A STUDY OF USER INTERFACE DESIGN OF MHEALTH APP IN CHINA: FEMTECH PELVIC FLOOR MUSCLE TRAINING

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A STUDY OF USER INTERFACE DESIGN OF MHEALTH APP IN CHINA: FEMTECH PELVIC FLOOR MUSCLE TRAINING

by

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LIST OF ABBREVIATIONS

APP	Application
PFMT	Pelvic Floor Muscle Training
PDF	Pelvic Floor Dysfunction
PDM	Pelvic Floor Muscles
UCD	User-Centered Design
DT	Design Thinking
UI	User Interface
UX	User Experience
HCI	Human-Computer Interaction
CLI	Command Line Interface
MUI	Multimedia User Interface
GUI	Graphical User Interface
5S	Strategy, Scope, Structure, Skeleton, Surface
SLR	Systematic Literature Review
UEQ	User Experience Questionnaire

LIST OF APPENDICES

KAJIAN TENTANG REKA BENTUK ANTARAMUKA PENGGUNAAN APLIKASI MHEALTH DI CHINA: LATIHAN OTOT LANTAI PELVIK FEMTECH

ABSTRAK

Dengan peningkatan peranti mudah alih dan penggunaan internet, mHealth telah mendapat perhatian global dalam pelbagai domain kesihatan manusia. Kajian ini memberi tumpuan kepada reka bentuk antara muka aplikasi mudah alih (APP) untuk latihan otot lantai pelvis (PFMT), yang menggabungkan mHealth dan Femtech. Berbanding dengan kaedah tradisional, apl mHealth menawarkan fleksibiliti yang lebih besar dan kos yang lebih rendah. Walau bagaimanapun, sesetengah apl direka bentuk tanpa mengambil kira ciri kumpulan pengguna sasaran mereka, sekali gus menjejaskan keberkesanan intervensi yang berpotensi. Matlamat kajian ini adalah untuk mereka bentuk antara muka pengguna (UI) aplikasi PFMT yang menarik untuk pengguna wanita yang boleh meningkatkan pengalaman pengguna (UX). Kajian ini menggunakan kaedah campuran dan mengamalkan proses penyelidikan 5 langkah berdasarkan pemikiran reka bentuk (DT). Lima langkah tersebut melibatkan (1) memahami, (2) empati, (3) prinsip, (4) prototaip, dan (5) penilaian. Kajian ini menemu bual 12 pengguna untuk mendapatkan maklum balas dan menjalankan penilaian Soal Selidik Pengalaman Pengguna (UEQ) terhadap 40 peserta. Melalui tinjauan pasaran dan pengguna, kajian ini mencadangkan prinsip reka bentuk UI dan membangunkan prototaip untuk penilaian pengguna. Keputusan UEQ daripada penilaian menunjukkan positif. Skala Daya Tarik dan Kebaharuan dinilai Baik daripada Data Penanda Aras, dan skala Rangsangan mendapat markah Di Atas Purata. Reka bentuk UI memegang kepentingan penting untuk lelaran dan peningkatan masa depan untuk apl PFMT.

Kajian ini adalah penyelidikan sistematik untuk menyediakan prinsip dan prototaip yang menawarkan cadangan dan rujukan untuk penambahbaikan UI.

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ABSTRACT

With the rise of mobile devices and internet usage, mHealth has gained global prominence in various domains of human health. This study focuses on the mobile application (App) interface design for pelvic floor muscle training (PFMT), which combines mHealth and Femtech. Compared with traditional methods, mHealth apps offer greater flexibility and lower cost. However, some apps are designed without careful consideration of the characteristics of their target user groups, thus undermining the potential intervention effectiveness. The goal of this study was to design attractive PFMT app user interfaces (UI) for female users that could enhance the user experience (UX). This study uses mix method and adopts a 5-step research process based on design thinking (DT). The five steps involve (1) Understand, (2) Empathy, (3) Principle, (4) Prototype, and (5) Evaluation. This study interviewed 12 users to obtain feedback and conducted a User Experience Questionnaire (UEQ) assessment of 40 participants. Through market and user surveys, this study proposed UI design principles and developed a prototype for user assessment. The UEQ results from the evaluation indicated positive. The Attractiveness and Novelty scales were rated Good from Benchmark Data, and the Stimulation scale scored Above Average. The UI design holds significant importance for future iterations and upgrades for PFMT apps. This study is systematic research to provide principles and prototypes offering suggestions and references for UI improvement.

CHAPTER 1

INTRODUCTION

This chapter introduces the definition and current situation of mHealth and Femtech. Due to its convenience and low-cost advantages, mHealth apps are increasing. The case study chosen for this research is an app from Femtech, which is mainly used to help women's health management and rehabilitation. Pelvic floor dysfunction (PFD), characterized by high incidence and low consultation rate, has become a social issue affecting women's lives. Pelvic floor muscle training (PFMT) is the first line of treatment for PFD. Using the PFMT app can better ensure correctness and adherence through mHealth, which helps the user to effectively improve PFD symptoms while reducing costs. Therefore, the PFMT app is a great help for self-management. Interface design is important for mHealth because it directly affects the user's operation and relates to the user experience of an app. Designing an effective use interface (UI) can help users reach their goals, promote user stickiness and maximize the performance of the PFMT apps, resulting in an intervention. This chapter states the UI design problems of the PFMT app, and the focus will be further research on how to improve the UI design of the PFMT app.

1.1 Background

1.1.1 mHealth

There are currently nearly 5 billion mobile phone users in the world, and more than 85% of the world’s population is now covered by commercial wireless signals, according to World Health Organization (WHO) Global Observatory for eHealth (2011a) data released by the International Telecommunication Union. In recent years,

the rapid development of smart mobile devices and the explosive growth of various mobile apps have penetrated every aspect of our lives.

