)
P10	20	White/Caucasian, Asian	2 (13.3%)
P11	39	Asian	11 (73.3%)
P12	21	Black or African American	2 (13.3%)
P13	36	Multiracial*	15 (100%)
P14	25	Black or African American	13 (86.7%)

Note: *Multiracial participant identified as American Indian or Alaskan Native and Black or African American.

participants for their names, e-mail addresses, if they already used Facebook, or, if they did not, if they would be willing to create a Facebook profile for the study.

Each participant was then e-mailed the informed consent document and invited for an onboarding Zoom video call where we discussed the study details and answered any questions they had. After the onboarding call, participants were asked to send a signed informed consent form to the research team if they had not already done so. Those who signed the informed consent document before the scheduled onboarding call were also added to the Facebook group during the session. Upon enrolling participants, we began week 1 of the ARC study. By the end of the onboarding period, 18 Participants agreed to enroll in the study. Of the 18 enrolled, 14 of these participants (See Table 5.1) completed the study.

5.2.3 Participants

Participants ranged in age from 19 to 39 years old (Mean age 27.7 years, std dev 7.1 years). All but one participant was born into a Muslim family; one participant converted to Islam later in life. All 14 participants tracked their menstrual cycles. In addition to tracking the menstrual cycle, 35.7% (5 participants) reported that they monitored their fertility, while 28.6% (4 participants) tracked hormonal changes. 50% of participants were born in the U.S., while a smaller percentage (22%) migrated to the U.S. An equal percentage (14%) either have lived in the U.S. for the most part or fall under the "Other" category. The others include an International student studying in the U.S. and individuals born in Canada who have lived in the U.S. for the last 4 years.

5.3 Weekly Activity Prompts

Our study was designed to be 16 activities over 8 weeks, where researchers posted activities at the start of the week (Sunday) and mid-week (Wednesday) (Sample Facebook post, see figure 5.3). However, given that the study intersected with religious obligations and religious holidays, participants voted to take a two-week pause through the study. Eventually leading up to 10 weeks of study. Table 5.2 indicates a summary of activities posted throughout the study. Activity types included survey, scenario-based questions, advice-columnist role play, design activities, and circle diagram and app-prototype test.

5.3.1 Week 1

Activity 1A Ice Breakers: We asked participants to introduce themselves by sharing the most recent religious-related social gathering they attended. We also encouraged them to share any photos of this experience if they felt comfortable doing so.

Table 5.2: Weekly Activities (N=15) for ARC Study

Wk	Activity Type	Activity Description	Engagement (N=14)*
1	[1A] Ice-breaker	Introduction	13 (92.9%)
	[1B] Survey	Demographic Survey	14 (100%)
2	[2A] Scenario	Menarche Experience [Religious]	13 (85.7%)
	[2B] Scenario	Menarche Experience [Health]	8 (57.1%)
3	[3A] Scenario	Navigating long menstrual length [Religious]	10 (71.4%)
	[3B] Scenario	Navigating long menstrual length [Health]	9 (64.3%)
4	[4A] Question-Based	Information/Knowledge Seeking	11 (78.6%)
	[4B] Circle Diagram	Information/Knowledge Seeking	8 (57.1%)
5–6	Break	Ramadan & Eid Holidays	–
7	[5A] Advice Columnist	Migrant mother raising US-born children	11 (78.6%)
	[5B] Advice Columnist	US-born adult Muslim	10 (71.4%)
8	[6A] Design Activity I	Letter From the Future	11 (78.6%)
	[6B] Voting	*Canceled to allow extra time for [6A]*	–
9	[7A] Design Activity II	Designing for Menarche	10 (71.4%)
	[7B] Usability Testing	App Prototype Test	10 (71.4%)
10	[8A] Reflection	Project Wrap-up/Reflection	7 (50.0%)
	[8B] Survey	Debrief Survey	7 (50.0%)

Note: *Engagement refers to the number of participants (out of 14) who completed each activity.

Activity 1B Demographic Survey: We introduced the week's second activity, which involves completing a survey estimated to take approximately 20 minutes.

5.3.2 Week 2

Activity 2A Menarche Experience [Religious Perspective] We presented the following scenario: "Amal is a 12-year-old and has just recently experienced Menarche (first period). [Imagine that Amal is your sister/daughter/niece/neighbor's child. Please pick a relation, choose what relationship you have with her]. Now based on what you know about Amal and your chosen relationship with her: (1) How would you go about educating or supporting

her to understand menstrual health from a *religious perspective?* (2) What resources would you recommend to her to learn more about menstrual health from *religious perspectives?* (3) What did you wish you knew when you were Amal's age? Feel free to share your own menarche stories, challenges, opportunities, and support".

Activity 2B Menarche Experience [Health Perspective] We presented the following scenario: "Amal is a 12-year-old and has just recently experienced Menarche (first period).[Imagine that Amal is your sister/daughter/niece. Please pick a relation, choose what relationship you have with her]. Now based on what you know about Amal and your chosen relationship with her: (1) How would you go about educating or supporting her to understand the menstrual *health perspective?* (2) What resources would you recommend to her to learn more about menstrual health from a *health perspective?* (3) What did you wish you knew when you were Amal's age? Feel free to share your own menarche stories, challenges, opportunities, and support".

5.3.3 Week 3

Activity 3A Navigating irregular menstrual health [Religious considerations] We presented the following scenario: "12-year-old Zara recently experienced her first period. A few months later, she discovered that her period length was unusually longer than she had previously experienced. Her period is 14 days (about 2 weeks) this time around.[Imagine that Zara is your sister/daughter/niece. Please pick a relation, choose what relationship you have with her]. Now based on what you know about Zara and your chosen relationship with her: (a) What are the religious guidelines and considerations you would recommend to Zara as she navigates this new context of extended period duration? (b) What support may she need for her religious well-being, practices, and spirituality? (c) How would you go about

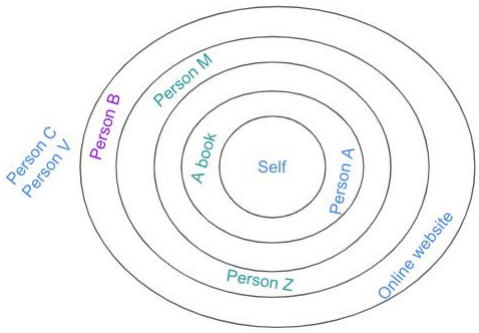

Figure 5.1: Example cycle diagram posted along with Activity 4B

helping her seek that support? (d) What are the opportunities, challenges, and gaps for support?"

Activity 3B Navigating irregular menstrual health [health considerations] We presented the following scenario: "14-year-old Sadia recently experienced her first period. A few months later, she discovered that her period length was unusually longer than she had previously experienced. Her period is 14 days (about 2 weeks) this time around. [Imagine that Sadia is your sister/daughter/niece. Please pick a relation, choose what relationship you have with her]. Now based on what you know about Sadia, and your chosen relationship with her, as you respond to the question below feel free to share your own experiences (if any) of navigating irregular menstrual length: (a) What health considerations would you recommend to Sadia as she navigates this new context of extended period duration? (b) What health support do you think she may need and how would you go about helping her get support? (c) What are the opportunities, challenges, and gaps for support?"

5.3.4 Week 4

Activity 4A (Information/Knowledge Seeking on menstruation.) We asked participants to share the types of religious information they sought regarding menstruation, providing the

following examples to help them think (e.g., spotting and ghusl, how to perform ghusl).

Activity 4B: Religious Information/Knowledge Seeking [Circle Diagram Activity] We asked participants to share whom they reach out to when they encounter religious concerns or questions about menstruation. We encouraged them to complete a cycle diagram based on whom they reach out to, moving from the inner to the outer circles (with the outer circles representing the most distant relationships). Additionally, we asked participants to place individuals they prefer not to talk to outside the circle and to answer the following questions

- 1. Based on your circle diagram, elaborate on the relationship with the persons (if you have specified a person above) on: (A) closer to self (B) farthest from self
- 2. Would this circle be different for Information seeking versus problem-solving?

5.3.5 Week 5 & Week 6

This week was a break to allow for the observance of the last few days of Ramadan and the observance of Eid. During this time, participants were permitted and encouraged to complete prior activities that they may have missed.

5.3.6 Week 7

Researchers created and posted advice columnists for Activity 5A and Activity 5B as follows (See 5.2a and 5.2b).]

Activity 5A [Advice Columnist]: Migrant mother living in the US & raising US Born Children

Activity 5B [Advice Columnist]: US Born Adult Muslim

5.3.7 Week 8

Activity 6A Design Activity I: Letter From the Future: Participants were instructed to imagine a future (e.g., the year 2050) where advanced technologies, systems, or solutions exist

MONTHLY NEWSLETTER

09.14.2024 **Activity 5A: Advice Columnist** Sunday

A5A: [Advice Columnist] : Migrant mother living in the US & raising US Born Children

"I am a mother of 2 daughters, a 14-year-old, and a 10-year-old. I migrated from the Middle East about 20 years ago. My daughters were born in America and have lived in the US all their lives. I try to educate them on Islamic values, but I worry that we may have a value clash given that I grew up in a culture that may prioritize Islamic values more". For example, I would like to discuss issues and Islamic views concerning women's health such as menstruation, contraception, birth control, and abortion (not limited to these). **How do we navigate these discussions with my daughters? In which of these health situations do you anticipate more value clashes and how would you address it?**

(a) Activity A5A

MONTHLY NEWSLETTER

09.17.2024 **Activity 5B: Advice Columnist** Wednesday

A5B: [Advice Columnist] - US-born Adult Muslim

Hi everyone, I am a 15-year-old girl. I was born in the US. My mother was born in and migrated from a country that is predominantly muslim where Islamic values are prioritized. She emphasizes that I need to understand the Islamic perspectives on women's health.

I do not think these things are necessary. Islam is just very patriarchal; I do not appreciate that I must learn these from Imams (male scholars). I still want to learn these, but not in the manner she puts it. What should I do, please advise me?

(b) Activity A5B

Figure 5.2: Prompts used for advice columnist activity during week 7

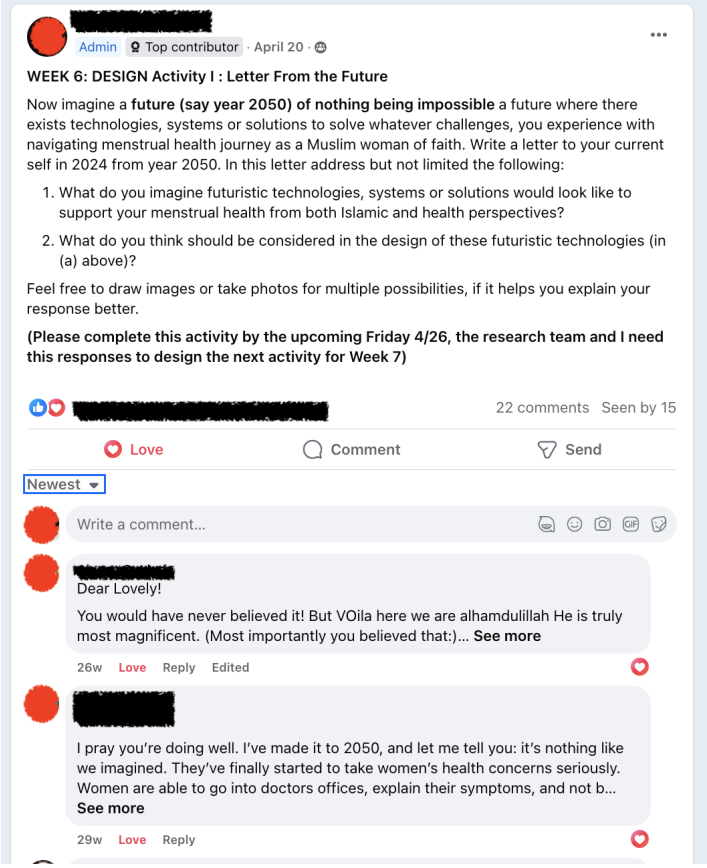

Figure 5.3: Sample Facebook Post (Featuring Activity 6A). For more images of Facebook posts corresponding to each activity, please see the supplementary materials.

to address any challenges faced in navigating the menstrual health journey as a Muslim woman of faith. They are to write a letter from the year 2050 addressed to their current selves in 2024. In this letter, participants were asked to address, but are not limited to, the following points: (a) What they imagined futuristic technologies, systems or solutions would look like to support your menstrual health from both Islamic and health perspectives? (b) What they thought should be considered in the design of these futuristic technologies (in (a) above)? Activity 6B Voting for Activity: This activity was removed to ensure that participants had more time to complete A6A.

5.3.8 Week 9

Activity 7A Design Activity II: Participants were instructed to undertake a three-part design task. **Part A** required them to choose one of two design directions for developing technologies. Design **Direction 1** focused on collaborative care that incorporates religious beliefs, involving professionals such as doctors, healthcare providers, and religious scholars working together to deliver the necessary care. **Design Direction 2** emphasized the use of virtual religious agents and scholars to support menstrual and overall health. In **Part B** participants were asked to consider various form factors and determine which types of technology would be most suitable for their chosen design direction. They were encouraged to think about options such as VR glasses, chatbots, smartwatches, implanted chips, or combinations of these technologies, while also considering other possibilities beyond the provided examples. **Part C** involved revisiting their selected design ideas through the lens of specific factors, including privacy, ethical implications, trust, and Islamic values or concepts (e.g., authenticity of information, Haya [modesty]). Participants were asked to specify any changes they might make to their designs to accommodate these aspects effectively.
Activity 7B App Prototype Test: We posted a survey that featured links to multiple interface designs and user flows of a prototype app. Upon completing each task, participants answered follow-up questions included within the survey to provide their feedback.

5.3.9 Week 10

Activity 8A Project Wrap-up/Reflection: Participants were asked to respond to a series of reflective questions, including what they learned about themselves through the process, what aspects of the study went well for them, what aspects of the study did not go well, and what improvements could be made to enhance future studies.

Activity 8B Survey: We asked participants to complete a debrief

5.3.10 Analysis

Our dataset included survey data, activity responses, follow-up comments, and sketches. We did descriptive analysis, averages, and survey summaries. However, our results were mostly focused on the qualitative aspects of the non-survey-based prompts. The findings section presented here focused on qualitative aspects of our analysis. Full descriptions on survey summaries are listed in the appendix section. We analyzed the collected data using the thematic analysis approach [210]. We adopted an inductive coding approach. The first two authors divided the data from different activities into two halves for open coding. For one-half of the data, the first author served as the primary coder, while the second author acted as the secondary coder; for the other half of the data, their roles were reversed. They met weekly to discuss, iterate, and refine the initial codes. The third author re-coded the design-based activities (Activities 8A and 9A). All survey-based activities (Activities 1B, 9B, and 10B) were analyzed by the fourth author and subsequently reviewed by the first and second authors.I and the researchers on this work, used the open-source software Saturate app [3] to facilitate collaborative qualitative analysis. We coded each of the non-survey activities individually. After completion of the initial coding, the researchers conceptualized themes by organizing similar codes into high-level categories. We combined themes from all activities into one codebook. Initial themes were iteratively reviewed, revised, and refined through several synchronous meetings within the research team. Our analysis revealed themes related to participants' practices, the tensions surrounding menstrual education, and the strategies they use to navigate and reconcile menstruation within the religious context.

