# The Digital Heartbeat:

# A Qualitative Descriptive Study on Women's Views of Xi-Care in Preventive Cardiovascular Diseases in Primary Care

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## DEDICATION

I wish to convey my profound gratitude to my initial advocate, my father, Essaid Bousbiat. His consistent support and inspiration have accompanied me unfailingly throughout my odyssey as a researcher. His resolute encouragement and indispensable aid have constituted pivotal factors in my accomplishments thus far.

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## ABSTRACT

**Background:**

Every 20 minutes, a woman's life is claimed by cardiovascular diseases (CVDs) — the leading cause of death among women globally. This represents not only a significant public health dilemma and a significant issue in family medicine practice but also imposes immense economic burdens. Alarmingly, a delay in diagnosis is prevalent in women, who are diagnosed approximately seven to ten years later than men, often missing early prevention opportunities. A delay that is potentially due to shifts like menopause and other sex-related factors which alter cardiovascular risk. Consequently, women receive a lower standard of cardiac care, sometimes with fatal outcomes. Despite advancements in digital health technologies, there remains a considerable disparity in their use for women's primary prevention. With the incidence of cardiovascular diseases increasing over the past three decades, the development of tailored sex-specific primary prevention strategies is urgent, particularly at the primary healthcare level.

**Objectives:**

This study is part of a larger Canadian Institutes of Health Research (CIHR)-funded project aiming to prevent cardiovascular disease among women using a prospective AI-enabled system named Xi-Care. This MSc study is designed with a twofold purpose: (i) to explore women's perspectives on cardiovascular diseases and the use of digital health tools as a means for primary prevention and (ii) to gather their insights on the essential features that should be incorporated into the development of an AI-enabled digital health tool, named Xi-Care, for the primary prevention of cardiovascular conditions.

**Methodology and methods:**

This study employed a descriptive qualitative methodology, using semi-structured, in-depth interviews of a purposeful sample of 15 women, at excess risk of developing cardiovascular diseases. Participants were over 40 years old residing in Quebec, having at least one cardiovascular disease-related risk factor and could give informed consent along with proficiency in English verbally and in writing. Recruitment occurred at the community level including a clinic affiliated with McGill University. An inductive approach to thematic analysis for data analysis was adopted.

**Results:**

Women's understanding of cardiovascular diseases and the use of AI-enabled digital health tools for primary prevention is limited. Many expressed a lack of comprehensive awareness, often associating the condition with acute events, and overlooking the broader spectrum of the condition. Despite that, women exhibited a proactive stance on their cardiovascular health, advocating for initiatives that provide both education and decision-making support tailored to their unique needs. The study showed an interest in digital health tools, with a common call for features that foster an engaging experience. Personalization stood out as an essential factor, with women prioritizing tools that offer customized health recommendations. The introduction of the Xi-Care was met with enthusiasm, with participants emphasizing the necessity of key features, e.g., monitoring and tracking of health data, educational modules on cardiovascular health and integrating pedometer data, to augment primary prevention efforts for cardiovascular diseases.

**Discussion:**

Despite the prevalence of cardiovascular diseases, there remains a significant gap in knowledge among women, particularly in understanding the chronic nature of these diseases and their varied manifestations. Women's limited understanding of the disease underscores the urgency for

comprehensive educational strategies that address both prevention and the broader implications of living with cardiovascular diseases. The enthusiasm for Xi-Care indicates a readiness among women to embrace digital innovations in their health journeys, provided these tools are tailored to their linguistic, cultural, and individual health needs. Overall, this study highlights that an AIenabled digital health tool, named Xi-Care, with its potential for customization and interactive engagement, might enhance the primary prevention of cardiovascular diseases in women. Moreover, it will offer insight into the next phases of the project, which ultimately will lead to the development of Xi-Care.

## RÉSUMÉ

**Contexte:**

Toutes les 20 minutes, la vie d'une femme est emportée par les maladies cardiovasculaires (MCVs) — la principale cause de décès chez les femmes dans le monde. Cela représente non seulement un dilemme de santé publique significatif et un problème majeur en pratique de médecine familiale, mais impose également d'énormes charges économiques. De manière alarmante, un retard de diagnostic est courant chez les femmes, qui sont diagnostiquées environ sept à dix ans plus tard que les hommes, manquant souvent des opportunités de prévention précoce. Un retard potentiellement dû à des changements comme la ménopause et d'autres facteurs liés au sexe qui modifient le risque cardiovasculaire. En conséquence, les femmes reçoivent un standard de soins cardiaques inférieur, parfois avec des issues fatales. Malgré les avancées dans les technologies de santé numérique, il reste une disparité considérable dans leur utilisation pour la prévention primaire chez les femmes. Avec l'incidence des maladies cardiovasculaires en augmentation au cours des trois dernières décennies, le développement de stratégies de prévention primaire spécifiques au sexe est urgent, particulièrement au niveau des soins de santé primaires.

**Objectifs:**

Cette étude fait partie d'un projet plus vaste financé par les Instituts de recherche en santé du Canada (IRSC) visant à prévenir les maladies cardiovasculaires chez les femmes en utilisant un système prospectif activé par l'IA nommé Xi-Care. Cette étude de maîtrise est conçue dans un double objectif : (i) explorer les perspectives des femmes sur les maladies cardiovasculaires et l'utilisation d'outils de santé numériques comme moyen de prévention primaire et (ii) recueillir leurs idées sur les caractéristiques essentielles qui devraient être intégrées dans le développement

d'un outil de santé numérique activé par l'IA, nommé Xi-Care, pour la prévention primaire des conditions cardiovasculaires.

**Méthodologie et méthodes:**

Cette étude a employé une méthodologie qualitative descriptive, utilisant des entretiens semi-structurés approfondis d'un échantillon intentionnel de 15 femmes, à risque excessif de développer des maladies cardiovasculaires. Les participantes avaient plus de 40 ans, résidaient au Québec, avaient au moins un facteur de risque lié aux maladies cardiovasculaires et pouvaient donner leur consentement éclairé ainsi que maîtriser l'anglais verbalement et par écrit. Le recrutement a eu lieu au niveau communautaire, y compris une clinique affiliée à l'Université McGill. Une approche inductive de l'analyse thématique pour l'analyse des données a été adoptée.

**Résultats:**

La compréhension des maladies cardiovasculaires par les femmes et l'utilisation d'outils de santé numériques activés par l'IA pour la prévention primaire sont limitées. Beaucoup ont exprimé un manque de sensibilisation globale, associant souvent la condition à des événements aigus et négligeant le spectre plus large de la condition. Malgré cela, les femmes ont adopté une position proactive concernant leur santé cardiovasculaire, plaidant pour des initiatives qui fournissent à la fois une éducation et un soutien à la prise de décision adaptés à leurs besoins uniques. L'étude a montré un intérêt pour les outils de santé numériques, avec un appel commun pour des caractéristiques qui favorisent une expérience engageante. La personnalisation s'est démarquée comme un facteur essentiel, les femmes privilégiant les outils qui offrent des recommandations de santé personnalisées. L'introduction du Xi-Care a été accueillie avec enthousiasme, les participantes soulignant la nécessité de caractéristiques clés, par exemple, le suivi et le monitoring

des données de santé, des modules éducatifs sur la santé cardiovasculaire et l'intégration des données du podomètre, pour augmenter les efforts de prévention primaire pour les maladies cardiovasculaires.

**Discussion:**

Malgré la prévalence des maladies cardiovasculaires, il reste un écart significatif de connaissances chez les femmes, particulièrement dans la compréhension de la nature chronique de ces maladies et de leurs manifestations variées. La compréhension limitée de la maladie par les femmes souligne l'urgence de stratégies éducatives complètes qui abordent à la fois la prévention et les implications plus larges de vivre avec des maladies cardiovasculaires. L'enthousiasme pour Xi-Care indique une volonté parmi les femmes d'embrasser les innovations numériques dans leurs parcours de santé, à condition que ces outils soient adaptés à leurs besoins linguistiques, culturels et de santé individuels. Dans l'ensemble, cette étude met en évidence un outil de santé numérique activé par l'IA, nommé Xi-Care, avec son potentiel de personnalisation et d'engagement interactif, pourrait améliorer la prévention primaire des maladies cardiovasculaires chez les femmes. De plus, il offrira un aperçu des prochaines phases du projet, qui conduira finalement au développement de Xi-Care.

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## LIST OF ABBREVIATIONS

1. AI– Artificial Intelligence
2. CCTA–Coronary Computed Tomography Angiography
3. CVDs– Cardiovascular Diseases
4. DHIs– Digital Health Interventions
5. MCVs– Maladies cardiovasculaires
6. WHHI– Women's Healthy Heart Initiative
7. MUHC– McGill University Health Centre

# 1 INTRODUCTION

This investigation is about the use of a digital tool to provide preventive care in primary healthcare settings to women at excess risk of developing cardiovascular diseases in primary care settings. In the ever-evolving healthcare landscape, Artificial Intelligence (AI) is transforming how we care for patients. AI, which encompasses the science and engineering of creating intelligent machines (McCorduck, 2004), holds tremendous potential for innovation and growth in the field of primary care (Lin et al., 2019). By leveraging AI technologies, primary care providers, notably family physicians, can tailor personalized care and prediction measures, making it a significant area for advancement (Abbasgholizadeh Rahimi et al., 2021; Lin et al., 2019). One specific area where AI shows great promise is cardiovascular health (Malik et al., 2019).

Cardiovascular diseases (CVDs), a collective term for conditions that affect the heart and blood vessels (World Health Organization, 2021), has witnessed a staggering increase worldwide over the past three decades. The cases nearly doubled from 271 million in 1990 to 523 million in 2019 (GBD 2019 Risk Factors Collaborators, 2020). Alarmingly, cardiovascular diseases accounted for 17.9 million deaths in 2019, approximately 32% of all worldwide deaths (World Health Organization, 2021). Moreover, the financial burden imposed by cardiovascular diseases on healthcare systems is substantial (Tarride et al., 2009): about $21.2 billion every year is estimated to be the medical cost of caring for cardiovascular disease patients in Canada.

Specifically, the impact of cardiovascular diseases on women's health is noteworthy (Heart and Stroke Foundation of Canada, 2015). In Canada, for instance, cardiovascular disease remains the leading cause of death among women, claiming one life every twenty minutes, five times the number of women lost to breast cancer (Heart and Stroke Foundation of Canada, 2018.). There is significant progress in promoting cardiovascular disease education and substantial financial

investments in care and treatment (Statistics Canada, 2023). However, these statistics underscore the pressing need for innovative approaches to primary prevention, especially ones toward women's cardiovascular health.

Preventive healthcare strategies aim to target various stages of an illness to avoid its emergence and subsequent secondary effects (Kisling & Das, 2021). At the primary care level, there are many primary prevention strategies involved such as shared decision-making between physicians and patients, assessment and management of associated risk factors, and the promotion of healthy lifestyles (Kisling & Das, 2021). Healthcare providers recognize the importance of shared decision-making via patient engagement and they are enabling patients to take an active role in managing and preventing acute or chronic diseases (e.g., cardiovascular disease), as well as modifying their health behaviours (Krist et al., 2017, Ferdinand et al., 2017). This marks a shift away from traditional healthcare models where clinicians were the sole decision-makers and instead emphasizes a cooperative approach where clinicians actively involve patients in their care (Krist et al., 2017).

### *Digital Health Interventions for Preventing Women's Cardiovascular Diseases*

Digital health interventions (DHIs) have emerged as a promising solution for the future of healthcare delivery, offering highly effective and easily scalable interventions that benefit both individuals and healthcare providers (Murray et al., 2016). A notable category of DHIs is mobile health technology (mHealth), which employs digital tools such as smartphones to facilitate lifestyle modifications and improve medical adherence (Klimis et al., 2018). An example of a mHealth intervention is the Care4Heart smartphone program developed by Zhang et al. (2017). In a randomized controlled trial involving 80 adults without a Congenital Heart defect (CHD) diagnosis, participants engaged in a 4-week mobile application program that covered various topics

such as signs, symptoms, risk factors, and the importance of maintaining a healthy lifestyle (Zhang et al., 2017). Ultimately, the study demonstrated improved CHD awareness and knowledge among the participants (Zhang et al., 2017).

DHIs play a revolutionizing role in healthcare offerings and preventive medicine, particularly in cardiology where AI brings additional opportunities, such as its capability to enhance risk prediction accuracy and enable disease prevention (Ledziński & Grześk, 2023). For instance, FDA-approved AI platforms, such as AI-Rad Companion (Cardiovascular), have shown effectiveness in aiding healthcare professionals in delivering precise diagnoses and comprehensive evaluations of various cardiovascular conditions (Karatzia et al., 2022). Additionally, in terms of heart failure, AI-based predictive models enable early interventions which potentially lead to improved patient outcomes (Moreno-Sanchez, 2023). The utility of AI extends to the detection and diagnosis of atrial fibrillation (AF) —an important risk factor for stroke— strengthening both healthcare quality and cost-efficiency (Jo et al., 2021; Zhang et al., 2024). Notably, according to Zhang et al. (2024), AI has demonstrated its capacity to even assess AF burden, by quantifying the duration and frequency of AF episode, ventricular rate and longest episode resulting in better stroke risk assessment. Ultimately, facilitating the timely and effective stroke prevention measures.