[3] http://www.saturateapp.com/

5.4 Results

The first finding begins by uncovering how female figures within the family (i.e., mothers, elder sisters, aunts, and grandmothers) use Islamic teachings to support young girls in their menarche transition. Next, I detail participants' approaches toward accommodating menstruation and religious practices into their daily lives. Finally, I present participants' envisioned design ideas to support their menstrual experience. Table 2.1 provides descriptions or meanings of various religious terminologies used throughout this paper. To set the context of the subsequent sections (5.4.2 and 5.4.3), I present reflective experiences of how our Muslim women participants prepared for menarche 5.4.1). This context is important in shaping the understanding of the broader menstruation experiences in adulthood (section 5.4.2) and informing supportive design solutions (section 5.4.3). Through advice columnist reflective activities from week 5 (Activity 5A), participants shared memories of their menarche preparation, revealing key themes that shaped their later experiences of menstruation in adulthood.

5.4.1 Experiences of Preparing for Menarche

Participants highlighted that early education about menarche through the lens of religious beliefs, values, and rulings was crucial in preparing them for the transition to adulthood. They discussed three approaches to facilitate religiously guided menarche education within the family context: (1) creating a welcoming environment for open discussion within the family, (2) illustrating contrasting experiences between Muslims and non-Muslims, and (3) sharing stories from Islamic history. While sharing their menarche experiences participants also reflected on tensions around menarche education. They shared how social constructs, such as gender norms, taboo topics, and cross-cultural perspectives, affect the framing and

delivery of menarche education within religious perspectives. The findings presented in this section are from the analysis of Activity 5A.

Early Menarche Education within Religious Perspectives: Participants discussed having menarche education from religious perspectives at an early stage. They highlighted that mothers and other female figures, such as elder sisters, aunts, and grandmothers, traditionally were responsible for preparing and educating young girls for menarche. These women played a crucial role in conveying menarche information within religious contexts. For instance, P3 talked about discussing menstruation at a young age to ensure a better understanding of both the menstrual experience and appropriate Islamic etiquette in order to make an informed decision. She also emphasized the roles a mother can play in providing the necessary information to empower daughters to make informed decisions about menstruation:

> "*I learned about menstruation before I started menstruating myself. I think daughters are mature and you can have these discussions with them when they are young (but still old enough to understand), teach daughters about menstruation- what it is and the appropriate Islamic etiquette. [...] Mothers need to give them the information they need to make an informed decision that is best for them.*" -P3 (Activity 5A)

Participants emphasized the importance of creating a welcoming environment where mothers and daughters can freely express themselves and engage in meaningful conversations to foster discussions about menstruation that are both informative and aligned with Islamic values. For instance, P14 emphasized engaging in conversations to foster a deeper understanding and create a long-lasting impact, rather than approaching this religious education

through a set of directives:

> "*I advise (mothers) to refrain from turning the discussion into a series of commands. So, instead of saying "you have to do this" or "you have to do that because Islam says so", she (mother) should approach the topic as "did you know that..." or "what do you think about this Islamic ruling about....". I believe this will help foster deep and engaging conversation between the parent and children in a way that will stick with everyone.*" -P14 (Activity 5A)

In addition, participants discussed navigating menarche conversations by presenting how contrasting experiences of non-Muslim women could provide valuable insights and understanding into how Islamic values uniquely address menstruation. This comparison could foster the installation and reinforcement of Islamic values by highlighting distinct practices and encouraging the respectful adoption of religious values in the context of menstruation. For instance, P7 shared that her mother taught her about Islamic values around menstruation through a *'us vs. them'* comparison, which emphasizes what she should do as a Muslim compared to what non-Muslims might do in similar situations. She also expressed her desire to adopt a similar parenting style with her daughters to help establish and reinforce their identity within a religious context.

> "*I was born and raised in North America with a set of parents who were born and raised in the Middle East. [...] when I become a mother, [...] I would start telling them [my daughters] about the mercy that Allah has bestowed upon women religiously and how to perform ghusl (purification after menstruation). [...] and tell them what I do vs what they [non-Muslims] do. This is something my mom taught me at a young age- "us vs them". [...] Establishing this at a young age makes it easier to have this kind of conversation.*" -P7 (Activity 5A)

Additionally, participants highlighted how historical Islamic stories ('Seerah') that have been preserved through the years could help navigate the discussions about menarche through an Islamic lens. For instance, P14 discussed how informative YouTube or TikTok videos featuring Islamic stories about historical female figures, such as the Wife of Prophet Mohammad, could be valuable tools for shaping perspectives on women's health at an early age:

> *"Islam has so many Seerah. One of the best ways to teach children about concepts and rulings in Islam is through these stories and Seerah. I know there aren't many regarding women's health, but there are some about Aisha (the wife of Prophet Mohammad), so she can be a role model. [...] Many kids nowadays enjoy funny videos on YouTube or TikTok [...] so maybe finding a video (an informative video on Prominent Muslim Women in History) to discuss the implications of the video and what it means for the daughters' womanhood and religion could be beneficial."*-P14 (Activity 5A)

Tensions Around Menarche Education Participants discussed encountering challenges and tensions around menarche education when it intersected with religious beliefs and values. They shared that social constructs, such as gender norms and taboo topics, affect how menstruation is taught, understood, and experienced in the religious context. They also expressed that menstruation is often considered to be private matters, dictated by gender roles and expectations, and not to be discussed openly with male family members. For instance, P7 shared how the taboo surrounding menstruation led to a lack of proper education and prevented her from discussing the subject openly with her father who was otherwise her closet confidant:

> "*Since it (menses) was a taboo topic I was not properly introduced to the sci-*

ence behind menses. [...] This is a delicate topic and it becomes harder to open up. I was not allowed to discuss it with my father, even though I told him most of my life (he is my best friend) but it is taboo to talk about it" -P7 (Activity 5A)

In addition, participants shared that early menarche education within the religious context often became challenging due to the differing perspectives between Western and Islamic values. For instance, P14 expressed concerns that her daughters might adopt Western values around contraception and abortion through exposure to these views at school and on the Internet:

"*I come from an African background. [...] I anticipate more clashes around contraception, birth control, and abortion because these are hot topics for women in the modern Western world. They ('referring to women in the modern Western world) advocate for things that are not completely aligned with Islamic views [...] My daughters are likely going to pick up Western values from school and the internet.*" -P14

Additionally, participants shared that menarche education often became challenging due to the differing perspectives between Western and Islamic views. They emphasized using the native language as a medium to preserve and reinforce the Islamic perspectives. For instance, P4 shared that Muslim families living in the US often deliberately resisted conforming to Western values by enforcing their native language as a means of communication in the homes to preserve religious values:

"*I know so many girls who were born here (in the USA) and some whose moms were raised here who speak fluent Arabic. Their (Islamic) ideologies are not*

influenced by the West at all. One thing I noticed about this is that their parents didn't conform to society. They did this by instilling practices of cultural preservation and Islamic education. The simplest thing is by only speaking Arabic, or in non-Arab cases, their mother tongue at home." -P4 (Activity 5A)

Another participant, P14, shared that having early conversations about Islamic values, such as modesty and wearing the hijab, could help navigate potential clashes between Western and religious perspectives:

"*It's up to the mom to facilitate the discussions early and become a voice of reason who challenges these (conflicting) values. [...] I think it's safer to give them (daughters) the initial knowledge (when they're ready) and help them understand that it doesn't align with their religion. [...] any desire to follow the Western norms can be avoided with a further conversation about modesty and hijab and protecting one of the biggest assets that a woman has [...]The daughters are developing their moral conscience and deciding what they believe and who they are at the ages they are at, so it's much more important for the mom to have these constant conversations to ensure that whatever culture the daughters adopt, isn't harmful to their wellbeing or their religious practice.*" -P14 (Activity 5A)

In summary, this section presents the influence of religion education in preparing for menarche. Participants discussed ways for early menarche education to help individuals prepare for their menarche transition. They highlighted the tensions around menarche education in religious contexts.

5.4.2 Navigating Religious Menstrual Education

Following preparation for menarche, participants highlighted the menstrual experience and incorporated it into everyday routines. Reflecting on the complexities of managing menstruation within a religious context, participants highlighted the importance of cultivating a strong religious foundation through comprehensive education and fostering a support network. The findings presented in this section are from the analysis of activities 4A, 4B, and 5B

Self-learning, Curating, and Refining Knowledge Though our participants attributed a strong early Islamic education as a key factor that enabled them to prepare and better manage their monthly cycle, they also noted that their early education was not comprehensive and often lacked context and depth, leaving them with unanswered questions. They often sought a comprehensive picture and recognized the importance of considering various factors influencing the meaning and significance of Islamic practices and rulings. For instance, P14 shared her struggle in fully grasping the details and nuances of religious guidelines related to menstruation, which she received from her mother during her younger years:

> "*What she (mother) told me wasn't sufficient for 2 reasons. The first is that I didn't understand why everything was necessary. All I was told is that I'm not clean, I'm impure, so that's why I had to do everything she told me to. [...] The other reason I felt [...] there were other questions that came up over time that weren't properly answered. For instance, what constitutes a period? Even to this day, I still struggle to know when my period officially (Islamically) ends. Everywhere I go, I'm told that it ends when there is no longer a tinge of color or after a certain amount of days. So, I do my best to follow that general rule.*"

-P14 (Activity 4A)

Participants discussed the importance of self-learning as they curated and refined their understanding of the rationale behind religious practices, aiming to feel more connected to their religion while respecting their menstrual cycle. Participants often relied on various online resources, i.e., Google searches, YouTube videos, Islamic forums, online courses, etc., to seek religious information. For instance, P1 mentioned using online forums and Google searches to look for Quran verses, Hadiths (Islamic traditions from the Prophet Mohammad), and their Islamic interpretations for self-learning and curating religious knowledge about female hygiene:

> "*I was not taught a lot about (religious) rulings on feminine hygiene. [...] A lot of my knowledge is from Google searches. If I wanted information on ghusl, I would use the step-by-step instructions given on IslamQA or WikiHow. [...] In a Google search, I'm specifically looking to see for any Hadiths or Quran verses that are easily accessible. [...] they come directly from Allah and the Prophet, and (search results) have credible sources attached so I'd feel comfortable following through on that information.*" -P1 (Activity 4A, 4B)

Another participant, P11 talked about taking online courses to build and refine her understanding of religious guidelines for various aspects and scenarios of mensuration:

> "*I took a course from Mizan Institute* [4] *that solely focuses on the worship rules around menstruation. They went over various case scenarios that deal with menstruation. This is the course I took. I ended up watching it a couple of times so that I could understand the material. [..] They also provide access*

[4]Mizan Institute: A platform that offers Islamic education to Western Muslims through a simple and accessible manner such as courses and modules. https://fiqh.mizaninstitute.org/

to female scholars by appointment (I like the fact that I can pay them for their time and expertise)." -P11 (Activity 4B)

A few participants discussed integrating medical professionals' perspectives and opinions while making informed decisions and adhering to religious guidelines. For instance, P3 mentioned consulting her gynecologist to determine what counts as a period due to her irregular cycle from polycystic ovary syndrome (PCOS) and then following Islamic guidelines based on that advice.

"*I grew up attending the masjid after-school program for nine years. In that, I learned about menstruation, what it is, and what it means in Islam. I learned about the rules, questions I had regarding spotting and ghusl (purification after menstruation), and how to perform ghusl. I do not seek (new) religious information about menstruation in this part of my life. [..] My period is irregular because I have PolyCystic Ovarian Syndrome (PCOS). I ask my gynecologist what is considered a period for spotting, etc., in my cycle. And then I follow the Islamic guidelines based on what is a period versus not a period.*" -P3 (Activity 4A)

Forming a Network of Support

Participants talked about building a strong support network of other Muslim women with whom they can share their experiences, ask questions, and seek advice about menstruation and related religious guidelines. This support system helped them feel more comfortable discussing menstruation, navigating challenges, and addressing concerns within the framework of Islamic rulings while fostering a sense of solidarity. For instance, P8 shared that being part of an online support network, Rabata Islamic Center [5], helped her adopt

[5]Rabata Islamic Center: An organization that supports the growth of Muslim women as scholars, community leaders, and cultural change agents. https://www.rabata.org/

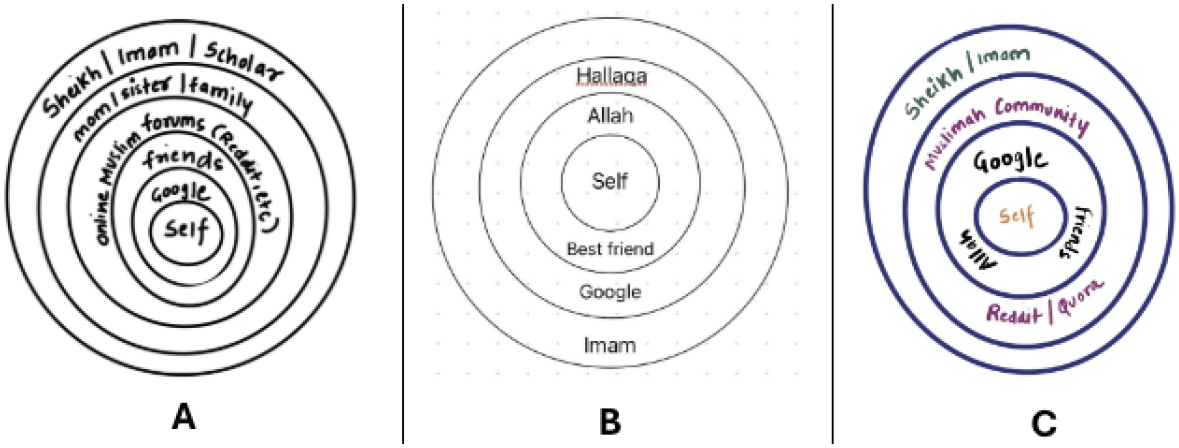

Figure 5.4: An illustration of participants' social support network. Here, (a) P1, (b) P7, and (c) P14 drew their social support network as a series of concentric circles, placing themselves at the center and positioning people or online sources at varying distances based on their comfort level with seeking and receiving informational and emotional support.

a more positive approach toward menstruation and celebrating femininity by emphasizing how women are valued and cherished in Islam through narratives of Muslim women from both the past (Islamic history)

> "*I am part of Rabata Islamic Center, an online platform that empowers Muslim women to learn about their deen (religion) and encourages women scholarship with the various classes, lectures, [...] The more you learn about Islam, the more you will be proud of the status that women hold in Islam.*" -P8 (Activity 5B)

Participants' support network consisted of both online and offline support sources, such as peers, female family members, halaqa groups [6], Islamic scholars, and online communities (Fig. 5.4). For instance, P14 shared that she relied on her primary support sources, i.e., Google, and her closest Muslim friends for informational, emotional, and spiritual support. However, when seeking more in-depth and comprehensive guidance to better understand

[6]Gathering or study circle where individuals come together to learn, discuss, and reflect on religious teachings, from their holy book (eg. the Quran) or other aspects of Islamic knowledge

Islam, she turned to the broader online Muslim community:

> "*My go-to places/people to discuss religion first start with Google [...] and my closest Muslim friends (Fig. 5.4c). Whenever I have a question, I Google it to see what Islamic institutes online have to say. I also like to make dua (supplication) and pray to Allah to guide my behavior, my research, and my thoughts toward what is good and what is correct under the religion. Then, I have about 2-3 knowledgeable Muslimah friends that I can contact and who will answer my questions without judgment or at least guide me to those who can answer. However, sometimes my friends don't have the answer or Google is showing me the 'clear, cut, and dry' response of the literal interpretation of the Quran. In those cases, I reach out to the larger Muslimah community that I am in or I go to the Subreddit Muslimah forums online and ask my question sincerely in hopes that someone can expand upon the common knowledge to include examples from their personal experiences. This step usually helps me feel like I'm not alone in my journey of understanding Islam better and it also clarifies my understanding of how to apply the religion to my own life.*" -P14 (Activity 4B)

Although participants acknowledged the value of people who are well-studied or have received formal Islamic education (e.g Islamic scholars) in offering in-depth, nuanced, and accurate interpretations of complex issues to enhance their understanding and practice of Islam, they often hesitated to discuss their menstruation experiences and concerns directly with them, as the vast majority of Islamic scholars were male. For instance, P4 shared that she asked her female friend to seek advice from the friend's brother, who is an Islamic scholar:

> "*I don't really feel comfortable at all asking a local Imam in person about anything. It's awkward as a woman since there's no opportunity to do that, or at least I haven't looked/attempted to, to be honest. [..] One of my close friends has a brother who studied at Madinah University and is very knowledgeable, so I often ask her to ask him.*" -P4 (Activity 4B)

While seeking social support participants preferred reaching out to those within their network who understood their experiences and resonated with their ways of thinking. They found comfort in seeking and receiving emotional and informational support from individuals who shared similar experiences and perspectives to Islam. For instance, P7 shared that after her marriage, she sought out *Halaqa* groups of newlyweds to gain information and guidance on Islamic rulings relevant to married women. Additionally, she shared that she preferred reaching out to Islamic scholars *(Imam)* based in the USA rather than those from her home country, believing they could offer more accurate, context-specific advice due to their better understanding of her environment and the people around her:

> "*What I seek these days (as a newlywed) is religious knowledge about spotting, ghusul, and intimacy. I have been trying to seek a halaqa for newlyweds or people who want to get married and would like to know all the information regarding menses and marriage (Fig. 5.4b). [..] When it comes to the Imam, I try to find a local imam or at least an imam in North America and not from the Middle East (which my family does not always agree on this point). Having an imam (a religious leader) who understands the nature of the environment and the people we surround ourselves with here (in the USA) makes the religious advice more accurate.*" -P7 (Activity 4A)

In summary, this section discussed how participants navigate and manage menstruation

within the religious context. Integrating religiously grounded menstrual experiences into daily routines required a strong religious foundation, achieved through comprehensive education and supportive social networks.

5.4.3 Participants Generated Design Ideas For Holistic Menstruation Support

Participants described a variety of technological solutions that have the potential to support their menstrual experience while addressing their health and religious needs. Their design concepts emphasized creating partnerships between medical providers and Islamic scholars, building support within the Muslim women's community, and promoting holistic health. Participants envisioned design concepts that leverage technologies such as mobile phone applications, portable virtual reality (VR) glasses, smartwatches, Artificial Intelligence (AI), and other more futuristic technologies such as implanted microchips. The findings presented in this section are from the analysis of activities 6A and 7A.

Collaboration Between Medical Professionals and Religious Scholars: As participants described technologies that supported their menstrual health, they highlighted the importance of ensuring it would be informed by medical knowledge, while respecting and aligning with their religious beliefs and practices. With that goal in mind, they described the designs of a mobile application that would bring together and support the collaboration between medical providers and female religious scholars *(Ustadha)* to address both medical and religious needs in menstrual health. This process and collaboration within a mobile application are shown in Fig. 5.5. For instance, P14 discussed how the collaboration would involve providers delivering medical care and information through private text messaging, while a female religious scholar would offer religious guidance tailored to an individual's daily needs:

"*A single doctor may not give the best advice based on our religious beliefs, but*

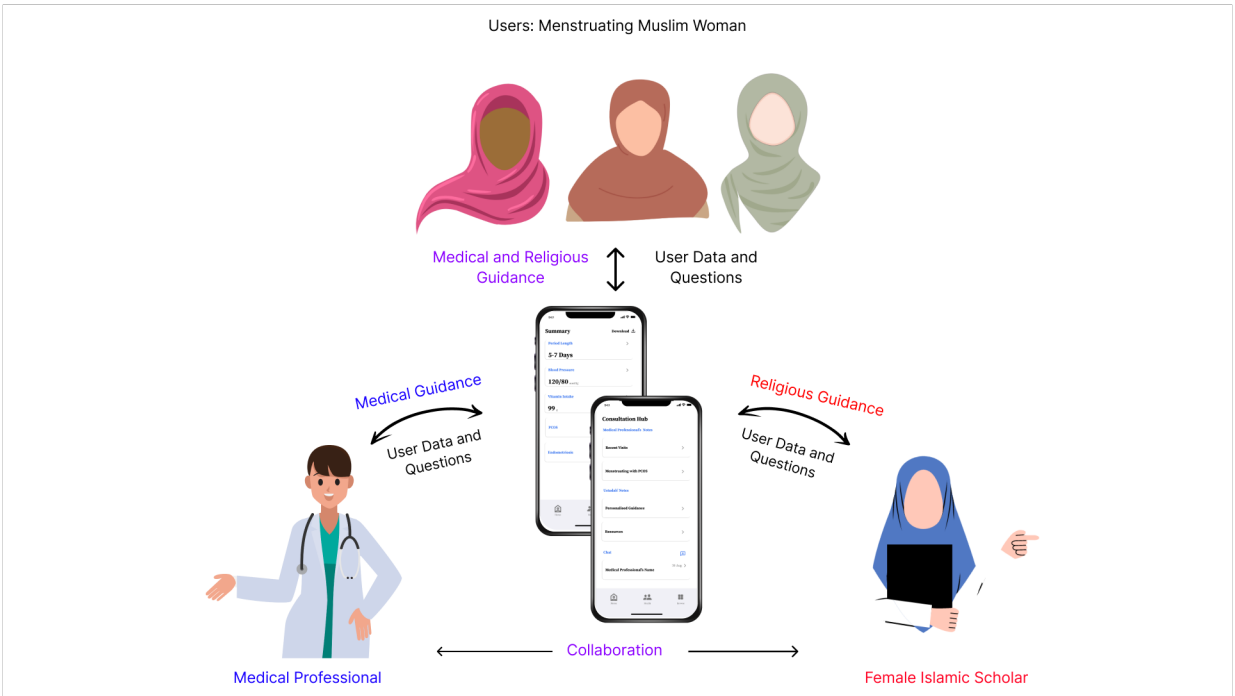

Figure 5.5: The diagram illustrates an information flow, conceptualized by participants, featuring a menstruating Muslim woman (user), a medical professional, and a female Islamic scholar, all connected via a mobile application. The user shares data and makes inquiries through the app, receiving integrated medical and religious guidance resulting from the collaborative team of the health provider and religious scholar.

> *they can collaborate with a female scholar (or other religiously knowledgeable women) to give the best care that aligns with our beliefs and our specific health needs. The form factors that I believe would be most suitable are in-app text messages and smartwatches. [...] If something is wrong and it is affecting your overall health, the doctor has baseline values to work off of and the religious scholar can gain insight through questionnaires that you answer about what's going on in your daily life to determine the next steps.*" -P14 (Activity 7A)

On the medical side, participants advocated for engaging with integrative medical providers like lactation specialists and acupuncturists, to improve menstrual support as these types

of providers offer broad perspectives and expertise [211]. Access to a diverse array of providers and perspectives could help participants make informed decisions that balance their religious and health needs. For instance, P6 shared how the variety of provider support could address the holistic nature of menstrual health, aiding with more informed religious decisions toward menstrual health:

> "*I would use this opportunity (collaboration) to pull in other supporting services, such as lactation specialists, acupuncture, massage therapy, and other healing options, as menstrual health is linked both physically and emotionally. And when you have access to different providers, it makes it easier to make religious decisions because you also have more information.*" -P6 (Activity 7A)

On the religious side, participants highlighted the need for information from women scholars to provide and validate information related to women's health. P6 detailed the importance of including these Islamic scholars, particularly female scholars, who are knowledgeable about contemporary health challenges, such as Polycystic Ovary Syndrome (PCOS) to guide Muslim women in a way that is faithful to Islamic values, responsive to current health issues, and supportive of their overall well-being:

> "*In terms of Islamic values, the most important thing for the future is to have more women scholars who can go through and validate Hadith related to women's issues as well as who are familiar with modern society and the challenges that arise from that, including new diagnoses, such as Endometriosis and PCOS*" -P6 (Activity 7A)

This collaboration between medical professionals and Islamic scholars within the design of a mobile application addresses both health and religious needs when navigating menstrual

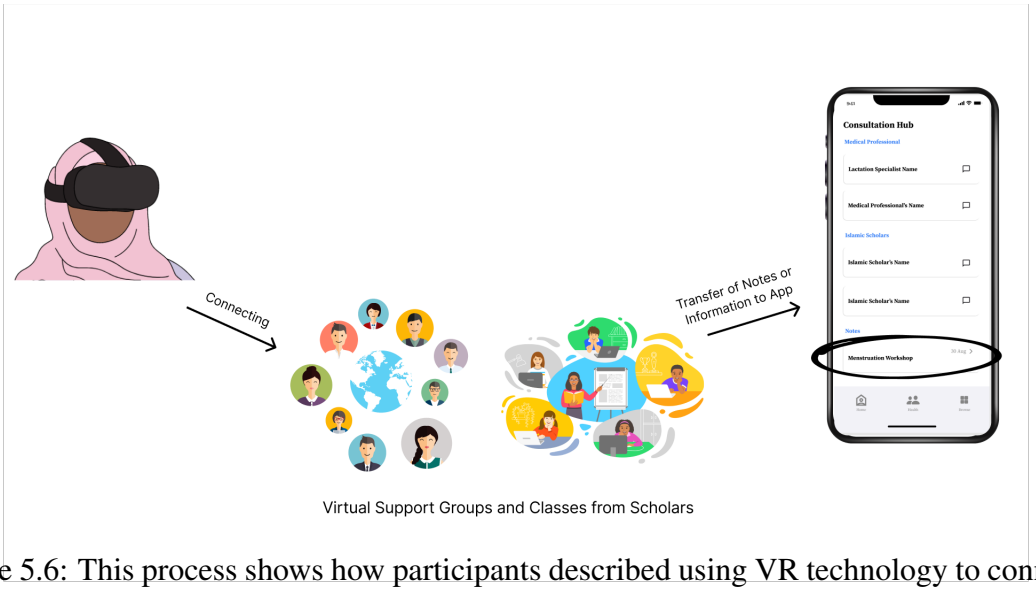

Figure 5.6: This process shows how participants described using VR technology to connect users with virtual, Muslim support groups and Islamic scholar-led classes, with notes and information transferred to a mobile application.

health information and advice.

Fostering Community Support: Participants highlighted the importance of having a support system comprised of individuals who share similar experiences, religious beliefs, and values. Consequently, they described ways to seek and receive support from a community of Muslim women and scholars. They imagined this community as a resource for sharing knowledge and providing guidance to younger Muslim girls, helping them better understand their bodies from a religious perspective and facilitating connections for Muslim women through technology. For instance, inspired by the Muslim social app *Salams* [7], P9 talked about having a menstrual support group for religious advice on how to address challenges with women's health, such as menstrual spotting, PCOS, endometriosis, etc.:

> "*It can even have some sort of support group of (Muslim) sisters in different parts of the world (like the Salams (an App) friends section) so people can*

[7]Salams: https://www.salams.app/meet-Muslims

attend spiritual events together, share experiences, or just form some sort of menstruation community." -P9 (Activity 6A)

However, some participants expressed concerns about the accuracy and validity of advice and information received from support groups. For instance, P6 expressed her challenge of navigating information from both expert and non-expert sources and expressed how technology can help with discussions primarily guided by experts like Islamic scholars:

"*I would stay away from forums or groups- it's time-consuming and not everyone is an expert because of their own experience...I would also like to see things moving away from social media and more into the hands of experts. [...] Chatting with a scholar online is also very helpful within the group that you trust.*" -P6 (Activity 7A)

Most participants generated design ideas that used technologies, such as generative AI or VR, to connect individuals to a community of Muslim women, whether scholars or non-scholars, similar to the example shown in (Fig. 5.6). For example, P14 generated several design ideas that she felt could help women like her find support or answers to specific health or religious questions: a recommendation system that would "follow" scholars or communities on social media, an AI system she could query that is specifically related to Islam and menstrual health, or VR technology to address challenges in openly discussing female health and provide a supportive virtual community for knowledge sharing:

"*Remember when you felt lonely because you couldn't ask certain questions about female health or feel connected to shared experiences in the Muslimah community? Well, that's over. VR goggles used to be expensive and inaccessible, [...] but everyone has it now (in the developed nations anyway). [...] It's*

easier than ever to speak with like-minded practicing Muslimahs with a wealth of knowledge and who can address concerns about menstruation." -P14 (Activity 6A)

However, emphasizing the role of experts, P14, shared that she was wary of using AI technology when seeking suggestions or advice related to religious guidelines and rulings:

"*You were able to hop on an AI chat, ask a brief question about things like ways to boost iman (belief) during menstruation, and receive a complete answer from a variety of trusted sources. AI is so advanced now that it feels like you're talking to another human. However, it's difficult to evaluate if the responses are truly valid interpretations of the Islamic faith or a mixture of beliefs and voices of other non-secular people who talk to or teach the AI.*" -P14 (Activity 6A)

While concerns were raised about the accuracy of advice, participants emphasized the importance of a supportive, religious-based community for Muslim women to discuss health and religious matters, discussing technologies like VR and AI as tools for spaces for expert-led guidance. AI-Powered Tools for Holistic Health and Religious Guidance: Participants expressed strong interest in AI-powered tools for holistic health tracking, particularly for menstruation and religious practices. They discussed technologies such as smartwatches and implantable chips to track their data and mobile apps to integrate health, religion, and daily life management while highlighting how personalized AI-backed apps could incorporate factors like health, stress levels, economic and ethnic background, and religious beliefs to offer tailored guidance for maintaining mental and physical well-being (Fig. 5.7). P4 expanded on this concept by generating a design of smartwatches or implantable chips that

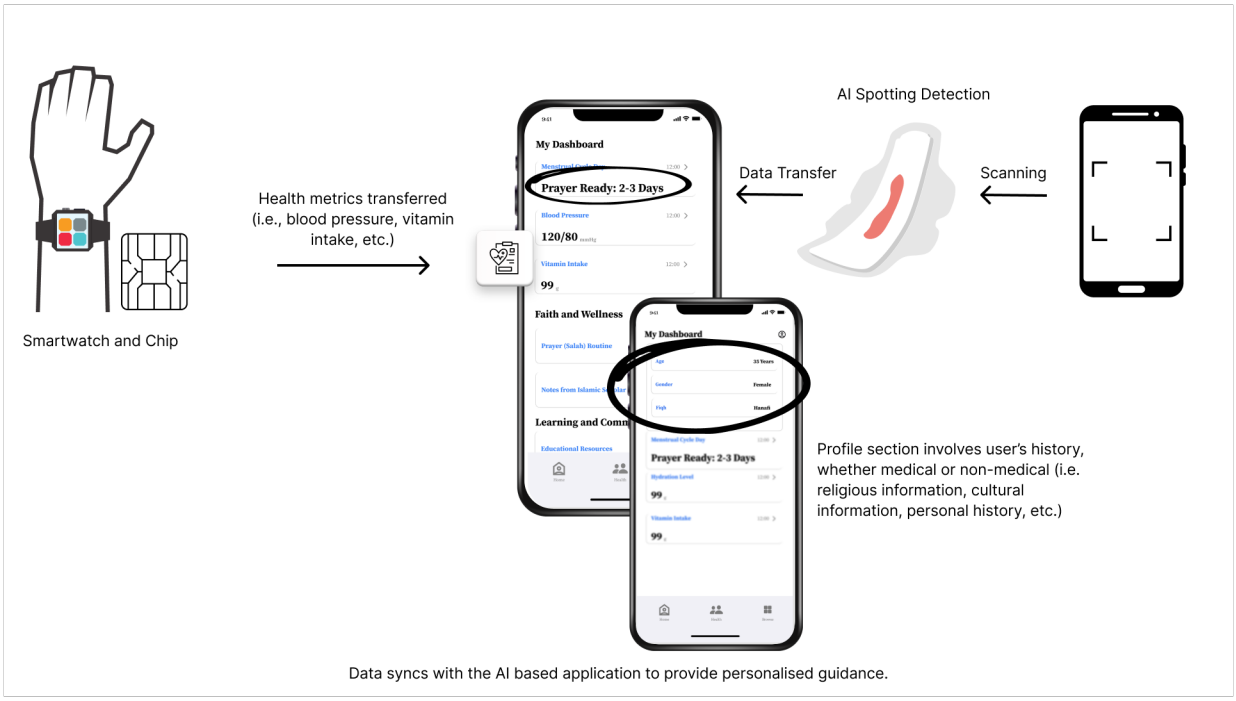

Figure 5.7: Participants discussed two data transfer processes to a mobile app: (1) health data from a smartwatch and embedded chip is transmitted to the app to display health metrics and personal history; (2) scanning menstrual spotting on a pad transfers data to the app to help determine appropriate prayer times.