Unfortunately, the existing problem of the under-representation of women in research studies and clinical trials has resulted in a limited understanding of the development, diagnosis, and prevention strategies for cardiovascular disease in this subpopulation (Jin et al., 2020, Tsang et al., 2012). Traditionally, cardiovascular prevention and management techniques have been developed based on a male-centric model, failing to fully account for gender variations and the unique needs of women (McDonnell et al., 2018). As it stands, there appears to be a correlation between the underrepresentation of women in cardiovascular research and the likelihood of

receiving an accurate diagnosis, underscored by the absence of sex-specific preventive guidelines (Bairey Merz et al., 2017). This raises significant concerns, as women tend to be diagnosed seven to ten years later than men (Maas & Appelman, 2010), leading to delayed treatment and poorer health outcomes. Furthermore, women are less likely than men to receive appropriate preventative measures or counselling, resulting in a lower quality of cardiac care and, in some cases, even mortality (Abuful et al., 2005; McDonnell et al., 2018).

Nevertheless, recent evidence suggests that DHIs and AI offer a compelling opportunity for primary cardiovascular disease prevention in women, such as cardiovascular screening, advancing precise cardiovascular care and sex-tailored risk prediction models (Adedinsewo et al., 2022; Morales-Lara et al., 2023). The incorporation of these technological advancements in the prevention landscape holds the potential for enhancing preventive strategies tailored to women's cardiovascular health (Adedinsewo et al., 2022; Morales-Lara et al., 2023). However, the current inequalities in healthcare, particularly for women, echo within the health data training AI algorithms (Adedinsewo et al., 2022). While AI has the potential to revolutionize cardiovascular care by leveraging vast amounts of data, including medical records and clinical trial data, concerns about biased predictions that disproportionately affect women and underrepresented minorities exit (Adedinsewo et al., 2022; Garzon-Siatoya et al., 2023; Tat et al., 2020). These groups have historically been underrepresented in cardiology research and clinical trials, limiting the practicality of AI findings for addressing their unique healthcare needs (Adedinsewo et al., 2022; Garzon-Siatoya et al., 2023; Tat et al., 2020). It is conceivable that women and underprivileged minorities may not gain the full advantages of AI in cardiovascular healthcare, which could even further exacerbate the current health inequalities (Tat et al., 2020). Therefore, to bridge these gaps

and advance women's cardiovascular care, it's important to integrate comprehensive, unbiased data into AI models.

***The Xi-Care Tool***

This study is a part of a larger CIHR-funded project (leading PI: Abbasgholizadeh-Rahimi) aiming to prevent cardiovascular disease among women using an AI-enabled digital health tool, i.e., XI-Care. It is a proposed tool that will aim to enhance primary preventive care for women at an exceeded risk of developing cardiovascular disease. In the form of a mobile application, XiCare aims to provide individualized recommendations for preventing cardiovascular diseases, guiding women through personalized health decisions and potential lifestyle adjustments. By fostering a collaborative environment, Xi-Care will empower women to engage meaningfully with their healthcare providers, ensuring a participatory role in their health decisions. In doing so, XiCare aims to elevate the standard of care and improve health outcomes, marking a significant advance in women-centred health technology.

In light of this context, the overreaching aim of this thesis is to explore women's perspectives on the concept of utilizing a prospective AI-enabled digital health tool, named XiCare, designed for primary preventive care within the primary care setting. Specifically, it focuses on women's understanding and receptiveness toward the potential of such a digital health tool in managing their health proactively.

# 2 LITERATURE REVIEW

Encompassing current knowledge about the topic that I have addressed in my master's thesis, this chapter offers an insightful overview of some of the ongoing initiatives aimed at digitizing healthcare for cardiovascular diseases, with a particular focus on women. I begin by explaining the substantial burden of these diseases. Subsequently, I explore sex-based disparities within the healthcare system, particularly concerning cardiovascular diseases, underscoring the need for tailored approaches to care and prevention. As this study aims to assess Xi-Care, I introduce the concept of digital tools and their transformative influence on cardiovascular healthcare, along with the primary preventive strategies employed in this context. I also explore the advantages of incorporating AI into these digital tools, specifically within the realm of cardiovascular disease. Lastly, I draw attention to the notable scarcity of AI-enabled digital tools designed to cater to women's unique needs in their preventive efforts against cardiovascular disease.

## 2.1.The Burden of Cardiovascular Diseases

Cardiovascular disease is an encompassing term that includes conditions affecting the heart and blood vessels: coronary heart disease, cerebrovascular disease, peripheral arterial disease, rheumatic heart disease, congenital heart disease and deep vein thrombosis and pulmonary embolism (World Health Organization, 2021). It is a global health concern of paramount significance as it consistently maintains its position as the leading cause of mortality worldwide (World Health Organization, 2021). Notably, individuals with chronic cardiovascular conditions often face challenges in accessing healthcare services, underscoring their heightened vulnerability (Statistics Canada, 2022).

In a striking comparison, cardiovascular-related deaths in 2020 surpassed COVID-19 fatalities by more than fourfold (Statistics Canada, 2022). This statistic highlights the immense

burden of cardiovascular disease, even amidst the global pandemic. More recent data from 2022 reveals that cardiovascular disease claimed approximately 57,357 lives in Canada alone, accounting for roughly 17% of the country's total deaths for that year (Statistics Canada, 2023). The financial implications are equally staggering, with cardiovascular disease imposing an annual cost of over $21.2 billion on the Canadian economy (Heart and Stroke Foundation of Canada, 2019).

Unfortunately, cardiovascular disease care exhibits a pronounced bias, with women bearing a disproportionate burden of the consequences (Heart and Stroke Foundation of Canada, 2018). This unfairness manifests in women experiencing premature mortality, falling short of their expected lifespan (Heart and Stroke Foundation of Canada, 2018). This disparity arises from a different factor, including under-researched, under-diagnosed, under-treated, under-supported, and under-awareness of cardiovascular disease in women (Heart and Stroke Foundation of Canada, 2018). Approximately seventy percent of what is understood regarding cardiovascular diseases is based on research focused on men (McDonnell et al., 2018). As an illustration, a study conducted by Jin et al. (2020) revealed that among the 740 clinical trials registered in ClinicalTrials.gov related to cardiovascular diseases, women comprised only 38.2% of the trial participants.

### 2.2.Disparities in Cardiovascular Disease Primary Prevention for Women

Historically, cardiovascular disease has been mainly associated with men, leading to misconceptions and underestimation of its prevalence and severity in women when in reality it is the primary cause of death in women globally (Woodward, 2019). Despite this, a significant disparity still exists in disease prevention between men and women. Women typically have their first cardiovascular event approximately 5-10 years later than men, often attributed to the

protective effects of estrogen. However, they have a higher risk of experiencing a stroke during their initial cardiovascular event (Leening et al., 2014).

In the domain of women's health, primary care takes on a special significance by empowering women with the necessary knowledge and tools to safeguard their health. It serves as the first point of contact for individuals and families within the national health system, bringing healthcare closer to the community. Nevertheless, previous research, exemplified by Turnbull et al. (2011), has shed light on concerning disparities in primary care, particularly in the context of women's health where these disparities manifest as significant underestimations and overestimations in the proportion of patients categorized as high and low risk.

Turnbull et al. (2011) highlighted that there was a substantial sex discrepancy when it comes to cardiovascular disease risk assessment, particularly affecting women. The study showed that the Framingham score—a widely recognized tool for estimating cardiovascular disease risk placed 54% of women in the high-risk category while general practitioners identified only 25% as high risk (Turnbull et al., 2011). Conversely, an overestimation of low-risk patients was evident, primarily among women, as the Framingham score categorized 36% in the low-risk category, while general practitioners classified 57% as low-risk (Turnbull et al., 2011). Furthermore, when compared to their male counterparts, sex-based disparities in risk assessment became even more apparent (Turnbull et al., 2011). The Framingham score categorized only 14% of males as low risk, while general practitioners classified 35% as low risk (Turnbull et al., 2011). This highlights the need for more sex-specific risk assessment tools in clinical settings to ensure equitable cardiovascular disease risk evaluation for women.

The issue of sex bias within the context of cardiovascular healthcare exceeds usual inadequacies in risk assessment for women. It extends its influence into the educational guidance

provided by healthcare professionals during patient visits. A retrospective observational study conducted by Hilleary et al. (2019) serves to illustrate this concern. Hilleary et al. (2019) reported a stark sex disparity in the provision of patient education for individuals diagnosed with coronary heart disease. Specifically, their findings reveal that a significantly lower proportion of women received patient education during their medical consultations. To be more precise, women were 14% less likely than men to receive the essential patient education required for their cardiovascular health (Hilleary et al.,2019).

Moreover, Bairey Merz et al. (2017) underscored a notable deficiency in the perceived proficiency of certain primary care providers and cardiologists when it comes to the prevention and management of cardiovascular disease in women. 21% percent of women reported that their healthcare providers addressed their vulnerability to developing cardiovascular disease (Mosca et al.,2013). In light of these shortcomings, it becomes evident that there exists a pressing imperative to strengthen the competence of primary care physicians in the domain of cardiovascular disease, with a particular focus on the female demographic (Mosca et al., 2013).

The emergence of this inadequacy in clinical competence has been a relatively recent development, as McDonnell et al. (2018) elucidated, signifying an evolving awareness among physicians regarding the sex-specific variations inherent in cardiovascular health. As contemporary research and interventions are moving towards personalized medical care, addressing these disparities in health care is an essential component (Humphries et al., 2017).

### 2.3.Digital Health Interventions at The Primary Care Level

Digital health tools, and software applications that are developed to enhance healthcare services, have permeated healthcare systems, including primary care which serves as the crucial foundation of the healthcare system, naturally giving rise to consequential implications. Digital

technologies, when integrated into primary healthcare, play a vital role in coordinating and maintaining care continuity across various healthcare services (World Health Organization, 2018).

Digital healthcare is the convergence of technology and healthcare, with the overarching goal of enhancing medical care delivery and improving both individual and population health (Fatehi et al., 2020). According to the World Health Organization (2021), it is defined as *"the field of knowledge and practice associated with the development and use of digital technologies to improve health".* This field is experiencing remarkable growth, characterized by significant technological advancements and substantial financial investment. In 2017 alone, the development of 325,000 mobile apps was coupled with a remarkable $5.4 billion investment in digital health start-ups (Pohl, 2017), signaling a promising outlook for its continued expansion.

The World Health Organization (2018) has established a taxonomy for digital health interventions, categorizing them based on their intended end-users such as clients of health services and their caregivers. At the client level, a diverse array of interventions is available. These include accessing medical histories, reviewing clinical records, and personal health monitoring, which involves the use of applications and wearable devices to track health metrics (World Health Organization, 2018). Another notable example includes on-demand information services for clients, enabling users to search for precise health-related information and make informed decisions (World Health Organization, 2018).

Willis et al. (2022) highlighted that integration of digital tools showed improvements in clinical and non-clinical outcomes across various stakeholders, including patients and their healthcare providers. For instance, providing patients with access to their electronic health records holds the potential to substantially augment healthcare quality (Neves & Burgers, 2022), enhance patient safety (Neves et al., 2020), and elevate patient satisfaction in doctor-patient communication

(Ross et al., 2004). Electronic Health Records (EHRs) capture comprehensive health information, including medical history, prevailing conditions, and prescribed medications (Häyrinen et al., 2008). Moreover, big data analytics, a process revealing intricate patterns within raw data, plays a pivotal role in discerning unique care requirements and crafting tailored interventions for specific patient cohorts (Neves & Burgers, 2022). This analytical approach is instrumental in assessing the local prevalence of chronic diseases, significantly contributing to strategic healthcare planning (Neves & Burgers, 2022).

A noteworthy illustration of digital health within primary care is the CONNECT intervention, a web-based application developed by Redfern et al. (2020). This tool is designed to provide personalized risk assessment, customized lifestyle guidance, and streamlined medication management (Redfern et al., 2020). Empirical evidence from the study indicates that the utilization of this application resulted in some improvements in mean systolic blood pressure (a reduction by 3.6 mmHg) and LDL cholesterol levels (a mean difference of -0.12 mmol/L), in comparison to the control group (Redfern et al., 2020). Furthermore, Lv et al. (2017) studied a personalized-care model for hypertension management, demonstrating remarkable progress after 6 months. In this study, both office-monitored and home-monitored blood pressure showed significant reductions below the critical thresholds of <140/90 mmHg and <135/85 mmHg, respectively (Lv et al., 2017).

### 2.4.Digitalizing Cardiovascular Disease Prevention

While cardiovascular disease is often considered highly preventable, adopting a healthier lifestyle remains a critical strategy for reducing the risk of this disease. International guidelines consistently advocate for a multifaceted approach to cardiovascular disease prevention, including medical treatments and lifestyle modifications (Kones, 2011; Stewart et al., 2017). Primary preventive strategies primarily involve lifestyle changes, including increased physical activity and

dietary improvements, both of which significantly impact cardiovascular risk factors including blood lipids and hypertension (Doughty et al., 2017; Tian & Meng, 2019; Yu et al., 2018).

The landscape of cardiovascular disease prevention is undergoing a transformative shift through digital health interventions transforming healthcare approaches to cardiovascular disease management and prevention while ultimately enhancing the delivery of higher-quality care (Tromp et al., 2022; Windmer et al., 2015). Central to this transformation is mobile health (mHealth), which employs mobile devices for data collection, healthcare information dissemination, and public health practices (Istepanian, 2022). mHealth encompasses a spectrum of interventions, from simple SMS-based approaches to sophisticated mobile applications (apps) (World Health Organization, 2011), such as The NEXit core program (Müssener et al., 2016) and AliveCor (Hall et al., 2020) respectively.

The acceptance and effectiveness of mHealth solutions in cardiovascular disease prevention are substantiated by findings from a population-based survey conducted in rural Kerala, India, by Feinberg et al (2017). The survey investigated mobile phone usage patterns and the local community's willingness to embrace mHealth interventions for health promotion and prevention, revealing strong support for these interventions (Feinberg et al., 2017).

Concrete examples further highlight the impact of digital health on primary cardiovascular disease prevention; notable among them is the Prevent Connect app (Agher et al., 2022). This app evaluates key risk factors, offering personalized recommendations and interventions. Remarkably, Agher et al. (2022) study reported that 80% of participants increased their awareness of the importance of health behaviour, with 77% acknowledging improved self-awareness. Additionally, other mHealth tools, prioritize behavioral changes to reduce cardiovascular disease risk. For

example, applications like FoodSwitch (Dunford et al., 2014) assisted users with information to make healthier dietary choices.

### 2.5. Digitalizing Cardiovascular Health: Opportunities and Limitations for Women

AI has become a ubiquitous force, seamlessly integrated into the healthcare evolution. Its transformative applications span a wide spectrum, featuring AI-powered functionalities such as clinical decision support, predictive analytics, virtual health coaches, and precision medicine. Each of these AI applications contributes significantly to elevating healthcare delivery and enhancing patient outcomes (Lin et al., 2019). For instance, Sehhaty Wa Daghty, translating to "My Health and My Blood Pressure" in English, is an AI-enabled app that fosters positive behavioural changes by enabling users to track their blood pressure and overall health indicators (Alzahrani et al., 2023). Offering tailored support, goal-setting features, and educational materials, the app encourages regular physical activity and empowers individuals to take a proactive stance in managing hypertension, a significant risk factor for cardiovascular disease. HORUS.AI is another example of an AI-enabled app (Donadello et al., 2022). Though not specifically related to cardiovascular health, the app's features and strategies align with promoting overall health and well-being, including aspects relevant to cardiovascular disease. HORUS.AI is developed to utilize persuasive dialogues and behavioural change strategies to motivate users to adopt a better and healthier lifestyle, such as healthy eating habits, physical activity, and alcohol moderation, and assist in managing chronic diseases (Donadello & Dragoni, 2022).

While AI tools' implementation at the primary care level remains somewhat limited (Abbasgholizadeh Rahimi et al., 2021; Kueper et al., 2020), the available AI-enabled platforms exhibit promising results, particularly concerning cardiovascular disease. For instance, AI models have been developed to predict the risk of progression from pre-diabetes to diabetes (Cahn et al.,

2020) and to analyze Coronary Computed Tomography Angiography (CCTA) images. This provides detailed insights into atherosclerotic plaque presence and characteristics in coronary arteries, exemplified by a tool named Cleerly (Cho et al., 2022). Similarly, Dominguez-Morales et al. (2018) described another noteworthy AI-enabled tool designed to aid physicians during the auscultation process. This innovative tool significantly enhances the accuracy and efficiency of diagnosing heart murmurs in primary care through AI-driven decision support (Dominguez Morales et al., 2018).

Research, including the work of Rising et al., (2020), has shown that women make up a significant portion of "super-trackers" – individuals who use multiple devices and mHealth interventions to monitor their health. Nonetheless, despite the increasing use of digital health tools by women with chronic illnesses, such as heart disease, to monitor their health metrics (Ajayi, et al., 2022), persistent healthcare inequities continue to affect women. Women remain starkly underrepresented, not only in the field of cardiovascular disease and its prevention but notably in digital health interventions and AI research (Adedinsewo et al., 2022).

However, a limited number of AI-enabled interventions designed for marginalized populations, such as women, show promise in reducing the risk of cardiovascular disease and promoting health through the delivery of customized and culturally sensitive interventions (Franklin & Arena, 2016). Furthermore, there is a dearth of AI-enabled digital tools for women that evaluate lifestyle behaviours, situational variables, psychological factors, and individual health goals, while also connecting this information to background knowledge on cardiovascular disease (Franklin & Arena, 2016; Walcott-McQuigg, 2000). Moreover, while new AI platforms hold promise in cardiovascular care, if these models are constructed with insufficient data representing underrepresented groups, especially women, it can result in biased model outcomes (Leifheit-

Limson et al., 2015; Puiu et al., 2021). These disparities underscore the need to bridge the sex gap in digital health and AI research for more inclusive and effective healthcare solutions.

### 2.6.Study Rationale and Research Question:

Notwithstanding the growing recognition of cardiovascular disease as a significant health concern for women, a notable knowledge gap exists in understanding their perspectives on cardiovascular disease and primary prevention strategies. There is less focus on sex-specific clinical aspects of cardiovascular disease and risk factors, such as early menopause and pre-term birth. Moreover, the design and development of AI-enabled digital tools for primary prevention of cardiovascular disease have predominantly followed generalized approaches, lacking sufficient consideration of sex-specific risk factors. Consequently, there is also a need to generate new knowledge about women's preferences on desired features in AI-enabled digital tools. Addressing this gap is crucial for informing the creation and implementation of effective, user-centred digital interventions tailored to women's primary prevention needs. Such endeavours have the potential to revolutionize cardiovascular disease management and alleviate prevalent health disparities in this population.

The motivation behind this study, grounded in the current lack of evidence on this issue, stems from the pressing need to confront sex-based disparities in cardiovascular disease primary prevention by harnessing digital tools. Central to this is Xi-Care, an AI-enabled digital health tool co-designed to transcend sex-based healthcare disparities and empower women in the primary prevention of cardiovascular disease. This tool will offer women invaluable insights, personalized recommendations, and a wide array of options for preventing cardiovascular disease. By actively engaging with this system, women can take charge of their cardiovascular health and effectively

reduce their risk of this disease. The seamless accessibility of Xi-Care through an intuitive AI enabled digital health tool ensures that women can effortlessly interact with the tool.

Recognizing the utmost significance of patient-centred research, we emphasize the imperative of involving users in the collaborative design process of cutting-edge digital solutions. This approach not only has the potential to strengthen the tool's effectiveness in addressing their unique healthcare needs but also fine-tunes it to align with their specific (Lipschitz et al., 2019), ensuring successful integration into primary care settings. In line with this, Xi-Care will meticulously be co-designed with women, representing a dynamic and comprehensive solution set to transform cardiovascular care, bridging sex-based healthcare disparities and promoting patient-centred, informed decision-making.

Accordingly, this empirical investigation has been guided by the following research questions:

1. What are women's perspectives on cardiovascular disease and the use of digital health tools for their primary prevention?
2. What are women's suggestions regarding the development of a digital health tool for cardiovascular disease prevention in primary care?

# 3 RESEARCH PLAN

## 3.1 Research Design

This study is a part of the first phase of a larger CIHR-funded project (leading PI: Abbasgholizadeh-Rahimi) aiming to prevent cardiovascular disease among women using Xi-Care, an AI-enabled digital health tool. I adopted a qualitative research methodology to provide meaningful answers to the aforementioned research questions for the capacity of this generic qualitative research design to comprehensively explore women's viewpoints, exploring their personal experiences while considering the contextual factors that influence their perspectives (Ormston et al., 2014). Previous research investigating the use of AI-empowered digital tools, particularly in primary care settings, has underscored the merits of employing a qualitative approach to comprehensively explore participants' perceptions (Laï et al., 2020; Nash et al., 2023). More particularly, in this study, I adopted a qualitative description research design (Sandelowski, 2000). I chose this approach because it is particularly well suited to gather women's perspectives and suggestions regarding a novel digital tool for preventive care, Xi-Care.

## 3.2 Participants and Sampling Strategy

According to the overarching purposeful sampling strategy (Palinkaset al., 2015), eligible participants in this investigation were adult women of 40, users of primary medical services, and presenting at least one risk factor to develop cardiovascular disease. This criterion of eligibility was applied because menopause, which typically occurs between the ages of 45 and 55, is frequently associated with an elevated risk of cardiovascular disease (Rodgers et al., 2019). In my effort to focus on the specific needs of women at excess risk of developing cardiovascular disease, certain groups of women were intentionally excluded from this study, namely: (i) women who had

previously received a diagnosis of cardiovascular disease and (ii) members of the scientific advisory board responsible for delivering medical care within the scope of this project.

Moreover, these women had to be able to provide written informed consent and possess the ability to communicate fluently in English, both verbally and in writing. For practical reasons, participants had to reside in Montreal, Quebec, Canada. In agreement with the research design adopted, I selected the final participants according to a convenience sampling technique (Robinson, 2014), always considering the following two major criteria of eligibility: age, and cardiovascular disease-related risk factors, i.e., obesity (BMI of 30), smoking, Diabetes Mellitus, Dyslipidemia, and a history of hypertension during pregnancy.

### 3.3 **Recruitment of Participants**

Following the release of the Institutional Review Board (IRB) approval from McGill University, Faculty of Medicine, and Health Sciences (see Appendix A), a trained research assistant of Abbasgholizadeh-Rahimi's Lab (M Lubamba, Master's in Public Health) and/or myself (BSc Honors in Cell and Molecular Biology) recruited participants in person at a primary care clinic affiliated with McGill University. During the period of recruitment (from December 2021 to May 2022), we approached women in the waiting room to assess their eligibility to participate in the study. If deemed eligible, we introduced the study to them and asked them for their involvement. Private rooms were made available for those who preferred a more confidential setting.

Interested participants were provided with a printed copy of the e-poster (Appendix B) and offered a consent form (Appendix C) for their signature. They were informed about the absence of known risks associated with the study, and compensation for their time was also mentioned. They were given the option to sign the consent form immediately or to request additional time. In cases where more time was needed, the consent form could be sent

electronically via email or delivered through Canada Post. Contact information, including phone number, email address, and/or residential address, was collected from potential participants.

For individuals who chose to sign the consent form in person, interview scheduling was initiated based on their convenience. For those who required more time to sign the form, it was sent electronically or delivered in person, accommodating their preferred method. Once we received the signed consent form, the research assistant scheduled the interviews with the participants at a mutually convenient time. The size of our final sample was n=15.

After individuals signed the consent form, whether in person or online (via electronic signature or email), a follow-up email was promptly sent within a two-day timeframe. This email contained a demographic and socio-economic information form, accessible through a hyperlinked questionnaire on the LimeSurvey website (Appendix D), which was completed before the interview was held.

**3.4 Data Collection**

The fifteen interviews for this study were in-depth, semi-structured, and centred around open-ended questions. Given the personal nature of the subject matter, these interviews were designed to facilitate rich and meaningful dialogues (Ryan et al., 2009). The interview guide was pilot tested with the trained research assistant (M Lubamba, Master's in Public Health) before collecting data. I took primary responsibility for conducting these interviews that took place between June 11, 2021, and May 26, 2022. However, in certain situations where logistical limitations arose, (e.g., time conflicts), the trained research assistant. On average, the interviews lasted approximately 60 minutes each. We respected the interviewees' preferences and conducted the interviews remotely using online platforms such as Zoom and WebEx. The interviewers, consisting of myself and the research assistant, which was were trained to avoid influencing the

participants' views. Instead, participants were encouraged to provide comprehensive and detailed responses by being prompted to elaborate on their answers.

The interviews consisted of two sections (Appendix E):

i. Needs assessment, which focused on gathering information about female patients' understanding of cardiovascular disease management and prevention.
    - It was adapted from the Decisional Needs Assessment in Populations Framework (Jacobsen et al.,1999).

ii. Female patients' needs and preferences on how to design Xi-Care and the use of such technology to make decisions concerning cardiovascular disease prevention.
    - It was adapted from the NASSS Framework (non-adoption, abandonment, scale-up, spread, sustainability) Framework (Abimbola et al., 2019) and System Usability Scale (SUS) Framework (Sauro, 2011).

**3.5 Methods for Analyzing Data**

I conducted an inductive semantic thematic analysis, allowing me to develop themes from the data without preconceived notions or predetermined categories (Boyatzis, 1998). I employed thematic analysis, a well-established and systematic approach, to identify, analyze, and document consistent patterns or themes within the collected data, following the work of Braun and Clarke (2006).

I accurately transcribed the recorded interviews, with the assistance of closed captions provided through the Zoom/WebEx platform for clarity. Following transcription, I developed a preliminary coding system, using the extensive data gathered from the interviews. The analysis focused exclusively on the first and second sections of the interviews as they directly related to addressing my research questions. To facilitate the analysis, I utilized the qualitative data analysis

software Dedoose (9.0.107), which allowed for systematic coding of the data in pursuit of addressing the research question.

Continuous comparison of the data that has been coded across transcripts was important as it enabled me to refine and formulate the codes in such a way that is more reflective of the concepts of interest targeted in the interview (Braune & Clark, 2022). The codes I created were used to develop the themes, in which overlapping themes addressing the same notion were merged into one concise theme (Braune & Clark, 2022). Finally, I ensured the accuracy of the themes in terms of the representations of the data and further refined them through discussion with my supervisor and thesis advisory committee. Hence, the thematic analysis of interviews and observational notes was used to determine participants' needs, preferences, and concerns in a descriptive manner (Boyatzis, 1998).