track various health metrics to anticipate menstruation and provide timely religious guidance:

> *"You now have a chip installed which monitors your BP, insulin, hydration, and cramps, and it anticipates your period. It also identifies if you are lacking vitamins. It uploads data to an app which tells you when you can and cannot pray and has a virtual Ustadha that answers your questions via an AI bot."* -P4

(Activity 6A)

Participants also generated ideas using AI tools that could assist in determining if they were able to pray by analyzing their period spotting (Fig. 5.7). P9 suggested the possibility of using image recognition technology for this purpose:

> *"I think some sort of app that you can submit a picture of what your spotting looks like that can detect if you can pray (hopefully AI will be well advanced by the time). Better technologies and remedies to help people with irregular periods and side effects they experience."* -P9 (Activity 6A)

P14 echoed this sentiment, explaining how the app would give users a sense of security by confirming religious observance guidelines:

> *"This app will literally become your friend because it will always have your back and create some sense of security as if someone (or something in this case) understands you very very well."*-P14 (Activity 6A)

While participants saw significant potential in AI-powered tools for managing health and religious practices, they also expressed concerns about the drawbacks of such technology. Participants highlighted the difficulty in determining whether AI-generated responses align with valid interpretations of the Islamic faith. P14 expressed concerns about advanced AI's predictive capabilities, likening them to fortune telling. She believes that since fortune telling is not permissible in Islam, AI's ability to make future predictions is similarly impermissible.

> *"I wish AI didn't develop its own sense of 'intelligence' and still maintained valid sources of knowledge, especially from female scholars regarding women's*

health in Islam...Also, religiously speaking, the predictive analysis might come a little too close to 'fortune-telling,' which in essence is frowned upon. So, I would advise that the app uses only past experiences, scientific information, and the user's social and health data to determine potential future experiences without using questionable outside sources or unreliable means."-P14 (Activity 6A)

Overall, participants were interested in AI-powered tools for holistic health tracking and religious guidance but stressed the importance of maintaining accuracy and alignment with Islamic teachings and interpretations by using reliable sources and avoiding predictive features that could conflict with religious principles.

5.5 Discussion

Our discussion section focuses on technology design promoting menarche education through storytelling and unpacking the ecosystem of religious information.

5.5.1 Fostering Menarche Education

I observed that early conversations between female figures and young girls played a crucial role in preparing young girls for the experience of menarche. Participants highlighted that these discussions often relied on personal narratives or historical, and religious stories, and, importantly, needed to take place in supportive environments that allowed young girls to comfortably ask questions and engage in open conversations. Participants stated the importance of preserving Islamic values by using their native language when having these conversations and sharing personal narratives, further embedding cultural nuances, and religious teachings into the dialogue (section 5.4.1). The process of sharing these stories

not only provided practical guidance but also reinforced a sense of identity and belonging within the religious community. As researchers like Progga et.al [212] and Hammid et. al [213] have pointed out, storytelling is one of the oldest forms of teaching and remains a powerful tool for conveying information in a meaningful way. Storytelling allows for the dissemination of complex and abstract concepts by making them more relatable and accessible, particularly when employed for educational, social, and cultural messaging [213].

Technology presents a unique opportunity to enhance menarche education and the instillation of Islamic values through storytelling. When considering how to integrate storytelling for menarche education, we can draw inspiration from the design approach discussed by Michie et al. [214] in their creation of the digital storytelling platform, *HerStoryTold*. This platform was developed to capture and share the narratives of women in Ireland who traveled out of the country to receive an abortion, providing a space for their experiences to be voiced and preserved. Similarly, we can design a platform that captures and disseminates historical and contemporary tales of Muslim women, focusing on Seerah stories and the experiences of women within their communities. These stories could focus on positive ways of addressing the initial experience of menarche and its disruptive effect on religious practices, such as exemptions from certain religious worship, like praying and fasting, and overall feelings of exclusion, as described by these researchers [14, 28]. Similarly, a digital storytelling platform for young Muslim girls could be tailored to reflect the rich diversity of religious experiences by allowing stories to be told in their native languages. By enabling women to share their narratives in their native languages, the platform would not only preserve the cultural and linguistic nuances embedded in these stories but also foster a deeper connection with young girls as they prepare for menarche.

The preservation of Islamic values and stories through language is particularly significant

as it carries with it the religious traditions and teachings that are often interwoven in these stories. However, this design presents some challenges. Stories told in one language may unintentionally exclude individuals who do not speak or understand that language. To address this issue, it is crucial to incorporate multilingual support, enabling users to switch between languages seamlessly and select the languages with which they are most comfortable. These stories can be accompanied by subtitles, translations, or interpretations, allowing people from diverse backgrounds to appreciate their cultural heritage without feeling excluded. Prior HCI research has provided relevant considerations for designing for multilingual support, and supporting 'code-mixing' (or linguistic style of switching between multiple languages) for multilingual users [215, 216, 217]. Additionally, incorporating universally recognized and culturally neutral visuals, such as icons and images, or providing alternative representations that accommodate different cultural norms can also help bridge this gap. Moreover, when telling historical tales about Islamic figures, it is crucial to maintain the Islamic value of "Authenticity" meaning that the stories must be conveyed accurately and faithfully, even when translated into different languages. Authentic storytelling is vital in preserving the religious significance of these narratives, ensuring that they resonate with audiences while remaining true to their origins.

5.5.2 Supporting The Religious Information Ecosystem

Participants seeking religiously aligned information on menstruation described following a hierarchical structure in their search for guidance, typically starting with imams or religious scholars, then turning to peer networks, and finally online search engines like Google. However, as individuals progress through this hierarchy, skepticism tends to rise, the process becomes more private, and access becomes easier. Designing solutions to support this information-seeking journey should consider these dynamics, aiming to improve access to

trusted sources, reduce skepticism, and strengthen connections to religious experts.

Furthermore, participants emphasized the insights and opinions of scholars or individuals with specialized knowledge of Islamic teachings and laws. These experts play an essential role in facilitating participants' self-learning, knowledge curation, and the refinement of their understanding of menstruation from a religious lens. As illustrated in the visual representation of our findings (see Fig 5.4), every participant included a religious figure within their support network, underscoring the role of religious authority in navigating menstrual health challenges. Additionally, as participants sought religiously aligned and culturally congruent answers to their menstrual health questions through self-directed learning and knowledge refinement, a potential design consideration could involve developing a social matching technology. Previous work, has explored technology for social matching and collaboration [218, 219, 220, 221] in different contexts e.g., matching for user-safety [221], context-aware social matching [220], and academic researcher matching [218]. This technology would connect individuals with scholars, religious experts, or even trusted friends whom they consider to be more knowledgeable or better suited to address their specific informational or health-related needs. Social matching would be particularly valuable in contexts where Muslim women seek guidance that aligns with religious beliefs. For instance, social matching could help women identify female Islamic scholars or knowledgeable individuals, including friends within their support network, who not only understand their social context—such as the unique challenges of living as a Muslim woman in the West—but also share their fiqh (Islamic jurisprudence) perspective and other commonalities like age, language, and similar life experiences. Participants also highlighted the importance of fostering collaboration between medical providers and Islamic scholars. This collaborative approach would not only ensure that medical advice is culturally and religiously aligned but also promote holistic health by integrating religious and community

support. This collaborative approach to providing healthcare (as illustrated in Section 5.4.3 and Figure 5.5) would cater to the comprehensive needs of Muslim women, bridging the gap between medical expertise and religious guidance.

While human experts are the primary source of religious information and guidance, Large Language Models (LLM) can serve as a supplementary information source. Generative AI tools could offer foundational support in helping individuals during the initial stages of menarche, learning the process of ghusl (ritual purification), or understanding basic Islamic tenets surrounding menstruation. However, a few participants expressed concerns about the accuracy of AI-generated religious responses, particularly when interpretations could be blended with non-religious or secular perspectives (Section 5.4.3). It is therefore necessary to incorporate design principles for "Appropriate Trust & Reliance," as described by Weisz et al. [222], particularly the use of friction to prevent over-reliance on Generative AI. This friction helps users discern when to trust or question the AI system's outputs by encouraging skepticism about potential quality issues, inaccuracies, biases, and under-representation. Design principles for trust and reliance are important in the context of menstruation, where religious laws and guidance are often interpreted based on each individual's unique situation, as highlighted by Ibrahim et al. [14]. While AI can offer support, it should serve as a supplementary tool rather than a primary source of religious information. To support practicing individuals make religiously informed decisions about their health care, HCI researchers and designers should consider designing socio-religious technologies that incorporate access to and guidance from recognized religious scholars alongside AI models' suggestions or recommendations, maintaining a balanced reliance on both AI and human expertise.

5.6 Methodological Reflection

Conducting an onboarding call before integrating participants into the ARC study proved invaluable in creating a comfortable environment where participants felt at ease sharing aspects of their lives beyond the scope of the study itself. While the Zoom call was designed to facilitate enrolling participants into the study, the secondary effect of meeting the research team face-to-face had additional benefits. Being able to see that members of the research team were ”people like them” made it possible for them to feel comfortable sharing information about their intimate health. Additionally, this openness led to participants feeling comfortable sharing significant personal milestones that impacted their ability to complete activities on time, such as the birth of a child, a pilgrimage trip, a new marriage, a move to a new home, becoming an aunt, or even a participant who was struggling with the loss of a loved one.

To our knowledge, this is the first study to employ the ARC method for researching faith-based groups. The flexibility inherent in the ARC method allowed us to adapt our study design in response to participants' needs and external challenges. Initially, we planned for the study to run for 8 weeks, but recognizing the impact of religious observances, we provided participants with a 2-week break to accommodate their schedules. In addition to the post visibility challenges [223], we encountered difficulties related to Facebook's algorithm, which limited the visibility of our study activities within the private, closed group. Specifically, participants had to manually adjust the sorting feature to view the most recent posts, as the default setting displayed posts with the most recent comments instead. To address this issue, we created pinned posts that included unique URLs for each activity, ensuring easy access to the most current content. 24 hours after posting a new activity, we sent an email to

all participants containing the unique link to the activity. This email served two purposes: it acted as a reminder for participants and provided a direct, convenient way to access the latest activity. These strategies enabled us to maintain participant engagement and ensure the continuity of the study despite the challenges encountered. To solicit participants' feedback on the study experience, we collected feedback from the participants once all of the study activities were completed. From their feedback, they shared how participating in the study, and engaging with other participants improved their knowledge about intimate health and religious intersection. Participants also highlighted how engagement in the study offered them the opportunity to share religious resources with each other, discuss their challenges, and help bridge the existing gap in their knowledge on health and religious issues. Regarding feedback on the overall study design, participants had mixed reactions with some appreciating the flexibility of online participation, while others suggested that pacing the activity would have been preferred allowing for more time in between each posted activity. The overall feedback was positive, and participants strongly appreciated the study's design and the emotional and intellectual benefits received from the activities.

5.7 Limitations

One limitation of our study is its skew toward participants who had Facebook accounts. Although participants were required to have a Facebook account to participate, we did receive interest and enrollment from individuals who created accounts specifically to join our study. It is unclear how our choice of platform specifically impacted the study however, it is worth noting that our participants had varying levels of familiarity with the platform before engaging in the study, and that the mix of experiences potentially impacted participation. Another limitation of our investigation is that we did not directly engage with individuals

transitioning from adolescence to womanhood, our work is retrospective. Moving forward, we are interested in working with adolescents experiencing menarche to learn more about their experiences while they are actively engaged in navigating the menarche experience.

5.8 Conclusion

We conducted a 10-week ARC study where 14 menstruating observant cisgender Muslim women engaged with up to 15 different activities to explore their experiences of menarche and menstruation. We uncover how Muslim girls are prepared for the experience of menarche through early education from religious perspectives. We also reveal tensions that arise from religious education about menarche. In addition to early religious education about menstruation, Muslim women actively seek out and refine their knowledge of menstruation often forming support networks. Additionally, we present our participants' design ideas that illustrate how they envision socio-religious technologies supporting their menstruation experience within the context of their religion. Building on our findings, we discuss how socio-religious technology can help Muslim women's experiences of menstruation by fostering menarche education and supporting the religious information ecosystem. We envision that HCI researchers and designers could further explore these implications in designing technologies to support practicing menstruating Muslims.

5.9 Summary of Contributions

Our study uncovers how Muslim girls are prepared for the menarche experience and how Muslim women integrate menstruation as part of their lives by creating and refining their knowledge of the menstruation experience in Islam. Our research makes the following contributions to the HCI literature: To offer insights into how to design solutions that can

better align with Muslim women's menarche and menstrual experiences, we **first** highlight the foundational understanding from experienced menstruating muslim women of how religious teachings, family dynamics, and early education influence Muslim girls' preparation for menarche and how Muslim women navigate their complex menstrual experiences within religious guidelines. **Secondly**, we present participants' design concepts that address the religious and health needs of Muslim women, emphasizing collaboration between medical professionals and Islamic scholars, fostering community support, and developing AI-powered tools for holistic health and religious guidance. **Finally**, we discuss ways in which technology can be leveraged to enhance menarche education and to foster an information ecosystem that facilitates the integration of religious knowledge and health information for navigating the complexities of menarche and menstruation.

CHAPTER 6

Discussion and Future Work

The findings and discussions across the three core studies that comprise this dissertation have collectively facilitated a deeper understanding of the various actors, influencing factors, and key stakeholders shaping the menstrual experiences of Muslim individuals. A central theoretical contribution emerging from my work is the development of the Muslim Menstruator Ecological Model, which serves as a valuable framework for analyzing the lived menstrual experiences of Muslim women through both health-related and religious lenses. This model is informed by Bronfenbrenner's ecological systems theory [224], which conceptualizes individual development and health behaviors as products of dynamic interactions within nested environmental systems—from proximal settings such as family and community, to distal influences including cultural norms and institutional structures. In constructing this model, I took into account the various stakeholders, actors, and factors influencing the Muslim menstrual experience, as identified in the preceding studies within this dissertation. I also adapted Bronfenbrenner's framework to reflect the unique intersections of faith, health, and social context that shape the lives of Muslim menstruators.

The following subsections elaborate on these ecological layers, identifying both potential avenues for intervention and design considerations that attend to the complex, multidimensional nature of menstrual health in religiously grounded contexts.

6.1 The Muslim Menstruator Ecological Model

Figure 6.2 presents an Ecological Systems Theory (EST) framework applied to menstrual health and tracking practices among menstruating Muslim populations. EST framework provides both an appropriate lens and critical analysis of existing menstrual lived experience. First, EST highlights the bidirectional relationships between individuals, healthcare providers, partners/spouses, peer networks, and family support structures, religious values and stakeholders, while emphasizing how religious dictates and guidelines both influence and are influenced by these interconnected relationships. Secondly, it acknowledges the considerable efforts and negotiation challenges undertaken by Muslim menstruating individuals as they coordinate their health and wellness across both religious requirements and health considerations. Third, I highlight how broader societal, cultural, and religious contexts influencing lived menstrual experiences of Muslim women. Through this ecological analysis, the interplay between menstrual health management, technological mediation, health, and religious perspectives becomes more clearly articulated.