# 4 RESULTS

## Sociodemographic Characteristics of The Study Population

In this study, I interviewed a total of 15 women who met the established eligibility criteria. The largest contingent of participants belonged to the white racial group, and a majority held university degrees. Among the 15 participants, only five reported a household income lower than $62,501 before tax. Additionally, the study predominantly included married women. Table 1 (Appendix F) offers a comprehensive summary of the participants' demographic characteristics.

The systematic thematic analysis yielded six major themes, each of which is comprehensively described and interpreted in the subsequent sections:

## Theme 1. Understanding Cardiovascular Disease in a Variety of Ways

Throughout interviews, participants provided insights into their perceptions of cardiovascular disease and reflected on the factors shaping their understanding. There was a prevalent lack of comprehensive awareness concerning cardiovascular disease. Many participants understood this condition as primarily related to cardiac afflictions, often attributing its occurrence to harmful dietary practices and excessive body weight. Nonetheless, it was manifestly evident that a broader, more nuanced comprehension of this disease remained understated within the broader public consciousness.

> *"I don't know about cardiovascular diseases frankly. I'm not familiar with what even they'd be called… what I know is generally about people who have had cardiovascular issues is that they have some kind of a heart condition." – Participant 3*

Furthermore, participants highlighted an association between cardiovascular disease and exigent circumstances, including myocardial infarctions, hypertension, and unforeseen fatalities.

This dominant perspective, while perceptible, appeared to underscore a selective appreciation of the multifaceted spectrum of cardiovascular disease.

> *"Well, I think people mostly think of it as … sudden death. I don't think they realize there's a broad spectrum of disease… Everybody thinks of chest pain, but nobody understands that one of the outcomes of coronary vascular disease can be heart failure, which is really very limiting for quality of life." – Participant 2*

This tendency to selectively assimilate information serves as a hallmark of the limited grasp of the comprehensive panorama of cardiovascular disease. It is noteworthy that certain individuals suggested that engaging in regular physical exercise and adhering to a nutritionally balanced diet were essential for maintaining cardiac well-being. However, their belief was anchored in personal conviction rather than an active search for rigorous information about this medical condition.

> *"To be honest, I don't that I would really have an answer to this, because I haven't really looked into it ... because I've actually not researched that. I always kind of figured that … doing exercise would … [make] my heart healthy as well as obviously eating properly." – Participant 14*

However, a few participants offered a more comprehensive understanding of how women perceive cardiovascular disease. They underscored the elevated susceptibility experienced by postmenopausal women due to hormonal fluctuations, accentuating the imperative for tailored awareness initiatives. The need for heightened emphasis on the distinct presentations of cardiovascular disease in women was also underscored, with an acknowledgment that conventional symptoms, such as chest pain, may not consistently serve as discerning indicators.

> *"How I understand it is that women at a certain age, basically after let's say menopause, [are at] more risk because of the hormones that are not in the body anymore. Also, I think*

*women signs let's say for cardiovascular disease are very different from men. There is some awareness, but I think we, we could emphasize a little bit more so that people can recognize the signs, the different signs versus men and women" – Participant 1*

Furthermore, leveraging social media platforms and establishing websites tailored to women's needs for disseminating information about cardiovascular disease emerged as another impactful strategy.

**Theme 2: Multifaceted Barriers to Women's Cardiovascular Health Education**

There are multifaceted barriers that women encounter in their search for education on cardiovascular disease prevention. In this context, barriers refer to multifaceted obstacles, encompassing limitations in current knowledge, a prevailing misperception, and a lack of accessible information and resources.

Undeniably, an array of impediments hinders women as they strive for effective prevention of cardiovascular disease. A noteworthy subset of participants openly acknowledged the limitations of their current knowledge. They simultaneously expressed a strong eagerness to acquire knowledge and cultivate a well-informed understanding of cardiovascular disease and the proactive measures for their prevention. This genuine enthusiasm for education becomes especially relevant considering the previously emphasized misperception. There exists a misperception that women are inherently at a lower risk of developing cardiovascular disease, compared to their male counterparts or individuals with specific lifestyle habits (e.g., smoking):

*"Well, first thing comes to mind it's always about men, rarely hear about women" – Participant 7*. And:

*"I think there is still a predominance thinking that it affects men more than women and that it affects people who have … a stressful life … or [are] overweight or smoke. So, I think that's how it's perceived in my mind by the public." – Participant 11*

In line with these perspectives, there is a substantial barrier to accessible information related to cardiovascular health education for women. This deficit encompasses a lack of awareness regarding digital health tools for cardiovascular disease and limited familiarity with reliable resources. Thereby, restricting the availability of comprehensive information essential for maintaining a healthy cardiovascular system. To address this, they often relied on established and validated sources like the National Institutes of Health (NIH) and the Mayo Clinic to ensure the acquisition of accurate and credible information: *"I would say that it's terribly to say American channels push their medications so much that it kind of gives you that subliminal information you know" – Participant 12*

Furthermore, participants expressed apprehensions about the limited integration of nutritional education within Western medical training, underscoring the importance of adopting holistic approaches, such as functional nutrition, to comprehensively address these gaps.

*"I have a friend who is … into … holistic things, she's going to study functional nutrition… That's like not even offered in Canada… I mean like considering that the food is literally like our gas, and … the fact that doctors like in the Western world don't do a single course of nutrition is just alarming like really worrying… I was in shock when I found out." – Participant 14*

Ultimately, participants encouraged educational and awareness initiatives tailored to women regarding the ailment, coupled with the provision of pertinent resources, with an emphasis

on the integration of comprehension of early disease indicators and age-related susceptibility, into educational contexts.

**Theme 3: Preeminent Challenges in Cardiovascular Disease Primary Prevention**

Women face challenges in their pursuit of primary preventive measures against cardiovascular disease. Challenges, in this context, refer to the tasks or difficulties that women face in the process of seeking education on cardiovascular disease primary prevention, including the need to overcome misperceptions and balance competing responsibilities.

The participants underscored a significant challenge related to the disparity in visibility between cardiovascular disease and other health conditions in government initiatives. They emphasized the pressing need to elevate the emphasis on cardiovascular disease prevention, similar to the attention given to conditions like breast cancer. Furthermore, they called for a more nuanced focus on sex-related indicators of cardiovascular disease and the active inclusion of women in clinical trials to address the unique impact of cardiovascular disease on women: *"I think, biology for women is different so I also think the pressures and the impediments to preventing cardiovascular health are different." – Participant 2*

Further, participants consistently emphasized the profound challenge of women prioritizing self-care and achieving a harmonious equilibrium in managing their personal and professional lives. They highlighted the need for a deep-seated introspection, urging women to assess and modify habits, all while recognizing the inherent challenge of prioritizing well-being amidst their multifaceted responsibilities: *"Prevention is better than cure... For women, it's more challenging, [than] men, because [as] women, we have to work more, and we have more responsibility." – Participant 05.* And: *"I think I think we're dealing with so many things on the time we don't put ourselves first." – Participant 12*

Throughout these discussions, participants mentioned a recurring challenge in the promotion of an active and health-conscious lifestyle as a foundational preventive measure against cardiovascular disease. The participants acknowledged the numerous merits of physical activity and its profound impact on overall well-being: *"I think that working out makes you feel good, and it ... release the good chemicals. So, ... I think that like once you start it's like not an issue. It's really the motivation to go to start at the beginning." – Participant 14*

However, they candidly acknowledged the intricate challenge of maintaining a nutritious diet, particularly when confronted with the omnipresence of fast-food establishments. Despite being well aware of the unsuitability of such foods, the convenience and ubiquity of fast food presented formidable obstacles to consistently making healthy dietary choices.

> *"But in life, everything that's wrong is out there. So, if I'm exhausted and I want to go home and I don't want to cook dinner. I just go through a drive through McDonald's it's so easy. And it's such garbage and yet, for some reason, everybody's addicted to it. And you know that's a big problem… there's no healthy food to go pick up and go. it's just garbage and it's so easily accessible, even at work, you know someone will come in and bring doughnuts" – Participant 6*

Collectively, participants articulated the compelling challenge of comprehensive educational efforts and tailored messaging to women. They recognized the complexities of navigating the vast sea of health advice, highlighting the significant challenge of finding reliable information. Accessible and credible resources are paramount to addressing this challenge effectively: *"I think there's a lack of it. I'm like I said earlier, we rarely hear about it. For men, it's a different story but for women it's barely out there." – Participant 7*

While acknowledging the existence of programs like the Women's Healthy Heart Initiative (WHHI), by McGill University Health Centre (MUHC), participants stressed that these programs face the daunting challenge of further development to enhance their effectiveness. They emphasized the crucial challenge of improving women's access to information and raising their awareness of the implications of cardiovascular disease. Empowering women with the knowledge needed to proactively embrace preventive measures could potentially lead to improvements in both their cardiovascular health and overall quality of life: *"I think that the MUHC also has a program for women and heart disease. But I don't think that it's developed as it should be." – Participant 2*

**Theme 4. Women Taking Charge of Their Cardiovascular Well-being**

This theme delves into women taking charge of their cardiovascular health, exploring their significant decisions related to cardiovascular health, their involvement in decision-making processes, and the individuals influencing these decisions. These themes resulted from the merge of two major subthemes: (1) women's proactive role in cardiovascular health, and (2) empowered decision-making in cardiovascular health.

Subtheme 4.1: Women's Proactive Role in Their Cardiovascular Health

Participants outlined a spectrum of decisions regarding their cardiovascular health management, reflecting distinct perspectives on their health-related choices. One cluster described a more traditional approach of using medical remedies before seeking professional advice for high blood pressure concerns. However, they noted that they would adopt a different approach for their older mother, versus a younger individual.

> *"My mother, she's older. [if] She felt …[a] problem [we] go for [seeing a] doctor for her checkup, because she's older. But as … we are younger… we [have more] …] stamina is*

*more…That's why… I don't feel [ the need] to go [see a] doctor for my checkup." – Participant 5*

Conversely, others emphasized the importance of incorporating physical activity and maintaining healthy dietary habits. They stressed the value of regular activities like swimming and walking as pivotal preventive measures and the need for a suitable, personalized healthy diet along with moderate alcohol consumption. However, it is difficult to make substantial lifestyle changes for cardiovascular disease prevention, especially when symptoms are not evident, and life's challenges divert attention from health concerns.

*"Well, I guess the decision to make some lifestyle changes, I think, is the most important one. And I think the problem is that, because you can have cardiovascular disease and not be symptomatic that it's too easy… just [to] get distracted by the problems of everyday living and not pay attention." – Participant 2*

Subtheme 4.2: Empowered Decision-Making in Cardiovascular Health

Participants displayed a variety of approaches to decision-making regarding their cardiovascular health, involving personal research, consultation with healthcare professionals, shared discussions within their social circles, or a combination of these. For example, engaging in discussions with physicians and supplementing this with personal research to facilitate informed conversations with healthcare experts. While underscoring their ultimate authority over the final decision, often aligned with professional suggestions: *"I don't believe in a doctor making all my decisions because when I go to his office. I expect to have a discussion, not a mandate." – Participant 04*

However, a pivotal observation is the significance of acknowledging and accommodating cultural contexts and levels of literacy. There is an essence of collaborative decision-making with

physicians, advocating against a unilateral approach where patients are merely recipients of instructions. Stressing the importance of patients' active involvement, the participant highlighted the necessity for physicians to be mindful of their patients' cultural backgrounds and dietary preferences.

> *"I really believe that when we go to doctor's office, we're not just there to be told what we have to do. And I believe that the patient should be involved in that decision-making… Simply because we're from different ethnic backgrounds; we do things differently; we eat differently; and therefore, it's important for the doctor or whoever it is to know what these foods are" – Participant 4*

On the other hand, some participants detailed a multi-dimensional approach involving personal research, consultations with medical experts, and discussions with their spouses or close family members. In contrast, a subset of participants expressed a preference for independent decision-making: *"I make the decisions myself." & "My husband is still around... I share it with my husband." – Participant 11*

**Theme 5. Mixed Perspectives Regarding Digital Technologies Use for Cardiovascular Disease Prevention**

In the second segment of the interviews, I asked participants about their perspectives on using innovative technology for cardiovascular health decisions and their experiences with decision-making tools designed to enhance their cardiovascular well-being. This theme delves into both the positive sentiments and apprehensions regarding the use of digital health tools for cardiovascular disease prevention.

Participants displayed enthusiasm and support for the development of health-related apps, particularly those that offer convenient options not only to patients but also to physicians. These

apps were seen as valuable tools for providing an overview of how the risk of cardiovascular disease evolves, starting from a baseline.

They further expressed a general agreement that people of all age groups, including the younger and older generations, benefit from cutting-edge technological advancements. They emphasized the importance of using modern technologies to improve overall health, especially in today's technology-driven era. However, an essential observation made during the interviews pertained to the language used when presenting recommendations through these tools: *"I think it is important because right now, especially [for] the young generation, and of course… older as well… They are affected by mobile technology" – Participant 5*

The intention behind incorporating health-focused digital tools was not to enforce actions or dictate choices but to increase user awareness and maintain active involvement in enhancing and monitoring health. Equally important was the provision of a substantiated rationale, along with resources supporting the rationale behind adhering to these recommendations.