6.2 Micro-Level: Individual Menstrual Experience and Islamic Context

The micro-level is the foundational layer of Bronfenbrenner's ecological model. At this level, it includes the individual with their unique constellation of personal attributes and experiences. This innermost system includes defining characteristics such as age, gender, life experiences, cultural background, and religious identity—particularly whether one is born into a Muslim family (born-muslim) or has embraced Islam later in life (sometimes called "convert/revert" to Islam). Micro-level holds special significance when viewed through an Islamic lens, as each person navigates their own distinctive spiritual journey. The degree to which Islamic principles shape an individual's life varies considerably based

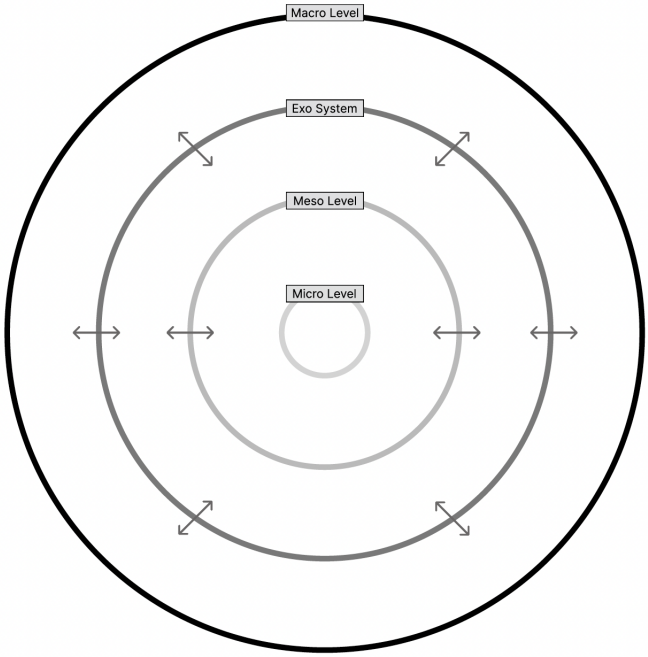

Figure 6.1: Bronfenbrenner's Ecological Systems Theory (EST) Model [224]

on their religious commitment and practice. For instance, Islamic rulings regarding menstruation—such as exemption from certain religious obligations during menstrual periods may profoundly influence the daily routines of devout Muslim women, while having minimal impact on those who do not adhere to Islamic practices. Similarly, the socio-cultural transitions that accompany menarche in Muslim contexts, including adopting the hijab and navigating Islamic guidelines and exemptions—create significant milestones in the lives of practicing Muslim teenagers. These transitions hold substantial meaning and impact for those who actively embrace Islamic practices, yet carry considerably less significance for individuals whose daily lives do not incorporate Islamic observance.

The micro-level also includes biological dimensions. These include physiological experiences such as menstrual symptoms (headaches, abdominal cramps, mood changes), the intensity of menstrual pain, cycle duration and regularity, and hormonal fluctuations. These

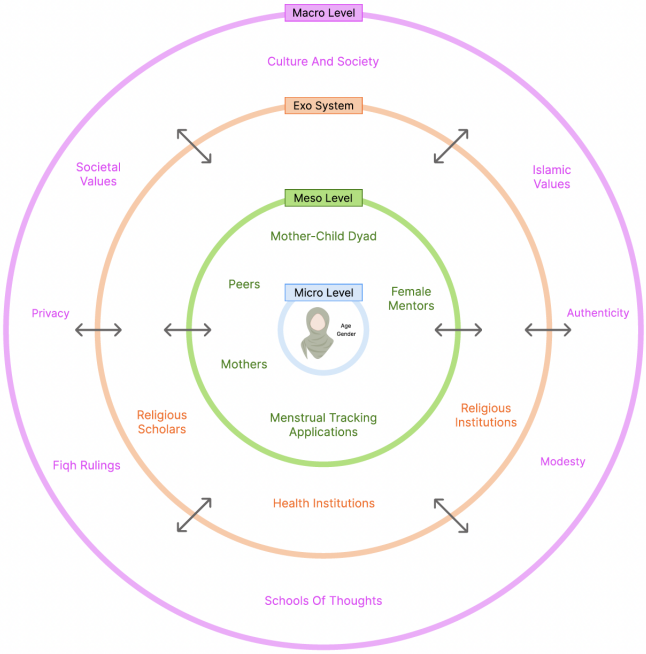

Figure 6.2: Bronfenbrenner's Ecological Systems Theory (EST) Model Applied To Muslim Menstruation

biological factors interact with spiritual and cultural dimensions to shape how individuals experience and manage their menstrual cycles. At this level, individuals develop their own distinct attitudes and beliefs about menstruation, as well as varying degrees of self-efficacy regarding menstrual management. This intricate interplay between physical experiences, personal beliefs, and management capabilities influences how menstruation affects daily functioning across various domains of life. The impact may manifest in work performance, school attendance, social interactions, and overall quality of life. For some, severe symptoms might necessitate accommodations in educational or professional settings, while others may experience minimal disruption to their routines. Through this nuanced understanding of the micro-level, we can appreciate how biological realities, religious practice, and personal identity converge to create highly individualized experiences of menstruation

within Islamic contexts.

Micro-Level Design Considerations: At the micro level, personal health informatics tools can assist in managing and tracking biological experiences such as headaches, abdominal pain, and cramps. A culturally responsive personal health informatics tool would first collect key identifiers, such as religious affiliation, or offer users the option to opt into or out of features that align with or conflict with their religious beliefs. This approach allows for more personalized and supportive experiences. This identifier functions similarly to how menstrual tracking and health apps currently collect information such as age during initial sign-up.

By incorporating such micro-level design considerations, these tools could have a long-term impact. For instance, integrating identifiers like age and religious affiliation could enable the adoption of an educational framework that incorporates essential aspects of religious well-being. Interventions supporting menarche could take an educational approach, helping young girls understand the expectations that become relevant as they enter adolescence. Additionally, for women who convert to Islam later in life or begin practicing at a later stage, these micro-level interventions could provide tailored educational content to help them catch up with religious guidelines on menstruation—knowledge that is often introduced during teenage years.

6.3 Meso-Level: Interpersonal Relationships & Support Systems For Menstrual Experiences

In the meso-level of Bronfenbrenner's ecological model, we observe the critical support structures and interpersonal interactions that shape the individual's experience. This level highlights the connections between various microsystems in which the individual actively

participates. Family relationships form a central component of this level, particularly the influential role of female mentors such as mothers, aunts, and older sisters. These relationships serve as primary channels for menstrual education, where knowledge transfer occurs through both formal instruction and informal storytelling (Chapter 5). Female family members transmit not only practical information about menstrual management but also convey religious perspectives on menstruation in Islamic contexts, helping younger generations understand both the biological and religious dimensions of menstruation.

Parent-child interactions represent another significant aspect of the meso-level. Mothers often engage in collaborative menstrual tracking with their daughters, supporting them in developing personal religious practices while navigating menstrual cycles (as seen in Chapter 4). This joint tracking activity facilitates adherence to religious obligations while fostering open communication about menstruation. Additionally, even as children mature into teenagers and young adults, many continue to seek guidance, and emotional support from parents regarding menstrual concerns, demonstrating the enduring influence of these relationships.

Peer interactions add another dimension to the meso-level. Within Muslim communities, young women may share experiences and knowledge about managing menstruation within religious frameworks. These peer relationships can provide validation, normalize experiences, and offer practical advice that complements parental guidance. The nature of peer support varies significantly across contexts. Some Muslim women actively seek out trusted social circles composed of like-minded faith -based individuals who share their religious values (as described in Chapter 5, Section 5.5.2). These self-selected support networks create safe spaces where women can discuss intimate health concerns while maintaining religious principles of modesty and appropriate conversation.

Digital platforms, particularly menstrual tracking apps with social forums, introduce

additional complexity to peer interactions. Within these spaces, Muslim women often face challenging value negotiations—balancing the desire for educational information against religious guidelines regarding modesty in conversation. The anonymous nature of many digital forums can both facilitate more open discussions and create tensions with Islamic etiquette. These online communities frequently include conversations about intimate topics such as sexual partners and sexual activities—discussions that may conflict with Islamic guidelines for appropriate conversation. The anonymous interactions with strangers in digital spaces can sometimes contradict religious principles regarding modesty and appropriate discourse, forcing Muslim women to carefully navigate these platforms and selectively engage with content that aligns with their religious values while avoiding aspects that contradict Islamic guidance.

The meso-level also reveals how religious exemptions during menstruation influence social planning and interactions. Some Muslim women strategically schedule social activities with non-Muslim friends during their menstrual periods, taking advantage of temporary exemptions from prayer obligations to participate more freely in events without concerns about missing prayer times. This demonstrates how religious practices at the micro-level interact with social relationships at the meso-level to shape behavioral patterns. Family dynamics significantly influence the quality of menstrual education and communication. In some families, open discussions create supportive environments where menstruation is treated as a natural process deserving of respect and accommodation. In contrast, other family systems may perpetuate stigma and silence around menstruation, limiting access to information and emotional support. These contrasting approaches within the meso-level can profoundly impact how individuals conceptualize and manage their menstrual experiences.

Meso-Level Design Considerations: Many of the design principles and concepts discussed in Chapter 5, particularly those related to supporting information-seeking ecosystems on menstruation, align with this level. However, enhancing personal health informatics systems for information-seeking requires incorporating the values emphasized by participants in Chapters 3 and 4. These key values include reflection, modesty, privacy, authenticity, and adherence to different schools of thought (or fiqh rulings). Additionally, this level presents opportunities to design effective tracking features for menstruation. For instance, long-term tracking support could assist women in managing missed fasts due to menstruation, extending to those missed due to pregnancy as well. Moreover, collaborative tracking features—such as mother-child dyads, peer tracking, and partner support—could enhance usability and foster a more supportive experience. Another important design consideration is reducing stigma, particularly for Muslim individuals who may still face societal or cultural taboos surrounding menstruation.

6.4 Exo-Level: Navigating Institutional, Social, and Technological Spaces

The exo-layer of Bronfenbrenner's ecological model revolves around the broader institutional, social, and technological environments that significantly impact menstruating Muslims, even when individuals do not directly participate in their development. This layer reveals critical gaps in how existing structures accommodate the intersection of menstruation and religious practices. Healthcare systems frequently operate with limited awareness of how religious observance intertwines with menstrual health. Medical protocols and health education rarely acknowledge the religious implications of menstrual cycle variations, creating a disconnect for practicing Muslims. This oversight becomes particularly significant for individuals experiencing extended menstrual bleeding, where determining

when bleeding transitions from menstruation (which exempts from religious obligations) to non-menstrual bleeding (which requires resumption of religious practices) becomes critically important for religious adherence. Workplace and educational institutions similarly demonstrate limited accommodation for the dual considerations of menstruation and religious practice. Muslim athletes, for instance, navigate complex challenges when managing both the physical demands of sports and religious obligations affected by menstruation. Training schedules, competition calendars, and facility designs rarely account for these intersecting needs, placing additional burden on individuals to develop personal adaptation strategies.

As highlighted in previous chapters 3, 4 and 5, the technological challenges presents perhaps the most evident gap. Menstrual tracking applications, despite their growing sophistication, typically fail to integrate religious dimensions of menstrual management. These apps often provide comprehensive health guidance—recommending appropriate foods, rest practices, and physical care during menstruation—yet neglect spiritual wellbeing considerations. They rarely offer functionality to track religiously significant events affected by menstruation, such as missed fasting days requiring makeup, temporary prayer exemptions, or guidance for maintaining spiritual connection during periods of exemption from formal worship. Furthermore, these technological solutions typically lack integration with culturally informed religious experts. From an Islamic perspective, holistic wellness includes both physical and spiritual dimensions, requiring guidance from knowledgeable religious authorities who understand the nuanced interplay between menstrual health and religious practice. The absence of this integrated approach leaves many menstruating Muslim women without technological support for a significant aspect of their menstrual experience. This technological gap extends beyond Islamic communities to other faith traditions where menstruation may impact religious participation. Developing more inclusive technological

solutions with religion-specific customization options and access to appropriate religious expertise could better serve diverse communities experiencing similar challenges at the intersection of menstruation and spiritual practice.

Exo-Level Design Considerations: At this level, we explore how to support menstruating Muslims within broader institutional, social, and technological spheres. For instance, institutions and social frameworks could consider the unique needs of menstruating Muslim athletes, ensuring that support systems accommodate their religious guidelines while promoting inclusivity in sports and physical activities. Also, a holistic and collaborative approach to menstrual health care could be integrated at this level, as recommended in the design concepts presented in Chapter 5. This may involve fostering interdisciplinary collaboration between healthcare providers, religious scholars, educators, and technology developers to create culturally responsive and faith-sensitive health informatics solutions (Chapter 5).

6.5 Macro-Level: Broader Religious Values, Societal Influences and Values

At the macro-level of Bronfenbrenner's ecological model, the broad religious, societal, and cultural value fundamentally shape how menstruating individuals interact with technology. This level includes overarching ideologies, belief systems, cultural norms, and religious guidelines that influence not only personal behaviors but also the design of menstrual technologies and personal health systems. For Muslim individuals, values such as modesty, privacy, and gendered interaction deeply affect Muslim women's use of menstrual tracking and health technologies. These religious principles influence which features on applications are adopted or avoided, what information is sought or shared, and how technological interactions align with spiritual commitments. This macro-level also highlights the influence of

dominant cultural narratives surrounding menstruation. Societies that frame menstruation through lenses of shame and concealment may design technology in ways that reinforce secrecy, while others that recognize menstruation as a natural process might emphasize openness and educational support. However, when Western medical perspectives prioritize fertility tracking and symptom management, they can unconsciously sideline other perspectives such as spiritual dimensions that are integral to many religious communities (For example, tracking to plan for religious pilgrimage as seen in Chapter 3). As a result, technologies can struggle to meet the holistic needs of menstruating Muslim individuals. Societal expectations surrounding gender roles and technology use further complicate the landscape for religious women. Tools developed primarily by and for secular Western contexts may unintentionally exacerbate cultural gaps, particularly when they neglect religious sensitivities or embed values at odds with Islamic principles.

Personal informatics tools often reflect these macro-level values, either facilitating inclusive engagement through culturally responsive designs or impeding it by assuming norms incompatible with certain religious values. When technologies respect religious observance, address privacy concerns, and honor cultural contexts, they affirm and integrate individuals' identities and thus adopt what To et al. [157] refers to as "designing for flourishing"—*looking at the attributes that make an individual or community unique as opportunities for amplifying their goals and identities through creative collaboration*. Alternatively, when these cultural and religious considerations that make individuals and communities unique are disregarded, individuals may feel pressured to compromise core values or forgo technological benefits entirely. By recognizing that even "neutral" design decisions, embed certain values, are shaped by deeply rooted cultural and religious norms, developers can create more inclusive menstrual health technologies that acknowledge and respect a diversity of worldviews.

Macro-Level Design Considerations: The macro level exerts significant influence on the other levels, shaping the broader context in which personal health informatics solutions are developed. As such, it is crucial for designers and researchers to understand the underlying values at this level and how they operate, as this insight will inform the design of digital health tools. Researchers [225, 147] emphasize the importance of value-sensitive design, urging us to consider how macro-level values influence, constrain, or promote the solutions we create. By integrating these values into the design process, we can ensure that digital health systems are not only technically effective but also socially and culturally relevant.