> *"I do like it. I'm very techie …I think if I had an app that would provide me [with] some information and choices. I would still go, and [get] research done…I don't think I could base my decision on information provided to me in that sense. I have to go back and then and look it up first. I need more than just lay information… You need more information to base to support your information. empowered with information. "– Participant 1*

In essence, the key to the effective use of these tools lies in reinforcing the reliability of recommendations and empowering users to modify their behaviours through the presentation of substantiating evidence and citations.

*"Well, you know what I do feel about it. It's like I said ... I think the key question ... or the key point is that it's not sufficient to provide people with data. You have to give them a reason to change. And to the extent that the app is helpful for that" – Participant 2*

When considering the usage of decision support system tools, not all participants had prior experience with such tools, and some did not directly associate them with cardiovascular health but rather with general health concerns. However, some participants recounted experiences with specific tools, such as the Opal app for stress reduction and sleep improvement or tools designed to aid in breast cancer therapy decisions.

*"I think I'm the only decision-making tool that I'm kind of familiar with, you know, in terms of choosing therapy for patients is that there's these graphs that you can use, you know, which each little square being a percent to help women decide if they want to do hormone therapy for breast cancer." – Participant 2*

Additionally, some participants mentioned digital tools for step counting, the use of Apple watches for goal setting, health education, monitoring, and familiarity with digital technology like robots and AI systems. However, a few participants lacked the necessary literacy to fully comprehend the concept of AI's role in medical care: *"I never heard of the, what do you call it again. Artificial intelligence system or robot so I am not able to give an answer on that right now." – Participant 4*

**Theme 6. Range of Suggestions for the Format and Design of a Prospective AI-enabled Digital Health Tool (Xi-Care)**

Participants engaged in discussions concerning the prospective integration of the app into their daily routines, yielding an average ranking of 4.5 out of 5.00 for the perceived difficulty associated with assimilating the Xi-Care. These themes resulted from the merge of two major

subthemes: (1) enhancing Xi-Care's accessibility and user experience, and (2) women's perspective on suggested features in Xi-Care.

Subtheme 6.1: Enhancing Xi-Care's Accessibility and User Experience

The interviews brought to light various suggestions regarding the accessibility and userfriendliness of the prospective Xi-Care. This subtheme encompasses two essential criteria for the

Xi-Care:

6.1.1. General Criteria for the Tool Setting

Participants consistently stressed the importance of customization and user satisfaction to cater to diverse demographics and individual preferences. Also, they viewed the personalization of features, goals, and risk assessments to align with each user's specific requirements as pivotal criteria. This adaptability is crucial not only for augmenting user engagement but also for enhancing the overall user experience.

Participants further highlighted the need for features that allow users to monitor their performance and receive real-time reminders and feedback to enhance adherence. They recommended engaging features such as tracking user progress, assessing risks, and visually representing data using charts for easier comprehension: *"Maybe your phone could just give you a signal to take a deep breath and relax that I think that'd be very wonderful because we all get into these intense situations, and we can get ourselves riled up" – Participant 6*

Participants emphasized the need for a visually appealing app with multilingual support, ensuring accessibility for a diverse user base. Particularly, multilingual support was highlighted to cater to older demographics and those more comfortable with their native language: *"For sure multi-language that's, that's something that is important." – Participant 01.* And: *"Colorful*

*appealing. it's it ...[has] to be visually appealing. You want to go into it." – Participant 10*

Acknowledging varying levels of digital literacy, especially among older individuals, participants emphasized designing an app that ensures ease of use for all user demographics. Simplifying the user experience and considering literacy levels were deemed essential: *"You have to make the user experience, the easiest and simplest possible. The least amount of work that they're going to have to do the better in terms of like the user experience". – Participant 14*

6.1.2. Facilitating Data Collection and Monitoring

Participants underscored the significance of data collection features that positively influence user engagement. They explored the balance between automated data collection and manual input, recognizing the potential burden of constant manual data entry. The tool's capability to automatically collect data and suggest relevant actions was seen as a valuable feature, reducing the burden on users: *"Tracking the meds, tracking the exercise. I think it would be great." – Participant 7*

There was an emphasis on the value of a comprehensive monitoring approach, covering both health risks and user behaviours. They highlighted the need to closely monitor data and integrate the tool into collaborative efforts with medical professionals and other health monitoring apps: *"Follow the progress in two ways. I mean, I know you probably have certain pre-determined questions… So, yes follow the progress in terms of monitoring the risk and follow the progress in terms of monitoring the behaviours." – Participant 2*

Participants suggested compatibility with various devices and smartwatches, advocating for integration with widely used health monitoring apps like Google Fit and Apple Health. This integration was seen as a practical approach to enhance the app's performance and user accessibility.

*"If you can automate things… for example, with the Apple health app, and I don't know what does it equivalent is on Android, then I think that would be really cool because and they would have like an overall overview of their health. That's important… The integrative aspects of it, I think, is really important terms of an app." – Participant 14*

Subtheme 6.2: Women's Suggestions for Xi-Care features

During the interviews, women were asked to rank specific features of the Xi-Care based on their interest and relevance using a Likert scale. The scores for six preliminary features are summarized in Table 2 (Appendix H) Here are the details of the discussions on each feature:

Feature 1: Educational Modules on Cardiovascular Health

This feature obtained an average interest rating of 4.5 out of 5 as depicted in Table 2 (Appendix H). Suggestions regarding the format of educational modules spanned from succinct summaries accompanied by hyperlinks to authoritative sources for further exploration, to multimedia elements encompassing videos, images, and infographics, particularly for individuals who may have difficulty with textual information: *"Especially for those who are not educated, I would say like a video is very helpful, easy to understand." – Participant 9*

Furthermore, a novel concept emerged, involving the integration of notifications within the learning modules, which entails receiving periodic reminders containing cardiovascular healthrelated information.

*"[if] It was a quick message, saying… drinking… X number of litres of water a day is great for your cardiovascular health. That's great... I'll process that piece of information.*

*But…[am I] going to go read, that I should be drinking water, and I should be this… probably not." – Participant 12*

Additionally, a suggestion was put forth to ensure that these modules encompass general information without advocating for self-diagnosis. Rather than solely emphasizing mortality attributed to cardiovascular disease, these modules would pivot towards highlighting the influence on quality of life: *"I think one of the things that people need to be told is. Look, it's not about whether you live or die. It's a question of how you live before you die." – Participant 2*

Feature 2: Diet Recommendations

Diet was seen as a critical factor in heart health, obtaining an average interest rating of 4.4 out of 5 as depicted in Table 2 (Appendix H), with unanimous consensus on its influence on cardiovascular well-being. Given the potential complexity of adhering to dietary recommendations, the introduction of reinforcement mechanisms and the establishment of challenges or milestones could potentially serve as effective strategies. These approaches might facilitate the sustained motivation of users and stimulate improvements in their dietary behaviours: *"Well, fun challenges are fun awards…[to] keep them [users] motivated to follow these diet recommendations." – Participant 14*

Furthermore, these recommendations could be presented through video-based culinary courses, provision of recipes, or comprehensive information about the essential nutrients that could be incorporated into their routine dietary practices: *"A video for a cooking with lessons" – Participant 13*

Likewise, participants emphasized the necessity of adopting a constructive approach toward this feature. Instead of solely instructing users to avoid certain foods, they suggested that providing nutritional information about foods that can be consumed to improve cardiovascular health would be more beneficial: *"There's a lot of recommendations that I don't want. I'm very selective in terms of what I eat, and there's a lot of stuff that is recommended that I don't eat." –*

*Participant 03*. And: *"When you want to change people's eating habits, it's easier to tell them…eat one piece of fruit in the afternoon, as opposed to saying, don't eat a donut in the afternoon… deprivation doesn't get very far." – Participant 2*

Feature 3: Guided Personalized Exercise

This feature obtained an average interest rating of 4.3 out of 5 as depicted in Table 2 (Appendix H). The subject of exercise gathered substantial interest among the participants, with many integrating it into their daily routines through various means like gym memberships and home workouts. Suggestions included personalizing exercise routines based on age, physical condition, and preferences to motivate users to maintain a consistent exercise regimen.

> *"If it was a personalized program, I would like that. Okay, [for example] videos, I mean there's so many on YouTube… and there's so many apps … but if they would … take my age … [and] take my condition…personalize exercise would be good." – Participant 1*

However, some participants raised concerns about the technical feasibility and safety of personalized workouts. They preferred guidance from experts, such as physiotherapists, to customize their workouts and cater to their requirements: *"I guess generally when it comes to something like that, I guess I would probably prefer … a physio, or somebody like a professional person who would have spoken to me and assessed me." – Participant 15*

Feature 4: Monitoring and Tracking of Health Data

This feature received the most favourable response, obtaining an average interest rating of 4.9 out of 5 as depicted in Table 2 (Appendix H). Participants highly valued the inclusion of data monitoring tools, especially for tracking health progress and making informed decisions, particularly when coupled with follow-up data, such as laboratory results and blood pressure measurements.

*"Tracking data is important because...if I start this month, and I… continue to input my data for a long time, so I can understand that improvement or… other negative side… I mean that rate of change so that [it] will help me to understand, like the quality and the progress of my health." – Participant 5*

Moreover, this functionality would enable users to track and comprehend changes in their health over time, resulting in efficient updates to their health data, such as weight, and saving them time in the process. Participants appreciated the convenience of monitoring their health data and found it, particularly reassuring for conditions that might not be outwardly observable.

*"I would like to know if there are things to be aware of that I might not know myself because I think we tend to just put things off …I guess the fear is that … it's going to indicate things that aren't, I guess it [monitoring tool] has to be pretty precise." – Participant 12*

However, concerns were raised about the addictive nature of monitoring technologies, with some individuals becoming overly reliant on wearable devices.

Feature 5: Step Count (Pedometer)

Pedometer obtained an average interest rating of 4.5 out of 5 as depicted in Table 2 (Appendix H). The integration of this feature was perceived as a straightforward activity that could seamlessly blend into participants' daily routines. Anticipations leaned towards the notion that adherence to this feature could be enhanced if it were to include predefined goals and challenges: *"It could be something that I would possibly adhere to increase and improve my health. but just to tell the steps, without like a goal, to me, it's not something that I look at." – Participant 1* Furthermore, this feature could serve as a compensatory measure for individuals who find regular exercise challenging or inaccessible, perceived as a simpler option, benefiting those struggling

with maintaining a consistent workout routine, including the elderly: *"It will help me to know. I mean workout is important for us but… I think it's difficult is sometimes." – Participant 05*. And: *"It obviously can differ among the different generations. You know the different … life stages. basically, so, I think that would change, depending on the lifecycle state… Maybe for a senior, it would be more important." – Participant 14*

However, participants raised concerns about the actual impact of step counts compared to cardiovascular exercises. Thus, they wanted information on how step counts relate to health benefits, making it more motivating.

Feature 6: Weight Tracking

This feature received the lowest rating was the inclusion of data monitoring tools within the Xi-Care, with an average interest rating of 4.1 out of 5 as depicted in Table 2 (Appendix H). Tracking progress to measure the effectiveness of their actions and behaviours on user's health is valuable, especially for individuals concerned about weight-related stress. Some suggested that weight tracking should be combined with other features and personalized for different users: *"If the weight tracking feature had different options, I guess, for different people, according to… what they decide with their dietitian or doctor, whatever."– Participant 2*

Conversely, weight measurements do not inherently require daily tracking. Several participants voiced the notion that being prompted to report their weight daily could be counterproductive. They emphasized that significant improvements require time to manifest, thus suggesting that the monitoring of weight and the assessment of associated risks should not be conducted daily:

> *"If an app is something that's meant to be used from day to day. Then I don't think putting the weight in is helpful if the app is going to include … a feature every three, … six or nine*

*months. You know, tracking your overall. I mean I don't think people should be looking at their risk, you know, recalculating their risk you know every week… recalculating the risk might be something that can be done every three months, you know, monitoring the behaviours. As a process that's that can be done more often."– Participant 2*

Various viewpoints on this matter revolved around health considerations, while others delved into aspects of self-consciousness and preoccupation. They stressed their preference for concentrating on sustaining a healthy lifestyle instead of fixating solely on the numerical value displayed on the scale.

# 5 DISCUSSION

This study investigated the perspectives of women at an elevated risk of cardiovascular disease. At its core, this research focused on understanding women's views on cardiovascular disease, with a particular emphasis on the potential role of Xi-Care, an AI-enabled digital health tool tailored for primary preventive care among women. Through qualitative methodology and in-depth interviews, this investigation sought to describe women’s receptiveness towards integrating digital health tools like Xi-Care in primary care. The goal was to unearth insights into these perspectives and to gather meaningful suggestions for the development and effective utilization of the tool. This chapter aims to answer the research questions and dissect the main findings of this investigation.

The findings first suggest that while there is some awareness of cardiovascular disease among participants, it often encompasses a limited view that overlooks the comprehensive range of complications, particularly the distinct risks and symptoms that post-menopausal women face. The disparity between the reality of cardiovascular disease as the leading cause of mortality among women and their awareness and understanding of the disease's risk factors and implications is concerning. This gap is emphasized by Roth et al. (2019), who pointed out the disconnect in women's recognition of their susceptibility to cardiovascular diseases. This narrow perspective is compounded by a worrying trend highlighted in recent literature, where engagement with cardiovascular health among women, especially younger ones, is declining, in contrast to their older counterparts (Berry et al., 2016; Cushman et al., 2021). This demographic discrepancy contributes to an underestimation of heart disease as a significant health threat, even though it remains the leading cause of death among women (Berry et al., 2016; Roth et al., 2019).

Moreover, the findings draw attention to the health education challenges experienced by participants regarding CVDs prevention. inadequate focus on cardiovascular disease in public

health initiatives targeting women, where they are often eclipsed by other health concerns like breast cancer. This observation aligns with the research by Berry et al. (2016) and Sutantri et al. (2023), which noted an underestimation of cardiovascular disease risk among women compared to a heightened awareness of breast cancer. The lack of sex-specific health guidelines, as shown by Mosca et al. (2011), exacerbates this issue, pointing to a significant educational shortfall in public health. Further, the study highlights societal challenges women encounter, which may inadvertently cause their health needs to be overlooked.

According to the participants, societal expectations and abundant obligations create a scenario where self-care and health are neglected. Furthermore, challenges in sustaining a nutritious diet and an active lifestyle amidst these pressures. Echoing these concerns, BeanMayberry et al. (2022) identified key obstacles to better cardiovascular health, including a lack of motivation, difficulty in prioritizing personal health, and the challenge of balancing wellness with family and professional responsibilities.

However, the study points out a growing interest in digital health tools, with a particular emphasis on the need for features that foster an engaging user experience. This would offer customized health recommendations, reflecting a broader demand for personalization in health technology. Such personalization is not merely a matter of functionality; it reaches into the essence of feminist intersectionality, recognizing the diverse identities users bring, including differences in race and age, as noted by (Couto et al., 2019; Figueroa et al., 2021). The pursuit of a humancentred, or user-centred, design is thus vital, as it seeks to diminish biases and bolster the efficacy of digital health tools for an inclusive user base, a principle supported by (Nijagal et al., 2021). Moreover, the integration of intersectional sex analyses in the development of digital health tools ensures that interventions are precisely tailored to distinct population subgroups, thereby respecting the

heterogeneity of experiences. This tailored approach is particularly crucial for older users who may not have the same level of technological literacy. Ultimately, the inclusion of a diverse range of stakeholders in digital health development is essential. This ensures that the viewpoints and healthcare requirements of all women, especially those from underrepresented groups, are not only heard but are also actively integrated into healthcare solutions.

Xi-care is as an innovative digital tool specifically designed for women's cardiovascular health, enabling a personalized approach to care. This tool incorporates a dual interactive system, one tailored specifically for women, the focus of my thesis, and another for primary care providers. The first system provides a various collection of primary options and educational resources on cardiovascular disease. The other enables primary care providers to assess a woman's cardiovascular disease risk and strengthen the critical role of the providers in patient education and engagement. Xi-care will be available as a mobile and potentially web application, to ensure effective communication between patients and their providers. For example, before a medical visit, Xi-care could engage women with evidence-based information on cardiovascular health, prevention, and a summary of their lifestyle routine (e.g., diet, physical activities… etc.), which is preparing for their visits. The tool also aims to enhance the efficiency of the clinical consultation by assisting physicians in guiding discussions on relevant screenings and lifestyle modifications based on the patient-specific profile. Thus, making appointment times more personalized to the patient's needs. However, to do so, women provided suggestions for the important features of the tool to ensure that it is developed properly to meet their needs.

In dissecting women's suggestions, there is a strong interest in having "Educational Modules" as part of the Xi-Care, for improving awareness and primary prevention of cardiovascular disease. Ultimately, these modules would assist in ameliorating the user's

understanding, enhancing patient empowerment, and improving health outcomes. This aligns with the current evidence that indicates that educational interventions significantly enhance selfefficacy, instilling confidence in users to manage their health behaviours effectively for cardiovascular disease prevention (Mohammadkhah et al., 2023). Furthermore, findings highlighted that educational modules could provide users with the needed knowledge is important to make informed health decisions. According to Mohammadkhah et al (2023), these modules play a critical role in reducing perceived barriers to healthy practices, making it easier for participants to adopt and maintain behaviours conducive to cardiovascular health.

Regarding the “Diet Recommendation”, findings highlight the appreciation of such intervention which provides practical and encouraging dietary advice. Moreover, there is a need for tailored diet plans which consider individual preferences and lifestyle factors. This approach can be more effective in preventing cardiovascular disease. And it resonates with the personalized medicine movement in healthcare, which has been shown to improve patient outcomes (Hong et al., 2023). Furthermore, findings illustrated that by transforming complex nutritional information into engaging, easy-to-follow video tutorials, this approach effectively simplifies the journey from complex nutritional information to practice in cooking. Thereby, encouraging individuals to embrace healthier eating habits with confidence. This concept aligns with Surgenor et al. (2017), who emphasize the empowering role of such interventions in boosting self-efficacy and demystifying the art of meal preparation.

Moreover, the study’s findings underscore the benefits of "Personalized Workouts", which ensure the workout regimen is not only impactful but also harmonizes with the user's way of life. Tailoring exercises to each individual's health condition, fitness level, and objectives, is essential for fostering sustainable health results (Ghanvatkar et al., 2019). This personalization ensures the

workout regimen is not only impactful but also harmonizes with the user's way of life. In contrast, the "Step Count" functionality takes a broader stance, emphasizing the essential element of physical activity: mobility. It offers an uncomplicated method to encourage physical activity, particularly suitable for individuals who may find organized exercise plans impractical due to time restrictions or the lack of exercise facilities. The contrast between these functionalities broadens the tool's applicability, addressing the needs of a diverse user base from those desiring bespoke exercise plans to those looking for simple methods to increase daily physical activity.

The highly rated feature of “Monitoring and Tracking of Health Data” stands out. This feature's popularity might underscore a growing inclination toward the Quantified Self-movement. Self-knowledge through self-tracking, which is increasingly sought after, has the potential to enhance health and well-being (Feng et al., 2021). According to Wittkowski et al. (2020), self-tracking technologies can empower users by providing customized health data. Yet, their effectiveness largely hinges on the user's self-efficacy, the belief in their ability to complete tasks and reach goals. Users with low self-efficacy may find these technologies counterproductive, possibly discouraging them from following health advice. In addition, the concurrent concerns about the potentially addictive nature of such technologies highlight the need for a balanced approach to design. As Brubaker (2020) illustrated, the ubiquity of digital technology can lead to over-dependence, making it crucial to incorporate mindfulness and balance into our interactions with technology. It’s a subtle yet profound reminder that while technology can be empowering, it must also be tethered to a sense of mindfulness to prevent over-dependence.

Conversely, the feature of “Weight Tracking”, scoring the lowest, might reveal a shift in health management perspectives. This diminished interest might indicate a movement away from traditional health indicators like weight, favouring a more holistic approach to cardiovascular

health. Such a model is further reinforced by the considerable interest in features like Educational Modules, Diet Recommendations, and Personalized Exercise Programs, pointing towards an integrative view of health. This trend reflects a growing awareness among users of the need for multifaceted health indicators, recognizing that a singular focus on numbers, such as weight, does not suffice for a comprehensive understanding of health and well-being (Raja & Rajasekar, 2023). Additionally, McCallum et al. (2023) illustrated how incorporating psychological support into weight management can enhance the effectiveness of addressing cardiovascular risk factors by not only reducing anxiety and increasing physical activity but also by improving overall heart health.

## 5.1 **Study Strengths and Limitations**

This study represents a pioneering initiative in the realm of primary care, focusing on the development of a digital tool specifically tailored for the primary prevention of cardiovascular disease in women at heightened risk. It is distinguished by the exploration of the nexus between women's health and AI-enabled digital health technology within a primary care setting. This meticulous approach substantially reinforces the study's academic rigour, relevance, and potential impact within the domains of primary care and digital health research. Moreover, the study underscores the salience of patient-centred methodologies and the revolutionary capacity of technology to reform cardiovascular medicine while confronting health disparities (Mosca et al., 2011).

However, the study does encounter certain constraints. The focus on a specific subset of women at risk of cardiovascular disease from one clinic located in an urban area limits the transferability of the study findings to similar contexts. An additional limitation resides in the limited criteria used for the selection of the participants (we adopted a convenience sampling approach), which did not include participants' socio-economic and cultural background, and digital

literacy in the use of AI-empowered digital health tools. This should be important to consider in future research, considering the very recent democratization.

## 5.2 Practical Implications

Women acknowledged the lack of educational initiatives that are sex specific and revealed their openness towards digital tools that could potentially assist in navigating primary prevention of cardiovascular disease. This consensus points towards a critical gap in current primary care practices —specifically, the underrepresentation of women understated cardiovascular disease's symptomatology in clinical decision-making. Accordingly, incorporating women's perspectives on cardiovascular health into Xi-Care's features (i.e., educational modules) could lead to earlier, sex-sensitive interventions and personalized educational initiatives.

Engaging both patients and primary care providers in the development process, Xi-Care can be refined to meet the diverse needs of women at risk of developing cardiovascular disease and health professionals, notably family physicians. Sustaining this collaborative process becomes an integral part of clinical practice that enhances the quality of care for women and aligns with the personalized nature of Family Medicine. Moreover, engagement of end users in the iterative design of digital tools is essential to address the practical needs of a diverse patient base, effectively democratizing AI and digital health tools benefits in healthcare.

## 5.3 Theoretical Contributions

Our study illustrated how digital health tools could potentially be leveraged to advance women's cardiovascular health. The findings of this study contribute to the advancement of knowledge in the discipline of Family Medicine, whose practice involves preventive actions, by revealing the potential of developing Xi-Care to facilitate targeted educational initiatives that promote behaviour changes. Such a tool can deliver personalized health recommendations,

fostering an excellent initiative for preventive practices and empowering women to take proactive steps and enrich their understanding of their health.

In addition, our study reinforces the core of the patient-centred care approach by showcasing how technology can be tailored to respect and respond to the unique preferences, needs, and values of users. Incorporating the suggestions of our participants into the design of our tool ensures that patient values guide clinical decisions, thereby enhancing the patient-provider relationship and improving the quality of care. Thus, Xi-care might add value to Family Medicine that prioritizes personalized education as a cornerstone of prevention and champions the customization of healthcare tools to align with the lived experiences and health goals of women.

## 5.4 **Recommendations for Future Research**

In advancing the scope of cardiovascular health research for women, a concerted effort is required across a variety of demographic groups. Future research must be inclusive of different age groups, ethnicities with a known predisposition to higher risks, those from economically-disadvantaged backgrounds, and larger cultural groups. This extension is essential to disclose the substantial variations in awareness, education, and the distinct presentation of cardiovascular conditions according to sex. Additionally, a comprehensive understanding of AI and digital health tools from the perspective of women is crucial. Future steps of the team include the development of Xi-Care and its evaluation and validation among women with diverse backgrounds at excess risk of cardiovascular disease.

# 6 CONCLUSION

There is a limited understanding of women's cardiovascular health, yet there is a clear recognition of the substantial potential for AI-enabled digital health tools to strengthen primary prevention efforts. Furthermore, there is a pressing need for the sex-specific application of digital tools within primary care to effectively address the distinctive cardiovascular health challenges faced by women. The notable receptivity and willingness among women to engage with digital health interventions, exemplified by the Xi-Care initiative, signal a promising trajectory for the enhancement of cardiovascular health education and the bolstering of preventive practices in the practice of family medicine, yet other healthcare providers. The patient-centred design of Xi-Care is commendable for its inclusivity, advocating for the incorporation of a wide spectrum of women's experiences in its development process, thus ensuring that the digital health tools are precisely attuned to their unique needs and preferences.

Reflecting on these outcomes, the study posits strategic recommendations for forthcoming research in family medicine. It suggests that subsequent investigations should integrate a broader and more varied population of women to ascertain the comprehensive applicability of digital health tools in the prevention of cardiovascular disease. Furthermore, this investigation underscores the imperative for continuous collaborative engagement among healthcare professionals, patients, and technologists to guarantee that digital health solutions are not only accessible and intuitive but also efficacious in advancing cardiovascular health among women.

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# APPENDIX

## Appendix A. IRB Approval

McGill | Faculty of Medicine and Health Sciences | Faculté de médecine et des sciences de la santé

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08 March 2021

Dr. Samira Abbasgholizadeh-Rahimi
Department of Family Medicine
5858 Ch. Côte-des-Neiges, Suite 300 (#330)
Montreal QC H3S 1Z1

**Info-Ed File Number:** **21-02-049** **(IRB Internal Study Number:** A03-B22-21A**)**

**Study/Protocol Title:** *Explainable intelligent system for cardiovascular disease management among women in primary care: need assessment*

**Principal Investigator**: Samira Abbasgholizadeh-Rahimi

**Sponsor Name (if applicable):** Canadian Institutes of Health Research (CIHR)

Dear Dr./Professor Abbasgholizadeh-Rahimi,

Thank you for submitting the above-referenced study for an ethics review.

As this study involves no more than minimal risk, and in accordance with Articles 2.9 and 6.12 of the 2nd Edition of the Canadian Tri-Council Policy Statement of Ethical Conduct for Research Involving Humans (TCPS 2) and U.S. Title 45 CFR 46, Section 110 (b), paragraph (1), we are pleased to inform you that a delegated review was conducted and ethics approval for the study was provided by the IRB Chair on 08 March 2021. **The ethics certificate is valid until 07 March 2022**. The study proposal will be presented for corroborative approval at the next meeting of the Institutional Review Board.