6.6 Potential Future Work

Given my findings and discussions within Chapters 3, 4, and 5, I present two potential areas for future research for scholars conducting studies that build upon my work. The first research direction builds on the design implications and considerations for menstrual technology presented throughout this dissertation. A logical next step would be developing and field-testing a menstrual application incorporating these recommendations among Muslim women to evaluate its effectiveness in supporting their health and wellness goals. This field deployment should include prototype development with features specifically addressing religious considerations, longitudinal user studies with diverse groups of Muslim women, and impact assessment measuring outcomes related to religious practice satisfaction and overall wellbeing. Although designed primarily for Muslim women, investigating how other faith communities with similar menstrual dictates might adopt this technology would prevent ”othering” while revealing insights about universal design elements and faith-specific requirements. Establishing methodologies for continuously incorporating user feedback and evolving religious interpretations would ensure the technology remains relevant.

The second direction emerges from the mother-child dynamics revealed in Chapters 3 and 4. These chapters demonstrated how mothers strategically support their children in fulfilling religious obligations through collaborative tracking and how maternal figures employ storytelling as a pedagogical approach to transmit religious teachings about menstruation. These findings highlight unique opportunities for advancing family informatics research within Muslim households. Future studies could explore the development of collaborative digital platforms that facilitate shared tracking between mothers and daughters, storytelling/narrative educational tools that preserve religious teachings, privacy-conscious family sharing systems, and technologies that support intergenerational religious knowledge transfer. Critically, these knowledge transfer mechanisms must prioritize authenticity and incorporate robust verification methods for validating transmitted information. This emphasis on authenticity becomes particularly relevant in the contemporary AI era, where tensions may emerge around information reliability—a concern of paramount importance in Islamic knowledge transmission. Islamic traditions place significant value on establishing credible chains of knowledge transfer (*isnad*), authenticating sources, and verifying religious information before adoption or further dissemination. Longitudinal research examining how these mother-daughter knowledge practices evolve over time would provide valuable insights into the dynamic nature of religious education within families, especially as technological mediators increasingly influence traditional knowledge transfer pathways. Such research could illuminate how families navigate the intersection of technological convenience and religious authenticity requirements across generations.

CHAPTER 7

Conclusion

My dissertation addresses a critical gap in HCI research by examining the complex interrelationship between menstruation, technology, and Islamic religious practice. Despite the recent proliferation of menstrual research in HCI, the menstrual lived experiences of faith-based individuals have remained largely unexplored, resulting in technological solutions that fail to provide comprehensive support for those whose menstrual experiences are simultaneously shaped by health considerations and religious commitments. Through three methodologically rigorous exploratory studies, my dissertation research illuminates the multifaceted nature of Muslim women's menstrual experiences. The investigation yields several significant findings: **First**, existing menstrual applications demonstrate fundamental limitations in accommodating religion-specific needs, creating barriers to technology adoption and sustained engagement for Muslim women. **Second**, this muslim menstruators exhibits distinct tracking motivations that diverge from conventional assumptions in menstrual technology design. Tracking to support religious adherence and to navigate worship exemptions emerges as a important motivation in addition to the health tracking motivations. **Third**, unique menstrual challenges manifest in religious contexts, particularly during observances such as Ramadan, which require specialized technological support currently unavailable in mainstream applications. **Fourth**, menarche education and knowledge acquisition follow distinct pathways within religious frameworks, with Muslim women developing sophisticated strategies to negotiate the delicate balance between health management and religious observance throughout their menstrual journeys. **Fifth**, through partic-

ipatory efforts, muslim menstruators have been able to envision ways in which technology can better support and provide a more holistic and comprehensive health that is inclusive of their religious beliefs and values.

By examining these nuances in depth, my research disrupts the tendency to ”other” religious menstruators and establishes a foundation for more personalized menstrual health technology- and by extension, personal health technologies- that holistically address diverse needs. The findings demonstrate how technological design that acknowledges religious dimensions of menstruation can enhance both user experience and health outcomes. Furthermore, my dissertation presents design considerations for developing inclusive and culturally responsive menstrual technologies. It emphasizes the paramount importance of designing while considering values that are important to individuals to foster adoption, eliminate alienation and prevent abandonment of technologies. My research articulates how individuals/users' value systems fundamentally shape their interaction with technologies and specific features within those technologies. Also, my research further highlights opportunities for enhancing menstrual health support through education by strategically leveraging existing information-seeking networks while respecting the religious boundaries that individuals voluntarily maintain. This approach recognizes the agency of users while providing enhanced technological support within their chosen value frameworks. In my discussion, I presented my theoretical contribution—the ecological model of the Muslim menstruator—which examines the experiences and interactions involved in lived menstrual experiences for Muslim women, considering both health and religious perspectives. Through the different layers of the muslim menstruator ecological model, I offer opportunities for intervention and design considerations that acknowledge the multidimensional nature of menstrual health within religious contexts. Ultimately, my research advances both the empirical understanding of menstrual experiences and the practical application of this knowledge in

HCI, contributing to more inclusive, values-centric, and culturally sensitive technology design.

CHAPTER 8

Reflection on My PhD Journey

8.1 How It All Began

My doctoral journey began with a clear focus on researching rare medical conditions, an interest shaped by my previous work at Genentech's Personalized Healthcare Informatics division, where I contributed to the development of a product for individuals with rare cancers. This direction aligned with my academic and professional background, including a Master of Public Health from the University of California, Berkeley, and roles at Massachusetts General Hospital and the health start-up ConnectMed South Africa. Collectively, these experiences reinforced my commitment to pursuing a health-centered research trajectory. However, shortly after visiting Indiana University in February 2020, the emergence of the COVID-19 pandemic and the imposition of global lockdowns presented an unexpected turning point. I was faced with a difficult decision: to begin the Ph.D. program under highly uncertain conditions, to defer my enrollment, or to pursue an alternative path. Ultimately, I chose to proceed. As a result, I began the program remotely from Nigeria during the Fall 2020 semester, navigating the complexities of virtual coursework, substantial time zone differences, and the broader challenges of adjusting to remote doctoral training during a global health crisis.

Despite the initial challenges, the disruptions of the pandemic also prompted a deeper reflection on the types of health inequities I wanted to address through my research. While I had initially intended to focus on rare conditions, I found myself increasingly drawn to issues situated at the intersection of health, identity, and community—particularly those that

remained understudied in mainstream health research. This shift was also informed by my personal values as a community-engaged and faith-oriented individual, as well as a growing awareness of the cultural and religious dimensions that shape health experiences. This evolving perspective led me to focus my dissertation on the menstrual health experiences of Muslim women—an area that is both underrepresented in HCI research and situated at the confluence of health, religion, and social norms.

8.2 Deciding on Research Trajectory

I did not initially anticipate that my research would focus on the intersection of religion and health. Yet, in hindsight, the trajectory that led me to this area now feels both coherent and deeply personal. Throughout my academic and professional journey, I have been drawn to a broad range of interests, driven by intellectual curiosity, a willingness to take on complex challenges, and a strong commitment to community service. As a person of faith, I have long been motivated by a desire to give back to my community in meaningful ways. My dissertation became an opportunity to integrate these values, serving both as a platform to support the Muslim community and as a bridge between Muslim lived experiences and broader research and design discourses.

This shift in research focus was further informed by my engagement with HCI literature in women's health. A recurring theme in this body of work was the persistent underrepresentation of cultural and religious diversity, particularly in relation to how health technologies are designed and studied. These gaps underscored the need for more inclusive, contextually grounded scholarship. Confronted with this oversight, I felt compelled to respond—both by amplifying marginalized voices and by producing research that recognizes and respects the multifaceted nature of identity in health-related experiences. In doing so,

I positioned my work at the intersection of HCI, health, technology and and faith-based community engagement.

8.3 Challenges

The first two and a half years of my Ph.D. program were marked by considerable professional and logistical challenges, including repeated setbacks in securing academic publications, internship placements, and external research funding. One of the most persistent obstacles I encountered was the difficulty of obtaining sufficient resources to ethically compensate research participants—a principle I consider fundamental to conducting responsible and respectful research. In response, I sought alternative and creative funding avenues, eventually becoming a faculty mentor through Indiana University's Center of Excellence for Women & Technology (CEWIT). In this role, I guided undergraduate emerging scholars through a year-long research program, which also provided access to mentorship-related research funds. While the mentorship experience was personally and intellectually rewarding, the associated funding played a critical role in sustaining my research activities, including participant compensation and other necessary expenses.

Navigating these early challenges would not have been possible without the steadfast support of my mentors: Dr. Katie Siek, Dr. Jacob Abbott, and Dr. James Clawson—whose guidance and encouragement were instrumental throughout my doctoral journey. Their mentorship helped sustain my motivation through periods of uncertainty and rejection. This perseverance eventually culminated in a breakthrough year at CHI 2024, where several of my previously rejected submissions were accepted in a single cycle [14, 15, 226, 227, 228]. Additionally, I secured a research internship at Microsoft Research under the mentorship of Dr. Mary Gray, who later extended a second internship opportunity. Together, these

experiences reinforced an enduring lesson: rejections are not denials but often part of a longer arc of growth, learning, and eventual success. One of the more subtle but ongoing challenges I faced during this time was navigating the Ph.D. journey largely on my own within the Healthcare Journeys Lab, where I was the sole doctoral student. This sense of academic isolation led me to actively seek support from peers in the broader ProHealth Lab community, where I found both intellectual companionship and emotional solidarity. These connections were invaluable in helping me stay grounded and engaged during the more solitary phases of the doctoral process. I am deeply grateful to my fellow ProHealth Ph.D. colleagues for their camaraderie, support, and the meaningful memories we shared throughout this journey.

8.4 Opportunities and Collaborations

To cultivate and sustain my broader research interests throughout my doctoral studies, I actively sought collaborations with scholars both within and beyond Indiana University. These interdisciplinary partnerships allowed me to diversify my research portfolio and contribute to a range of scholarly publications. Notable outcomes from these collaborations include work on gestational diabetes [226], methodological insights from conducting systematic reviews [229], and investigations into addressing fraudulent participants in research studies [228, 230]. I was particularly fortunate to receive mentorship from Dr. Katie Siek, whose support has been instrumental in shaping my academic development. Under her guidance, I was invited to participate in the Computing Community Consortium (CCC) workshops—unique opportunities that expanded my professional network, allowed me to share my research with a wider audience, and deepened my understanding of how academic scholarship can influence public policy. During my Ph.D. journey, I attended two CCC

workshops: (1) *Future of Pandemic Prevention and Response* in September 2023 [231], and (2) *Supporting At-Risk Users through Responsible Computing* in December 2024. These engagements enriched my research perspective and reinforced my commitment to socially impactful, community-centered work.

Beyond my doctoral training, I am eager to remain actively engaged in HCI and deeply committed to amplifying the perspectives of underrepresented and traditionally marginalized groups in HCI research and design conversations.

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8.5 Appendix

This section includes the study instruments used in each of the three studies presented in Chapters 3, 4, and 5. For Chapter 3, I include the Qualtrics survey and the interview script used in the menstrual tracking study. For Chapter 4, I provide sample Qualtrics surveys used for the Daily Log (DL) and the Reflection Log (RL). For Chapter 5, I present the weekly prompts used in the Asynchronous Remote Communities (ARC) study, along with sample screenshots of Facebook posts shared during the study.

8.5.1 Supplementary Materials For Chapter 3

Qualtrics Survey: Menstrual Tracking

1. As best as you can remember, how old were you when you first got your period?

2. Do you try to keep a record of when your period has happened?

    - Yes
    - No
    - Sometimes
    - I do not get my period anymore

3. Do you try to predict when your next period will be?

    - Yes
    - No
    - Sometimes
    - I don't get my period anymore

4. How do you know when your next period will be?

5. What app do you use to keep track?

    - App
    - Calendar
    - Paper System
    - Memory / "I simply remember"

Tracking Behaviors

1. Why do you keep track of your period?

2. Please describe your method for keeping track of your period.

Period Frequency & Regularity

1. Are you on birth control that impacts the regularity or duration of your cycle?

    - Yes
    - No
    - Prefer not to disclose

2. How does your birth control impact your period?

3. On average, how long is your period cycle?

    - <24 days
    - 24–38 days
    - >38 days
    - I do not know

4. On average, how long does your period last?

    - Less than 4.5 days
    - 4.5–8 days
    - 8–15 days
    - Greater than 15 days
    - I don't know

5. Is there anything else notable about the frequency or regularity of your period?

Demographics

1. How old are you?

2. What is your race? (Select all that apply)

    - White
    - Black or African American
    - American Indian or Alaska Native
    - Asian
    - Native Hawaiian or Pacific Islander
    - Other

3. What is your annual household income? (If living with roommates, personal income)

    - Less than $25K
    - $25–34.9K
    - $35–49.9K
    - $50–74.9K
    - $75–99.9K
    - $100–124.9K
    - $125–149.9K
    - Greater than $150K

4. What devices do you personally own?

5. What devices do you share with others?

    - Smartphone
    - Desktop / Laptop
    - Tablet
    - Other

6. Country of origin:

7. What is your gender identification?

8. What religion do you identify with? (If none, write “None”)

9. Do you identify as:

    - Practicing Muslim
    - Non-practicing Muslim
    - Other

10. Do you observe any aspect of the Muslim fast (e.g., Ramadan)?

    - Yes
    - Sometimes
    - No

11. Current location (country):

12. Are you willing to be contacted for a one-hour interview over phone or Zoom?

    - Yes
    - Maybe
    - No

13. Please provide your name, email address, or phone number:

8.5.2 Supplementary Materials For Chapter 4

DAILY LOG

Introduction Thank you for taking the time to complete this daily log. You will be required to complete a daily log entry for 10 distinct days. Try to allow 1–2 days to pass between

each entry. Please answer thoroughly; the log should take 8–15 minutes. You will be compensated $5 per completed entry.

Q1. Please enter today's date. (Format: March 23, 2023)

Q2. Please enter your name.

Q3. Enter the daily log number (e.g., "Day 1", "Day 5").

Ramadan/Fasting & Menstruation

Q4. Did you fast yesterday?

- Yes
- No

Q5. Did you track your fasting yesterday?

- Yes
- No

Q6. How did you track your fast?

Q7. Why did you **not** track your fast?

Q8. Were you on your period yesterday?

- Yes
- No

Q9. What were your reasons for abstaining from fasting yesterday?

Faith-related Goals

Q10. What faith-related goals did you track yesterday?

Q11. How did you track these faith-related goals?

Q12. Did you complete your faith-related tracking goals yesterday?

- Yes
- No

Q13. What prevented you from completing your faith-related goal yesterday?

Q14. What challenges did you encounter in tracking your faith-related goals yesterday?

Health-related Goals

Q15. What health-related goals did you track yesterday?

Q16. How do you track the health-related goals you mentioned above?

Q17. Why do you track the health-related goals?

Q18. Did you complete your health-related tracking goals yesterday?

- Yes
- No

Q19. What prevented you from completing your health-related goal yesterday?

Q20. What challenges did you encounter in tracking your health-related goals yesterday?

Other Tracking Experience

Q21. What are your other tracking goals (unrelated to faith or health)?

Q22. Why are these goals important to you?

Q23. **Optional:** Upload a photo of your tracking experience (journal, screenshot, app, etc.).

Do not upload data of others or shared family data.

REFLECTION LOG

Introduction There are two Reflection Logs:

- Complete the first after Daily Log 5.
- Complete the second after Daily Log 10.

Please answer with as much detail as possible. Allow 15–20 minutes to complete.