The following documents were reviewed and approved:

- Study Protocol (includes Initial Review Form, Budget, and Data Management Plan) dated 8 March 2021
- Email for recruitment of care providers in domain of cardiovascular diseases
- Follow-up email after receiving response to send the consent form to care providers
- Information and Consent Form (Care Providers), version 05 March 2021
- Script and Interview Questions: Primary Care Providers
- Script for recruitment of women at risk of cardiovascular diseases
- Information and Consent Form (Women at risk of CVD), version 05 March 2021
- Script and Interview Questions for women at risk of CVD.

***Consideration should be given to the inclusion of French language speakers given the demographics of the Province of Quebec. Please review the Tri-Council Policy Statement, 2018, Article 4.1: Appropriate Inclusion.***

The Faculty of Medicine Institutional Review Board (IRB) is a registered University IRB working under the published guidelines of the Tri-Council Policy Statement 2, in compliance with the Plan d'action ministériel en éthique de la recherche et en intégrité scientifique (MSSS, 1998), and the Food and Drugs Act (17 June 2001); and acts in accordance with the U.S. Code of Federal Regulations that govern research on human subjects (**FWA 00004545**). The IRB working procedures are consistent with internationally accepted principles of good clinical practice.

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**The Principal Investigator is required to immediately notify the Institutional Review Board Office, via amendment or progress report, of:**

- Any significant changes to the research project and the reason for that change, including an indication of ethical implications (if any)
- Serious Adverse Effects experienced by participants and the action taken to address those effects
- Any other unforeseen events or unanticipated developments that merit notification
- The inability of the Principal Investigator to continue in her/his role, or any other change in research personnel involved in the project
- A delay of more than 12 months in the commencement of the research project, and
- Termination or closure of the research project.

***The Principal Investigator is required to submit an annual progress report (continuing review application) on the anniversary of the date of the initial approval (or see the date of expiration).***

The Faculty of Medicine IRB may conduct an audit of the research project at any time.

If the research project involves multiple study sites, the Principal Investigator is required to report all IRB approvals and approved study documents to the appropriate Research Ethics Office (REO) or delegated authority for the participating study sites. Appropriate authorization from each study site must be obtained before the study recruitment and/or testing can begin at that site. Research funds linked to this research project may be withheld and/or the study data may be revoked if the Principal Investigator fails to comply with this requirement. A copy of the study site authorization should be submitted the IRB Office.

It is the Principal Investigator's responsibility to ensure that all researchers associated with this project are aware of the conditions of approval and which documents have been approved.

The McGill IRB wishes you and your colleagues every success in your research.

Kind regards,

Roberta Palmour, PhD
Chair
Institutional Review Board

cc: Associate Dean, Research (Medicine)
A03-B22-21A / 21-02-049

**Appendix B. E-poster**


***What is the purpose of this study?***

We will assess the needs, preferences, perspectives, and ethical concerns for the future development of an AI technology used to predict and prevent cardiovascular diseases (CVD) in women.

***Why are we studying this?***

CVD is the leading cause of death globally and the second leading cause of death among women in Canada.

***Who are we looking for?***

Women over the age of 40, living in Quebec, and able to speak and write in English with one or more of the following risk factors for CVD:

a) Smoking
b) Obesity
c) Hypertension
d) Dyslipidemia
e) Diabetes Mellitus
f) History of hypertensive disorders during pregnancy

***What will you do?***

You will participate in an approximately 60-90-minute virtual interview.

**YOU WILL BE COMPENSATED $25 FOR YOUR TIME.**

**Please contact xicare.fammed@mcgill.ca for more details.**

**Appendix C. Consent Form**


**RESEARCH STUDY TITLE**: Xi-Care: eXplainable intelligent system for Cardiovascular disease management among women in primary care; Need assessment

**PRINCIPAL INVESTIGATOR**: Dr. Samira Rahimi, Assistant Professor, Department of Family Medicine, Faculty of Medicine and Health Sciences, McGill University

**RESEARCH ASSISTANT:** Lisa Byers, Department of Family Medicine, Faculty of Medicine and Health Sciences, McGill University

**SOURCE OF FUNDING:** Canadian Institutes of Health Research (CIHR)- Strategy for Patient-Oriented Research (SPOR)

## 1. INTRODUCTION

You are invited to participate in a research study. Take the time to carefully read, understand and think about the information that has been explained and given to you included in this form. If you choose to take part in this research study, we will ask you to sign this consent form.

This form may contain some words or information that you do not understand. We encourage you to ask the researcher responsible for this research study (i.e. Dr. Samira Rahimi, the principal investigator) or a member of the research team all questions that you may have. Ask them to explain all words and information that are unclear. They have the obligation to answer in such a way that you can understand all the information presented to you.

## 2. NATURE AND OBJECTIVES OF THE RESEARCH STUDY

In Canada, 206 people die every day from cardiovascular disease (CVD), with 60% of them women (WHO, 2018). The rate of death among women with CVD is higher than men due to late CVD diagnosis; women tend to be diagnosed seven years later than their male counterparts (Heart & Stroke 2018 Heart Report, 2018). Moreover, less than one in five physicians are aware that more women than men die each year from CVD. For this reason, there is a critical need to assist primary care providers in preventing CVD among women. The overarching goal of this study is to improve quality of care and patient outcome by early detection and timely management of CVD among women using cutting edge AI technologies. Thus, our objective for this study is to assess needs, preferences, and perspectives of ethical aspects on AI among primary care providers and women at risk for CVD regarding different areas of prevention and management of CVD in women.

## 3. RESEARCH STUDY PROCEDURES

We are inviting 20-30 women over the age of 40 who are at risk for CVD to participate in our study to communicate their needs, preferences, and perspectives of ethical aspects on AI among care providers in different areas of prevention and management of CVD. We are also inviting 2030 primary care providers who have experience with cardiovascular health care to participate in our study, evaluating similar aspects.

As a participant in this study, you will be asked to:

Participate in a 60–90-minute interview. The audio-video interview will take place virtually over Zoom/WebEx audio-video call (according to McGill University's guidelines for Zoom/WebEx meetings). Before the start of the interview, a McGill University's Zoom/WebEx Tutorial will be

sent to you to familiarize yourself with the procedure (https://www.mcgill.ca/continuingstudies/ files/continuingstudies/zoomstudents_en.pdf ). The interview will continue with the questions related to the study. Interviews will be audio-videorecorded and transcribed for further analysis. All the information we collect in this interview will remain confidential.

**4. RISKS, INCONVENIENCE AND DISADVANTAGES RELATED TO RESEARCH PARTICIPATION**

There are no known risks in participating in this study; however, you may feel fatigue during interviews. You may take a 10 to 15-minute break if you wish.

You may avoid answering questions, choose to end the interview, and may withdraw from this study without consequence nor having to provide reasons for withdrawal.

To avoid a data breach, our team ensures that we are using high-encryption software for sensitive data, as well as weekly software updates. We will also be enforcing strong credentials and password-protected authentication to ensure substantial cybersecurity practices. If needed, PI will reach out to the IT team within Faculty and McGill, for further support related to data storage and data security.

**5. POTENTIAL BENEFITS RELATED TO RESEARCH PARTICIPATION**

There may not be an immediate benefit for you; however, your responses from this study will be contributing to the generation and advancement of knowledge of the applications of AI for CVD management in primary care.

**6. COMPENSATION**

We will compensate you with a $25.00 CAD e-gift card for your time answering the questionnaire and participating in the interview. Should you choose to withdraw prior to the end of the research study, the full honorarium will still be given, nonetheless.

**7. CONFIDENTIALITY**

Quebec laws require that we respect personal privacy. It is a fundamental right protected by the Charter of Rights and Freedoms, the Civil Code of Québec, The Act Respecting Health Services and Social Services as well as all professional deontological codes. As part of this research, we will collect personal, identifying information from you.

Every researcher involved in the project adheres to a privacy policy. Only information necessary for the proper conduct of the project will be collected and will remain strictly confidential within the limits provided by law. All participants will be identified by a code number to preserve their identity. The code key linking the name to the file for each participant will be kept by the principal investigator in a password protected file on the principal investigator's computer at McGill University's password-protected online server (OneDrive).

There will be no manual data entry by participants or care providers. The data will be kept in Montreal. This data will be analyzed in a secure platform. This platform will be available to the research team only. The research team will have access to de-identified data for analysis during the study.

The principal investigator and her team will use the data for research purposes only and for the purpose of meeting the scientific objectives of the research project. No scientific publication or communication will contain data to identify participants. Data will be kept at our research center

under the responsibility of principal researcher, Dr. Rahimi, for seven years after the end of the research project. After this time, all the data will be permanently destroyed.

The interview will also be audio-video-recorded for qualitative analysis and will not be published. In order to protect your privacy, all information collected will remain confidential to the extent permitted by law. All activities will be delivered remotely through emails, phone calls, and Zoom/WebEx audio-video call. No form of travel is required.

Your de-identified information may be shared. This information will be subject to the same protection as afforded by the laws in Quebec. For monitoring, control, protection and security purposes, your research study file could be checked by persons authorized by the Research Ethics Board at McGill University. These persons are bound by a confidentiality agreement.

**8. VOLUNTEER PARTICIPATION AND THE RIGHT TO WITHDRAW**

Your participation in this research study is voluntary and ongoing. You are free to refuse to participate. You may withdraw from this research study at any time without having to give a reason and without any consequence to you now or in the future.

Whether you decide to participate or not, or if you withdraw at any time from this research study, your decision will not affect the quality of care and services that you have the right to receive or your relationship with your care providers in any way.

If you withdraw from this research study before it ends, the information we already collected from you will be kept for the project, unless you ask us to destroy it.

**9. FUTURE USE, COMMUNICATION AND PUBLICATION OF RESEARCH RESULTS**

With your permission, the data collected from you could be used for future research related to this study or for future studies. However, you would no longer be identifiable.

The research study results will be presented as grouped data (results are gathered together), where individual results will be summarized and aggregated into overarching themes for analysis. However, study participants will be able to obtain their own personal/individual results for reference.

The results may be presented at conferences, published in specialized journals or be the subject of scientific discussions or be used for teaching purposes. We will take all necessary measures to ensure that you are not identified.

You may communicate with the research team to obtain information on the general progress or the results of the research project. Project updates will be posted on our website. We will not communicate any individual results to you. However, study participants will be able to obtain their own personal/individual results for reference.

**10. RESOURCE PERSONS**

If you have any questions regarding this research study, you can contact the principle investigator, Dr. Samira Rahimi at (514) 399-9218 or samira.rahimi@mcgill.ca or xicare.fammed@mcgill.ca. For all questions concerning your rights during your participation in this study, or if you have any complaints or comments regarding your experience in taking part in this research study, you can contact Ms. Ilde Lepore of the McGill REB at (514) 398-8302.

**STATEMENT OF CONSENT**

**Xi-Care: eXplainable intelligent system for Cardiovascular disease management among women in primary care; Need Assessment.**

**PARTICIPANT STATEMENT**

I understand the information that was explained to me as contained in this consent form. All my questions were answered to my satisfaction. I will receive a copy of this signed consent form. My participation is voluntary, and I can withdraw from the research study at any time without any consequences and without having to give a reason. Withdrawing from this research study, at any time, will not affect my medical care now, or later, in any way (where applicable). By signing this consent form, I do not give up any of my legal rights.

I agree to participate in this research study.

Name of Participant or legally authorized representative:

_____

_____ _____

Signature Date

**RESEARCHER STATEMENT**

I, as the person obtaining consent, certify that I have explained to the participant or his/her legally authorized representative (where applicable) the research study information contained in this consent form and have answered all questions. I have clearly explained to the participant or

his/her legally authorized representative that s/he is free to withdraw at any time without providing a reason, and without any consequences. I commit, together with the members of the research team to respect all conditions described in this consent form and to give a signed copy of the consent form to the participant.

_____ _____

Name and signature of the researcher or person delegated to obtained consent.

_____

Date

**Appendix D. Pre-Interview Demographic Questions (LimeSurvey)**

| |
|---|
| *What is your marital status? |
| • Single<br>• Married<br>• Divorced<br>• Widowed |
| *What is your highest level of education? |
| |
| *What is your household's estimated yearly income before tax? |
| • Equal or less than $25,500<br>• $25,501 - $36,000<br>• $36,001 - $44,000<br>• $44,001 - $51,000<br>• $51,001 - $57,000<br>• $57,001 - $62,500<br>• More than $62,501 |
| *How do you identify your race/ethnicity? Please check all that apply. |

- Aboriginal (Inuit, Metis, North American Indian)
- Arab/West Asian (e.g. Armenian, Egyptian, Iranian, Lebanese, Moroccan)
- Asian
- Black (e.g. African, Haitian, Jamaican, Somali)
- Latin American
- Southeast Asian
- White (Caucasian)
- Other

*Please type your first name and last name below.