Q1. Enter today's date:

Q2. Full name:

Q3. Is this your first or second reflection log?

- First Reflection Log
- Second Reflection Log

Tracking Motivations

Q4. Why do you track your faith-related goals?

Q5. Why do you track your health-related goals?

Q6. What is your overall motivation for tracking?

Apps & Tools

Q7. What tools or apps do you use for your faith-related tracking goals?

Q8. What tools or apps do you use for your health-related tracking goals?

Q9. What tools or apps support both your health- and faith-related tracking goals?

Menstruation & Fasting

Q10. On average, how long is your period cycle?

- <24 days
- 24–38 days
- Greater than 38 days
- I don't know

Q11. On average, how long does your period last?

- 4.5–8 days
- 8–12 days
- Greater than 15 days
- I don't know

Q12. Did you have your period during the last 5 DAILY logs?

- Yes
- No

Q13. How has your period in Ramadan shaped what you track?

Q14. Do you think fasting affects menstruation or your cycle?

- Yes
- No

Q15. How does fasting affect your menstruation or menstrual cycle?

Fasting Experience & Tracking

Q16. How has your fasting experience influenced what you track?

Q17. How has your tracking pattern changed due to fasting or other religious obligations?

Reflection

Q18. Describe your overall tracking experience (WHAT, HOW, WHY).

Q19. With whom have you discussed your tracking experiences?

Q20. What did you learn about yourself through this tracking exercise?

Q21. What challenges did you encounter in tracking?

Q22. What could be improved about your tracking experience?

Q23. Upload a photo of your tracking (paper, app, tablet, etc.). Describe the photo.

Q24. Is there anything else you'd like to share about this experience?

8.5.3 Supplementary Materials For Chapter 5

Activity 1B: Demographic Survey

Introduction Thank you so much for taking the time to complete the survey. We encourage you to answer the questions as best as you can, **thoroughly** and **accurately**. This survey will take approximately 20 minutes to complete. **Demographic Information**

Q1. Please enter your full name.

Q2. Age

Q3. Do you identify as:

- Revert
- Born Muslim
- Self-identify (please specify)

Q4. Do you consider yourself a practicing Muslim?

- Yes
- No
- Other (please specify)

Q5. How long have you been practicing the faith (Islam)?

Q6. Ethnicity:

- White / Caucasian
- Asian
- Native Hawaiian or Other Pacific Islander
- Hispanic or Latino
- American Indian or Alaskan Native
- Black or African American

Tracking Experience

Q7. What aspect of women's health do you track?

- Menstruation
- Fertility
- Hormonal Change
- Other (specify)

Q8. What are your motivations for tracking these aspects of women's health?

Q9. How long have you been tracking aspects of your women's health?

- 0–3 months
- 3–6 months
- 6–12 months
- 1–3 years
- 3+ years

Q10. Do you experience menstrual periods longer than 10 days (1.5 weeks)?

- Yes
- No
- Sometimes

Q11. Please specify if you have any women's reproductive health concerns (e.g., PCOS, Endometriosis).

Q12. How do you track your menstrual cycle?

- App (specify)
- Birth Control
- I simply remember
- Physical Calendar
- Digital Calendar
- Other (specify)

Fiqh Guidelines

Q13. Are you familiar with any of the following Islamic Fiqh schools?

- Yes
- No

Q14. What Fiqh do you adhere to for menstrual guidelines?

- Maliki
- Hanbali
- Shafi'i
- Hanafi
- Other

Q15. Why do you adhere to the specific guidelines you chose above?

Q16. How did you learn about the Fiqh of menstruation guidelines?

(If you never heard of this until now, please indicate in your response.)

Religious Experience

Q17. Please choose which describes you the most:

(We would like to know what cultures influence your life.)

- I was born in the U.S.
- I migrated to the U.S.
- I have lived in the U.S. for the most part of my life
- Other

Q18. In your immediate family, are you the first-generation of Muslims living in the USA?

- Yes
- No
- Self-describe

Q19. How long have you lived in the US? (in years)

Q20. In your immediate family, are you the second-generation of Muslims living in the USA?

- Yes
- No
- Self-describe

Q21. Please describe your family's religious history.

Q22. How do you gain overall religious information?

Social Media Use

Q23. How frequently do you use or engage with the following social media platforms?

Platform	Once a Day	Multiple Times a Day	Once a Week	Multiple Times a Week	Once a Month	**Never**
Facebook						
TikTok						
Instagram						
Reddit						
YouTube						
Twitter/X						
Snapchat						
Other						

End of Survey

Activity 7B: Prototype Testing Feedback

This survey explores your experience with an app-based prototype designed to support your

menstrual health journey as a Muslim woman. You will complete 5 tasks and answer questions about each one.

Task 1: Period Activate Mode

- Log into the app. It will automatically populate your name and navigate you to the home screen.
- Click the "period icon" to activate the period mode.
- Click here to start the task.

Q1. Were you able to activate period mode?

- Yes
- No

Q2. What challenges did you encounter completing Task 1?

Q3. What changes do you want to make?

Task 2: Articles Feature

- Navigate to the articles tab to learn more about Hayd or the fiqh of menstruation.
- Click here to start the task.

Q4. Were you able to navigate to the articles tab?

- Yes
- No

Q5. What challenges did you encounter completing Task 2?

Q6. What changes do you want to make?

Task 3: Support Group Feature

- Navigate to the conversations tab and choose a support group.
- Click here to start the task.

Q7. Were you able to navigate to the support features section?

- Yes
- No

Q8. What challenges did you encounter completing Task 3?

Q9. What changes do you want to make?

Task 4: Scholars Feature

- Navigate to the conversations tab and ask a scholar.
- Click here to start the task.

Q10. Were you able to access the scholars feature?

- Yes
- No

Q11. What challenges did you encounter completing Task 4?

Q12. What changes do you want to make?

Task 5: Tracker Feature

- Navigate to the tracker feature to view how many missed fasting days you have.
- Click here to start the task.

Q13. Were you able to access the tracker feature?

- Yes

- No

Q14. What challenges did you encounter completing Task 5?

Q15. What changes do you want to make?

Additional Feedback

Q16. How would you describe the overall experience/look and feel of the app?

Q17. What additional features would you like to see for the app-based prototype?

Q18. Why would you like to have the additional features?

Q19. Any additional feedback and/or comments?

Q20. Please enter your full name (First/Last).

End of Survey

Activity 8B: Debrief Survey / Final Activity

Introduction Thank you so much for taking the time to complete this survey. This survey wraps up the research and will consist of your feedback on the overall experience. It should take approximately 10–15 minutes to complete. Please answer the questions as best as you can.

Weeks	Activities
1	A1A: Ice breaking [Intro, most recent religious social experience] A1B: Survey – [Demographic information etc. Via Qualtrics]
2	A2A: Scenario – [Menarche Experience, Religious] A2B: Scenario – [Menarche Experience, Health]
3	A3A: Scenario – [Navigating long menstrual length, Religious] A3B: Scenario – [Navigating long menstrual length, Health]
4	A4A: Question Based – [Information/Knowledge Seeking] A4B: Circle Diagram Activity – [Information/Knowledge Seeking]
5	A5A: [Advice Columnist] – A parent's post A5B: [Advice Columnist] – An adult child's post
6	A6: Design Activity I {Letter from the Future}
7	A7: Design Activity II {Designing for 2–3 Prominent themes in A7}
8	A8: Study Wrap up

Q1. What activity did you like the most and why?

Q2. What activity did you like the least and why?

Q3. Pick the activity you'd like to give feedback on (you can choose more than one):

- A1A: Ice breaking
- A1B: Demographic survey
- A2A: Menarche Experience (Religious)
- A2B: Menarche Experience (Health)
- A3A: Navigating Long Menstrual Length (Religious)
- A3B: Navigating Long Menstrual Length (Health)
- A4A: Question-Based (Knowledge Seeking)

- A4B: Circle Diagram Activity (Knowledge Seeking)
- A5A: Advice Columnist – Parent's Post
- A5B: Advice Columnist – Adult Child's Post
- A6: Letter from the Future
- A7: Designing for 2–3 Prominent Themes
- A8: Study Wrap-up

Q4. Please provide any additional overall feedback for the researchers.

Q5. Please enter your full name (First and Last).

End of Survey

Week 1: Activity 1B Survey Completion

Tracking Experience

What aspect of women's health do you track? - Selected Choice

Aspects Tracked	No Of Participants	Out Of 14 Participants
Menstraution	14	
Fertility	5	
Hormonal Changes	4	
Others (Specify)	5	

What aspect of women's health do you track? - Other (Specify): - Text

Other Aspects that are tracked by the participants include:

- Physical symptoms from medical treatments
- Blood sugar
- Steps
- Exercise
- Bowel movements
- Water intake
- Cramps and libido changes
- Mood
- Energy level

What are your motivations for tracking these aspects of women's health?

Motivations for tracking previous aspects of women's health are:

- Adhering to religious requirements, such as making up missed prayers
- Understanding rulings about physical relations during menstrual cycles
- Tracking menstrual cycles
- Managing health conditions such as PCOS and endometriosis effectively
- Adhering to a regimen that promotes good health and well-being
- Identifying overall patterns in health

- Enhancing overall awareness of personal health and fostering a better connection with their bodies
- Connecting with other women about similar, often unspoken, experiences

How long have you been tracking aspects of your women's health?

	Count
3+ years	9
1-3 years	3
6-12 months	1
3-6 months	1
Grand Total	**14**

The 65% of respondents have been tracking aspects of their women's health for over 3 years, indicating a long-term commitment to monitoring their health. While about 21% of the participants have tracked between 1-3 years, 12% for 6-12 months, and 12% for 3-6 months.

What Fiqh do you adhere to for menstrual guidelines? - Selected Choice

	Count
Hanbali	1
Hanafi	3
Maliki	2
Shafi'i	1
Shia	2
None	4
Do not wish to specify	1
Grand Total	**14**

What Fiqh do you adhere to for menstrual guidelines? - Others

Out of all the respondents, the largest proportion, 29%, do not follow any particular fiqh for menstrual rules. This is followed by 22% who adhere to the Hanafi fiqh. Maliki and Shia fiqh

are each adhered to by 14% of participants. Both Hanbali and Shafi'i fiqh are followed by 7% of the participants each.

Why do you adhere to the specific guidelines you chose above?

The reasons for adhering to specific menstrual guidelines vary among individuals.

- Many follow the guidelines they grew up with, aligning with their beliefs of Islam and sticking to the fiqh they initially learned.
- Family influence plays a significant role, with some adhering to the school of thought their family follows or consulting with the imam's wife for guidance.
- Personal religious convictions also guide adherence, while a lack of knowledge about differences between schools of thought leads some to follow what they know.
- Community influence, such as the Senegalese community following the Maliki madhab, also affects adherence.
- Others inherit religious practices from their family or find a particular practice the most logical.
- Some do not specify their adherence due to the perceived insignificance of the differences, while others were taught a specific practice and find it makes the most logical sense.

How did you learn about the Fiqh of menstruation guidelines? If you never heard of this until now, please indicate in the response.

Respondents' adherence to specific Islamic Fiqh is primarily influenced by:

- Cultural heritage and familial traditions, demonstrating a strong tie between community practices and individual religious observances.
- Education also plays a crucial role, as many follow teachings specific to their community or learned through religious schooling.
- Some base their adherence on personal convictions and the logical coherence of the teachings with their beliefs, while others acknowledge a lack of detailed knowledge about the differences among Fiqh, affecting their ability to adhere to a specific one.

Religious Experience

Please choose which describes you the most (We would like to know what cultures influence your life): - Selected Choice

	Count
I was born in the U.S.	7
I migrated to the U.S.	3
I have lived in the U.S. for the most	2
Other	2
Grand Total	**14**

The majority of respondents (50%) were born in the U.S., while a smaller percentage (22%) migrated to the U.S. An equal percentage (14%) either have lived in the U.S. for the most part or fall under the "Other" category. The other includes an International student studying in the U.S. and individuals born in Canada who have lived in the U.S. for the last 4 years.

In your immediate family, are you the first-generation of Muslims living in the USA? - Selected Choice

	Count
First Generation	7
Second Generation	5
Self-describe	1
Grand Total	**14**

In your immediate family, are you the second-generation of Muslims living in the USA? - Selected Choice

The majority of respondents (50%) are first-generation Muslims living in the USA, followed by 36% who are second-generation Muslims.

How do you gain overall religious information?

Respondents gain their overall religious information through various ways:

- Many attend masjid lectures, classes led by Islamic scholars, retreats, and workshops, occasionally supplemented by Google searches.
- Formal education through engaging in Quran translations, Tafseer classes, and attending institutes like Maryam. Islamic education at school, weekend school, and the internet also contribute to their knowledge.
- Family influence is notable, as many receive early education and learn from family members such as dads, sheikhs, uncles, and friends' dads.
- Online resources like YouTube halaqas, Google, and websites from Sheikhs and Institutes like Yaqeen are also utilized.
- Additionally, living a religious routine helps reinforce what is learned academically.

Social Media

How frequently do you use or engage with the following social media?

Social Media Engagement	Count					
	Daily Once	Daily Multiple	Week Once	Week Multiple	Monthly Once	Never
Facebook	1	4	1	3	3	1
Tiktok	1	4	1	0	0	7
Instagram	1	6	0	1	2	3
Reddit	1	0	2	1	3	6
Youtube	5	4	2	2	0	0
Twitter	0	3	1	0	1	8
Snapchat	0	2	1	1	3	6
Others	0	0	0	0	0	0

- YouTube and Instagram are the most actively used platforms daily.
- Facebook and Reddit show moderate engagement, with usage peaking on a weekly or monthly basis.
- TikTok, Twitter, and Snapchat have higher proportions of non-users, suggesting these platforms are less favored or relevant for the surveyed group.

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Bloomington, IN

Education

2020–25*	**Ph.D.**, Informatics, Indiana University Bloomington
2017-19	**MPH**, Public Health, University of California, Berkeley
2010-14	**BA.** Biochemistry, Mount Holyoke College

Research Experience

2020–25*	Graduate Student Researcher, Healthcare Journeys Lab, Indiana University (Advisor: Dr. James Clawson)
2024 Fal.	PhD Research Intern (Fall), SMC Group, Microsoft Research New England (Advisor: Dr.Mary Gray)
2024 Sum.	PhD Research Intern (Summer), SMC Group, Microsoft Research New England (Advisor: Dr.Mary Gray)
2023 Sum.*	Graduate Student Researcher, ProHealth Lab, Indiana University (Advisor: Dr.Katie Siek)

Awards & Honors

2024	Two special recognition for Outstanding CHI 2025 Reviews
2024	Digistars Scholar (University of Utah)
2024	Rising Stars in EECS (Massachusetts Institute of Technology)
2024	Mastercard Foundation Alumni Scholars Impact Fund (Project: Naijacoders $15K)
2024	CHI 2024 Honourable Mention Award (Top 5% Best Paper Award)
2024	NSF-Sponsored ACM CHI 2024 Doctoral Consortium Award ($1700)
2024	IU GPSG Travel Award ($500)
2023	ACM-W Travel Award Scholarship ($1200)
2022	Jose Blakeley Ph.D. Summer Research Award ($4,400)
2022	CRA-WP Grad cohort IDEALS Selected Participant (Twice received: 2022 & 2021)
2022	CRA-WP Grad cohort for Women Selected Participant (Twice received: 2022 & 2021)
2022	Grace Hopper Conference Student Scholarship (Twice received: 2022 & 2021)
2017	MasterCard Foundation Scholarship (Full cost of Master's degree: $140,000 total)
2017	Division of Pulmonary and Critical Care Medicine Citizenship Award ($1500)
2016	Young African Youth in Public Service -2016 Pursuer

*Expected.

2011 Merill Prize

Work Experience

2022-25 Faculty Mentor For IU Emerging Scholars Research Experience Center of Excellence for Women in Technology (CEWIT), Bloomington IN
2024-25 Liason/External Mentor For OLIN SCOPE program, OLIN SCOPE (Senior Capstone Program in Engineering), Cambridge, MA/Remote
2024 Fa. PhD Research Intern (Fall) , Microsoft Research, Cambridge, MA
2024 Su. PhD Research Intern (Summer) , Microsoft Research, Cambridge, MA
2021-25 Assistant Instructor, Indiana University, Bloomington, IN
2021-25 Graduate Student Researcher. Indiana University, Bloomington, IN
2019-20 UX Research Intern, Genentech Inc, South San Francisco, CA
2018 Su. Health & Benefits Intern Grad Intern, Willis Towers Watson, San Francisco, CA
2014-17 Lead Content Editor and Partnerships Manager, Opportunity Desk, Nigeria, Remote
2014-16 African Markets Research Lead, ConnectMed, South Africa, Remote
2014-17. Pulmonary Technologist, Massachusetts General Hospital, Boston, MA

Publications

Google Scholar
† → Equal contribution

Journal Articles

J1. Arash, Z., Michaela, K., **Ibrahim Zaidat**, Forum, M. & Katie, S. Taking Stock of Studies Using Asynchronous Remote Communities (ARC): A Scoping Review. *Interacting With Computers* (2025).

J2. Brown, T. T., Ahn, C., Huang, H. & **Ibrahim, Zaidat**. Reducing the prevalence of low-back pain by reducing the prevalence of psychological distress: Evidence from a natural experiment and implications for health care providers. *Health Services Research* **55,** 631–641 (2020).

Peer-reviewed Conference Proceedings

C1. **Ibrahim, Zaidat**, Caldeira, C. & Chung, C.-F. *Supporting Experiential Learning in People with Gestational Diabetes Mellitus* in *Proceedings of the CHI Conference on Human Factors in Computing Systems* (ACM, Honolulu, HI, USA, 2024). https://doi.org/10.1145/3613904.3642674. *(26.4% acceptance rate).*

C2. **Ibrahim, Zaidat**, Nurain, N. & Clawson, J. *Tracking During Ramadan: Examining the Intersection of Menstrual and Religious Tracking Practices Among Muslim Women in the United States* in *Proceedings of the CHI Conference on Human Factors in Computing Systems* (ACM, Honolulu, HI, USA, 2024). https://doi.org/10.1145/3613904.3642374. *(26.4% acceptance rate)*
–Honorable Mention Award (Top 5% of Best Paper Award).

C3. **Ibrahim, Zaidat**, Panchpor, P., Nurain, N. & Clawson, J. *"Islamically, I am not on my period": A Study of Menstrual Tracking in Muslim Women in the US* in *Proceedings of the CHI Conference on Human Factors in Computing Systems* (ACM, Honolulu, HI, USA, 2024). https://doi.org/10.1145/3613904.3642006. *(26.4% acceptance rate)*.

C4. Panicker, A., Nurain, N., **Ibrahim, Zaidat**, Wang, A., Ha, S. W., Wu, Y., Connelly, K., Siek, K. A. & Chung, C.-F. *Understanding fraudulence in online qualitative studies: From the researcher's perspective* in *Proceedings of the CHI Conference on Human Factors in Computing Systems* (ACM, Honolulu, HI, USA, 2024). https://doi.org/10.1145/3613904.3642732. *(26.4% acceptance rate)*.

Peer-reviewed Extended Abstracts

A1. **Ibrahim, Zaidat**. *Expanding Personal Informatics: Menstruation and Pregnancy Healthcare Journey For Practising Muslim Women* in *Extended Abstracts of the 2024 CHI Conference on Human Factors in Computing Systems* (ACM, 2024). https://doi.org/10.1145/3613905.3638178. *(24% acceptance rate)*.

A2. **Ibrahim, Zaidat**, Karimi, P., Martin-Hammond, A., Harrington, C. & Siek, K. A. *What Do We Do? Lessons Learned from Conducting Systematic Reviews to Improve HCI Dissemination* in *Extended Abstracts of the 2024 CHI Conference on Human Factors in Computing Systems* (ACM, 2024). https://doi.org/10.1145/3613905.3637117. *(24% acceptance rate)*.

Workshop Papers

W1. **Zaidat Ibrahim** & Clawson, J. *Conceptual Investigation of Values in Pregnancy Healthcare Journey Research* Hamburg, Germany, 2023.

W2. **Zaidat Ibrahim** & Siek, K. *Investigating Identity in Reproductive Health and HCI: A Systematic Review* Hamburg, Germany, 2023.

W3. **Zaidat Ibrahim** & Clawson, J. *Reflections on Considerations For Research Within Muslim Women Population* New Orleans, LA, USA, 2022.

Papers in Review

R1. Félix, B., **Ibrahim, Zaidat**, Nunes, M. L., Pichel, F., Gomes, A. R., Chia-Fang, C., Verdezoto, D. N. & Nunes, F. *Standing up for Gestational Diabetes: Insights from self-monitoring practices of women with GD* New York, NY, USA, 2024.

R2. **Ibrahim Zaidat**, Michaela, K., Grimme, S., Bosco, C., Koelle, M. & Siek, K. *Women's Reproductive Health Research in HCI: A Systematic Review* New York, NY, USA, 2024.

R3. **Ibrahim Zaidat**, Nurain, N., Jain, P., Vallabhaneni, S. & Clawson, J. *"All I was told is that I'm not clean, I'm impure": Unpacking Muslim Women's Menstrual Education and Experiences* New York, NY, USA, 2024.

R4. Rifat, M. R., Das, D., Doyle, D. T., Mim, N. J., **Ibrahim, Zaidat**, Sultana, S., Smith, D. C. E., Brubaker, J. R. & Soden Robert Ahmed, S. I. *Religion, Faith and Spirituality, Secularism, and Disciplinary Paradigms* 2024.

Presentations

Invited Talks

T1. **Ibrahim, Zaidat**. *Health and AI Guest Lecture on "Data Stewardship"* Indiana University Bloomingtin (In-person). 2025. **April 10, 2025**.

T2. **Ibrahim, Zaidat**. *Doctoral Consortium: Expanding Personal Informatics* **ACM CHI 2024.** (Hawaii, USA). May 2024. **In-person, May 11, 2024** | – **Pub:** [A1].

T3. **Ibrahim, Zaidat**. *Investigating Data Sharing & Consent in Health Community.* Microsoft Research (Cambridge, MA, USA). 2024. **In-person, September 5, 2024**.

T4. **Ibrahim, Zaidat**. *Menstrual Health & Tracking through a religious lens: Unpacking Muslim Women's Menstrual Tracking Practices* University of Utah (Utah, USA). 2024.
– **Host:** Kristin Attaway | **In-person, September 30, 2024**.

T5. **Ibrahim, Zaidat**. *Menstrual Health & Tracking: The Menstruating Muslim Perspective* University of Victoria (Victoria, BC, Canada). May 2024.
– **Host:** Sowmya Somanath | **In-person, May 28, 2024**.

T6. **Ibrahim, Zaidat**. *Microsoft Give Campaign Pitch For Naijacoder Project* Microsoft Research (Cambridge, MA, USA). 2024. **In-person, October 17, 2024**.

T7. **Ibrahim, Zaidat**. *Microsoft Research: Data Consent* Flok Family Camp (Camp Belknap, New Hampshire, USA). 2024.
– **Host:** Flok/Sarah Chamberlain | **In-person, September 21, 2024**.

T8. **Ibrahim, Zaidat**. *Panelist 'Case Studies: Methods'* **ACM CHI 2024.** (Hawaii, USA). May 2024. **In-person, May 14, 2024** | – **Pub:** [A2].

T9. **Ibrahim, Zaidat**. *Panelist 'Reflection and Regulation For Wellbeing'* **ACM CHI 2024.** (Hawaii, USA). May 2024. **In-person, May 13, 2024** | – **Pub:** [C1].

T10. **Ibrahim, Zaidat**. *Tech Ethics RoundTable: Understanding and Developing Data Platforms to Support Marginalized Community Health Needs* Berea College (Kentucky, USA). 2024.
– **Host:** Jasmine Jones | **In-person, October 19, 2024**.

T11. **Ibrahim, Zaidat**. *Twice invited panelist 'Menstrual Tracking and Health'.* **ACM CHI 2024.** (Hawaii, USA). May 2024. **In-person, May 13, 2024** | – **Pub:** [C2, C3].

T12. **Ibrahim, Zaidat** & Harris, T. *Microsoft Give Campaign Pitch For Naijacoder Project* PennHCI, University of Pennsylvania (Remote). 2024. **Remote, November 1, 2024**.

T13. **Ibrahim, Zaidat**. *Twice invited poster presenter: WISH @ CHI 2023* **ACM CHI 2023.** (Hamburg, Germany). 2023. **In-person, April 28, 2023** | – **Pub:** [W1, W2].

Invited Workshops

N1. **Computing Research Association's CCC**. *Supporting At-Risk Users Through Responsible Computing* **Computing Community Consortium (CCC)** (Washington DC, USA). 2024. *This is an invite-only national workshop CRA Computing Community Consortium.

N2. **Computing Research Association's CCC**. *Future of Pandemic Prevention and Response* **Computing Community Consortium (CCC)** (Ann Arbor, MI, USA). 2023. *This is an invite-only national workshop CRA Computing Community Consortium. **See** Report.

Workshops Organized

O1. Panicker, A., Nurain, N., **Ibrahim, Zaidat**, Wang, A., Ha, S. W., Kaziunas, E., Wolters, M. K. & Chung, C.-F. *Forms of Fraudulence in Human-Centered Design: Collective Strategies and Future Agenda for Qualitative HCI Research* 2024. *(49% acceptance rate)*.

Posters

P1. **Ibrahim, Zaidat**. *Expanding Personal Informatics: Menstruation and Pregnancy Healthcare Journey For Practising Muslim Women* **ACM CHI 2024.** (Hawaii, USA). May 2024. **In-person, May 11, 2024** | – **Pub:** [AI].

P2. **Ibrahim, Zaidat**. *Your Data, Your Rights, Your Consent* **Flok Family Camp 2024.** (Camp Belknap, NH USA). May 2024. **In-person, September 21, 2024** | – **Talk:** [T8].

P3. **Ibrahim, Zaidat** & Clawson, J. *Conceptual Investigation of Values in Pregnancy Healthcare Journey Research* **WISH @ ACHI 2023.** (Hamburg, Germany). 2023. **In-person, April 28, 2023** | – **Pub:** [W1].

P4. **Ibrahim, Zaidat** & Siek, K. *Investigating Identity in Reproductive Health and HCI: A Systematic Review* **WISH @ ACHI 2023.** (Hamburg, Germany). 2023. **In-person, April 28, 2023** | – **Pub:** [W2].

Selected Media Coverage

2025 The Guardian News, Advancing care for underserved communities through health informatics: A conversation with Zaidat Ibrahim

2025 Nigerian Tribune, Innovations in health informatics: A new era of responsible data-sharing

2024 MIT Rising Star in EECS 2024, Zaidat Ibrahim-MIT Rising Stars in EECS 2024 Feature

2024 Luddy News, Luddy School impresses during major Human-Computer Interaction conference

2024 Social Media Collective, Welcoming our new SMC postdoc and 2024 interns!

2023 ACM-W Scholar-Zaidat Ibrahim, Zaidat Ibrahim

2022 The Conversation, No, submitting junk data to period tracking apps won't protect reproductive privacy

2022 Computing Research News, CRA Board and CCC Council Member Katie Siek Releases Paper Discussing why Submitting "junk data" to Period Tracking Apps will not Aid in Protecting Reproductive Privacy

2019 Berkeley Haas News, Africa Business Forum to focus on opportunity, innovation in a growing economy

2017 Premium Times Nigeria, U.S. govt offers scholarship to 140 Nigerian students into American universities

2014 Opportunity Desk, Zaidat Ibrahim From the United States is December 2014 Young Person of the Month

Skills

Research	User Studies, Interviewing, Inductive and Deductive Qualitative Coding, Think-Aloud Method, Literature Review, Diary Study, Co-design, Survey
Technical	Python, HTML, Arduino
Design	Experience Mapping, Storyboards, Personas, Wireframing, Usability Testing
Tools	Flowmapp, Adobe XD, Miro, TinkerCard
Language	English, German

Teaching

Assistant Instructor, Indiana University Bloomington

2025 Sp.	Info-I590 **Health and AI** [Undergraduate | 20 students]
2024 Sp.	Info-I202 **Social Informatics** [Undergraduate | 40 students]
2023 Fa.	Info-I549 **Advanced Prototyping** [Graduate | 12 students]
2023 Fa.	Info-I400 **Mobile HCI Design** [Undergraduate | 19 students]
2022 Fa.	Info-I542 **Foundations of HCI** [Graduate | 40 students]
2022 Sp.	Info-I300 **Intro. to HCI & design** [Undergraduate | 40 students]
2021 Fa.	Info-I549 **Advanced Prototyping** [Graduate | 20 students]
2021 Fa.	Info-I400 **Mobile HCI Design** [Undergraduate | 18 students]
2021 Su.	Info-I301 **Presentations For IT Professionals** [Undergraduate | 17 students]
2021 Sp.	Info-I301 **Presentations For IT Professionals** [Undergraduate | 40 students]

Research Mentoring

Undergraduate

Zaidat has advised 8 undergraduate researchers - 6 from underrepresented groups in STEM (75%); 7 women (87.5%), 7 from historically excluded minority groups in STEM (75%).

2024-25	Gupta Lina, Indiana University, Emerging Scholar
2024-25	Mariah Rawson, Indiana University, Emerging Scholar
2023-24	Aastha Sharma, Indiana University, Emerging Scholar
2023-24	Mang Par, Indiana University, Emerging Scholar
2022-23	Linda Tial, Indiana University, Emerging Scholar
2022-23	Yetika Choudhary, Indiana University, Emerging Scholar
2021-22	Shane O'Niell, Indiana University, Emerging Scholar
2021-22	Nimish Bhat, Indiana University, Emerging Scholar

Academic Service

Reviewer (Paper & Scholarships)

Expert Reviewer	BMJ Digital Health and AI (2025)
Reviewer	CHI (2024), UIST (2024), IWC (2024), CSCW (2024), CHI (2023), CHI (2022)
Reviewer	Cal Alumni African American Scholarship Awards (2022-2025)
Reviewer	Cal Alumni Leadership Scholarship Awards (2022-2024)

Associate Chair	CSCW (2024)
Committee	IU GPSG Travel Awards 2021 Committee Member
Reviewer	Microsoft Research Undergraduate Internship Applications 2024

Mentoring

2022-25	Emerging Scholars Program, Research Mentor–Indiana University
2018-19	Getting-into-Grad School, Academic Mentor–UC Berkeley

Student Volunteer

2022	ACM CHI Conference 2022, Student Volunteer
2021	ACM CSCW Conference 2022, Student Volunteer

Broader Impacts

Naijacoders, a non-profit, has trained over 100 under-served high school students in Nigeria through a hybrid summer code camp. As one of 15 co-organizers, I volunteered 10 hours per month and helped raise $15,000 in grants to support the program.

Certifications & Memberships

Certifications

2024	Google Cloud Introduction to Generative AI Learning Path
2020	CITI Program/Human Subject Research
2020	IBM Data Science Professional Certificate
2019	User Experience Certificate

Professional Memberships

2021-25	ACM (Association of Computing Machinery) Student Member
2021-25	IEEE (Institute of Electrical and Electronics Engineers) Student Member
2021	AnitaB.org Member

Last updated: June 16, 2025