Note: Hyperlink to access the survey online: https://xicare.limesurvey.net/122436

## Appendix E. Interview questions for women at Increased risk of Cardiovascular Diseases

| Section I: Needs assessment<br>Inquire about participants' current diagnosis and treatment in primary health care. | |
|---|---|
| How do you think cardiovascular diseases are generally described and understood by the public?<br><br>Yes/No<br>Comment | i.e., What comes to mind? |
| Have you ever been informed about your cardiovascular health? How?<br><br>Yes/No<br>Comment | <u>Follow-up questions:</u><br><br>• How are you informed?<br>• What are some questions that you have had about cardiovascular health/diseases, if any? |
| What are the most frequent and important decisions you face related to your cardiovascular health? | <u>Follow-up questions:</u><br><br>• What do you do when faced with making important decisions?<br><br>• Note: focus on if there is an awareness of a decision to be made (i.e. prevention of CVD in system 2) |
| What is your usual role in making decisions about your cardiovascular health? What do you want your role to be? | Probe role:<br><br>• Do you usually:<br>a. Make the decisions yourself<br>b. Share the decisions with the doctor<br>c. Your doctor makes the decision for you<br><br><u>Follow-up question:</u><br><br>• Who else besides yourself is typically involved in the decision process? |
| | Probes if they need examples for ideas: |

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| What do you think are some challenges and needs in preventing and managing cardiovascular diseases (from your perspective as a woman at risk of CVD)? | • Challenges examples: lack of resources (e.g. information, appropriate tools for decision making)<br>• Needs examples: a guide on how to maintain cardiovascular health<br><br>Note: Probe a bit more, this is a very important question. Ask: "Are there any other needs or challenges you have in this context?" |
| Section II: The Xi-Care Tool<br>Introduce a technology that aims to assess and prevent cardiovascular diseases to the participants. | |
| Have you ever considered a decision support system to help you in any decisions related to your cardiovascular health?<br><br>Yes/No<br>Comment | <u>Follow-up questions:</u><br><br>• If yes, how was your experience?<br>• If yes, what is missing or needs to be considered?<br>• If no, will you be interested in using one?<br>• Is it something you think you would need?<br><br>Note: decision aids can be used in any context and may not necessarily be collaborative (but they also can be). |
| What are your thoughts on using digital technology (e.g., mobile apps, AI systems/robots) to make decisions in relation to your cardiovascular health? | Note: explain AI if the question or the concept was not clear. |
| *Questions adapted from NASSS framework.* | |
| How would you like us to design and develop this Xi-Care tool that is useful, helpful and effective for women at risk of CVD (e.g. no risks to users)? | Probe:<br><br>• What are features would you like to include?<br><br>Note: You can ask that as a general question and see if they can think of ideas off the top of their heads.<br><br>If they mention one of the features that we have included on the following slides (i.e. 20 – 25), you can say "ok, how would you rate that on a scale of 1 to 5, one because not at all helpful and 5 being very helpful?" |

| *Questions adapted from the System Usability Scale Framework* | |
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| On a scale of one to five, one being not at all helpful and five being very helpful, what features would you find helpful in preventing and managing CVD?<br><br>• 1 (least helpful)<br>• 2 (Somewhat unhelpful)<br>• 3 (Neither helpful nor unhelpful)<br>• 4 (Somewhat helpful)<br>• 5 (Very helpful) | Probe features:<br><br>• Monitoring tools that track health data over time?<br>• Step-count feature?<br>• Weight tracking feature?<br>• Educational modules on cardiovascular health?<br>• Guided exercise activities? (Personalized exercise)<br>• Diet recommendations?<br><br><u>Follow-up questions:</u><br><br>• 'Not helpful' answers: why this would be not helpful?<br>• 'Helpful' answers: how would this help you? |
| Would you like to be able to follow your progress and receive push-notifications through the Xi-Care tool? | <u>Follow-up questions, if yes:</u><br><br>• Would you like to receive push-notifications? If so, what about?<br>• How often would you like to receive notifications?<br><br>a. Multiple times a day?<br>b. Once at the beginning of every day? At the end?<br>c. Once a week?<br>d. Once a month?<br>e. Customizable? |
| *Questions adapted from NASSS framework.* | |
| How difficult/easy do you think it will be for you to integrate the Xi-Care tool into your daily life?<br><br>• 1 (Very difficult)<br>• 2 (Somewhat difficult)<br>• 3 (Neither difficult nor easy)<br>• 4 (Somewhat easy)<br>• 5 (Very easy) | <u>Follow-up questions:</u><br><br>• How often would you see yourself using the Xi-Care tool?<br>• What will facilitate its integration in your daily life activities?<br>• What type of support will you need for this technology; do you need any interventions for learning this technology? |

**Appendix F. Table 1: Sociodemographic Characteristics of Participants**

| Participant | Marital Status | Highest Level of Education | Household income estimated (Before tax) | Race/ethnicity |
|---|---|---|---|---|
| 01 | Married | College | More than $62,501 | White |
| 02 | Single | PhD Degree | More than $62,501 | White |
| 03 | Widowed | MSc Degree | More than $62,501 | White |
| 04 | Married | University Degree | $36,001- $44,00 | Black |
| 05 | Married | MASc in ECE | Equal or less than $25,500 | Asian |
| 06 | Married | Diploma from Continuing Education at Concordia University | $36,001- $44,00 | White |
| 07 | Married | University Degree | More than $62,501 | White |
| 08 | Single | Graduate Diploma | More than $62,501 | White |
| 09 | Married | BSc in Nursing | More than $62,501 | Black |
| 10 | Married | CEGEP & Office Systems Technology Certificate | More than $62,501 | White |
| 11 | Married | University Degree | More than $62,501 | White |
| 12 | Married | M.A | More than $62,501 | White |
| 13 | Married | University Degree | $44,001 - $51,000 | Asian |
| 14 | Single | Some University | Equal or less than $25,500 | Other |
| 15 | Married | Certificate in Graphic Design | More than $62,501 | Other |

## Appendix G. Codebook for Qualitative Analysis

| Name | Description |
|---|---|
| Challenges and Needs in Preventing and Managing CVD as a Woman at Risk | Participants discuss the challenges and specific needs they face in preventing and managing cardiovascular disease (CVD) as women at high risk. |
| Concerns about Digital Technology for Health and CVD Management | Participants express their concerns or reservations regarding the use of digital technology, such as AI systems or mobile apps, for managing cardiovascular health. |
| Consideration of Decision Support System for Cardiovascular Health Decisions | Participants contemplate the potential benefits of using a decision support system, such as a mobile app, for making informed decisions about their cardiovascular health. |
| Data Monitoring Rating | Represents participants' use of a Likert scale from 0-5 to rate the data monitoring feature of the Xi Care tool. |
| Decision'-'Making Dynamics in Cardiovascular Health | Participants discuss their decision-making processes and factors that influence their choices related to cardiovascular health. |
| Decision'-'Making Strategies for Important Cardiovascular Health Decisions | Participants share their approaches and strategies for making significant decisions about their cardiovascular health. |
| Diet Recommendation Rating | Represents participants' use of a Likert scale from 0-5 to rate the diet recommendation feature of the Xi Care tool. |
| Discerning Misleading Information | Participants share their experiences and insights into distinguishing accurate and reliable information from misleading sources. |
| Disseminating Cardiovascular Health Information to Women with a High Risk of CVD | Participants discuss the dissemination of cardiovascular health information to women who are at high risk of developing CVD. |
| Educational Modules Rating | Represents participants' use of a Likert scale from 0-5 to rate the educational modules provided by the Xi Care tool. |
| Effects of Retirement on Blood Pressure Control | Participants reflect on the potential impact of retirement on their ability to manage and control their blood pressure. |
| Family History Influence on Health Awareness | Captures the influence of the participant's family history, particularly their mother's experience with high blood pressure and taking heart print blood pressure medication. The participant discusses how |

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| | they noticed their own blood pressure being consistently high and later brought it up with their mother and the doctor, leading to the realization of their mother's similar experience. The code highlights the impact of family history on the participant's health awareness and subsequent discussions with healthcare professionals. |
| Feedback on Data Monitoring Feature | Represents participants' feedback and opinions on the data monitoring feature of the Xi Care tool. |
| Feedback on Diet Recommendation Feature | Represents participants' feedback and opinions on the diet recommendation feature in the Xi Care tool. |
| Feedback on Educational Modules | Represents participants' feedback and opinions on the educational modules provided by the Xi Care tool. |
| Feedback on Personalized Workouts Feature | Represents participants' feedback and opinions on the personalized workout feature in the Xi Care tool. |
| Feedback on Step Count Feature | Represents participants' feedback and opinions on the step count feature in the Xi Care tool. |
| Feedback on Weight Tracking Feature | Represents participants' feedback and opinions on the weight tracking feature in the Xi Care tool. |
| Female Patient Understanding and Perceptions of CVD | Captures participants' understanding and perceptions of cardiovascular disease (CVD) from a female perspective. |
| Frequency of XI'-'Care Tool Usage | Captures how frequently participants would see themselves using the Xi Care tool. |
| Frequency Preference for Health Notifications | Represents participants' preferences for the frequency of health-related notifications from the Xi Care tool. |
| Health Information Update Notifications | Participants discuss the need for updates and notifications about their health information from the Xi Care tool. |
| Importance of Early Prevention and System Use Determinants | Participants discuss the importance of early prevention in managing cardiovascular health and factors influencing their use of the Xi Care tool. |
| Influence of External Sources on Health Information | Captures the impact of external sources, such as friends or holistic approaches, on participants' health information and choices. |
| Information for Women's Cardiovascular Health Education | Represents participants' insights on the availability and sufficiency of information regarding women's cardiovascular health. |

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| Information Sources for Workout Ideas | Participants discuss the sources they use to find workout ideas and suggestions for maintaining cardiovascular health. |
| Inquiries about Cardiovascular Health Disease | Captures participants' questions and inquiries related to cardiovascular health disease and their quest for information. |
| Integration Ease Rating | Represents participants' use of a Likert scale from 0-5 to rate the ease of integrating the Xi Care tool into their daily life. |
| Integration of Xi'-'Care Rating | Represents participants' use of a Likert scale from 0-5 to rate the integration of the Xi Care tool into their lifestyle. |
| Lack of Knowledge on Cardiovascular Health Applications | Participants express their lack of knowledge or awareness about available mobile applications related to cardiovascular health. |
| Lack of Trusted Online Sources for Cardiovascular Health Information | Participants share their difficulty in finding reliable and trusted online sources for cardiovascular health information. |
| Participant's Engagement in Shared Decision'-'Making with Healthcare Providers | Captures participants' experiences and views on engaging in shared decision-making with healthcare providers, specifically related to cardiovascular health. |
| Participant's Proactive Engagement in Cardiovascular Health | Represents the participant's proactive approach to managing their cardiovascular health and seeking information and support. |
| Perceptions of Digital Technologies for Cardiovascular Health Decision'-'Making | Participants share their perceptions and opinions about using digital technologies, such as AI models or mobile apps, for making decisions related to cardiovascular health. |
| Personalized Workout Rating | Represents participants' use of a Likert scale from 0-5 to rate the personalized workout feature in the Xi Care tool. |
| Preventive Measures Discussion | Participants discuss the preventive measures they have considered or adopted for managing cardiovascular health. |
| Previous Preventive Measures Adopted Prior Diagnostic (Hypertension). | Participants discuss preventive measures they adopted before being diagnosed with hypertension, based on family history and discussions with doctors. |
| Progress Tracking and Push Notifications Preferences | Captures participants' preferences for progress tracking and receiving push notifications from the Xi Care tool. |

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| Proposed Design of Xi Care Tool for Women at Risk of CVD | Participants provide suggestions and ideas for designing the Xi Care tool to be useful, helpful, and effective for women at risk of cardiovascular disease (CVD). |
| Public Perception of AI Models and Technological Adoption | Participants share their views and perceptions of AI models and the adoption of technology for managing cardiovascular health. |
| Risk'-'based Interventions and Personalized Care | Participants discuss the importance of risk-based interventions and personalized care in managing cardiovascular health. |
| Significant Decisions in Cardiovascular Health Management | Participants discuss important decisions they need to make regarding their cardiovascular health and the considerations involved. |
| Step Count Rating | Represents participants' use of a Likert scale from 0-5 to rate the step count feature in the Xi Care tool. |
| Step Measurement Tools/Devices | Participants discuss the tools or devices they use to measure their step count and monitor their physical activity. |
| Strategies for Smooth Tool Integration | Captures participants' strategies and suggestions for integrating the Xi Care tool smoothly into their daily lives. |
| Support Needs for Tool Integration | Participants discuss the support they may need to integrate the Xi Care tool effectively into their daily routines. |
| Unaddressed Needs in Cardiovascular Health for Women | Participants express their opinions on unaddressed needs in cardiovascular health specifically pertaining to women. |
| Use of Mobile Applications/ Tools for Decision'-'Making | Participants share their experiences and opinions about using mobile applications or tools for making health decisions. |
| Weight Tracking Rating | Represents participants' use of a Likert scale from 0-5 to rate the weight tracking feature in the Xi Care tool. |

**Appendix H. Table 2. The Linkert scale of the six features anticipated to be included in the XiCare Tool**

| Feature | Score |
|---|---|
| Monitoring and tracking of health data | 4.9 (Highest) |
| Educational Modules on Cardiovascular health | 4.5 |
| Step count (Pedometer) | 4.5 |
| Diet recommendation | 4.4 |
| Guided personalized exercise | 4.3 |
| Weight tracking | 4.1 (Lowest) |