The WHO first discussed ‘mHealth’ in 2009. Based on the findings of the second global survey on eHealth (Electronic Health) entitled mHealth new horizons for health through mobile technologies, pointed out that “mHealth is a component of eHealth” (WHO Global Observatory for eHealth., 2011a).

> To date, no standardized definition of mHealth has been established. For the purposes of the survey, the Global Observatory for eHealth (GOe) defined mHealth or mobile health as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices.
>
> （WHO Global Observatory for eHealth., 2011b, P6)

Application is one of the common forms of mHealth is widely used. App refers to the download and installation of third-party app software on personal intelligent mobile devices, used as the carrier to provide users with diversified information to meet their health needs of users, to achieve remote transmission of medical information and services, remote monitoring of personal health status, remote communication with medical service personnel, etc., to achieve the purpose of disease prevention and control and health promotion (Sun & R Li, 2016).

> mHealth applications are being tested in such diverse scenarios as improving timely access to emergency and general health services and information,

> managing patient care, reducing drug shortages at health clinics, and enhancing clinical diagnosis and treatment adherence, among others.
>
> (WHO Global Observatory for eHealth., 2011b)

Recent reports show that more than 325,000 mHealth apps are available in major app stores, and more than 84,000 mHealth app publishers have entered the market (Research 2 Guidance, 2017). Evidence suggests that the mHealth app can promote patient health management and help with cost control (Widdison et al., 2022a). There are currently more than 165,000 mHealth apps concentrated in health management apps, such as fitness, and disease management apps, especially chronic diseases (Gong et al., 2018).

1.1.2 Femtech

The Femtech industry is an emerging and rapidly growing field of women's health technology. The cost of women in health around the world is enormous every year, so the women's market cannot be ignored. In 2019, the Femtech industry generated $820.6 million in global revenue, as well as $592 million in total venture capital (Farah Nayeri, 2021).

The term "Femtech" was coined by Ida Tin, the Danish-born founder of Clue, which is a menstrual and ovulation tracking app created in Germany in 2013 (Wiederhold, 2021a). There is currently no clear academic definition. The more common definition is:

> Femtech is a term applied to a category of software, diagnostics, products, and services that use technology to focus on women's health. The Femtech

> industry is comprised of digital or standard health tools focusing on fertility solutions, period-tracking, pregnancy, and nursing care, women's sexual wellness, and reproductive system health care.
>
> (Roses, n.d., 2019)

Although women represent nearly half of the world's population, the number of technology companies that address their specific healthcare needs is but a small fraction of the global technology market (Farah Nayeri, n.d.). Most families are made 80% of their health care decisions by women, who spend more than men 30% on health care, but only a tiny 3% percentage of digital health deals have focused on women's health. In recent years, there have been an increasing number of apps and high-tech services specifically aimed at females, which is an undervalued market (Wiederhold, 2021b).

There are currently two main categories of Femtech products on the market, and many of the available technologies include devices that are synchronized with the accompanying mobile application or single-use that only involves mobile applications (Rosas, 2019b). Femtech products involve wide areas. The areas covered by Femtech are shown in Figure 1-1 Femtech Includes below:

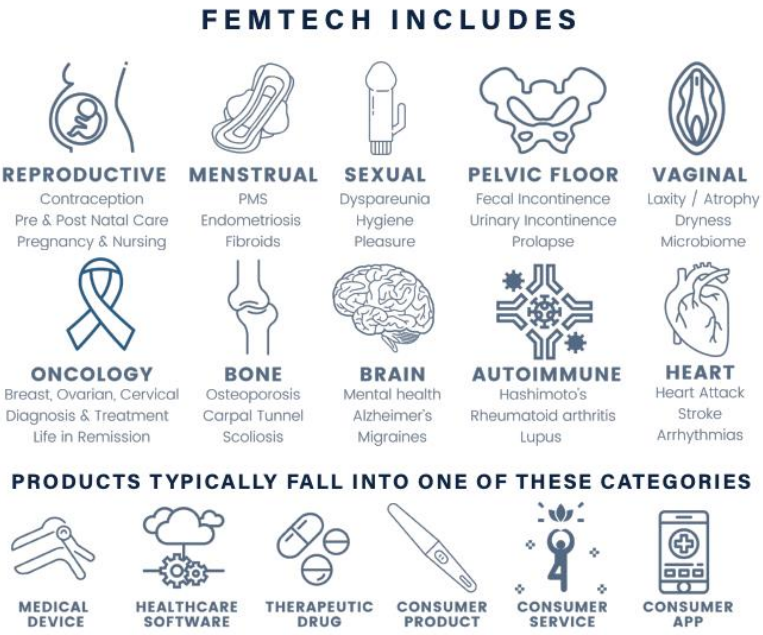

Figure 1.1 Femtech Includes.

The image from: https://femtechfocus.org/research/

Rosas, (2019b) points out that the most popular Femtech product on the market today is the Elvie Trainer, which strengthens pelvic floor muscles (PFM) and reduces leaks. When users purchase Elvie Trainer, they will get a Kegel device. After registering in Elvie's mobile application, they can implement real-time visual PFMT through their app screen.

The relationship between mHealth and Femtech is very close and overlapping. mHealth includes many health apps for different physical problems and different populations. Femtech, specifically refers to products that target women's health, therefore, target a more focused group of people, narrowing the scope of mHealth. Female users have specific user experiences, the interface design is more specific and customized to the user's needs, and is more valuable to special populations. This study

summarizes the relationship between mHealth and Femtech, and finally selects the PFMT product as the case study. Please see the picture drawn by the author as follows Finger 1-2 Relationship between mHealth and Femtech.

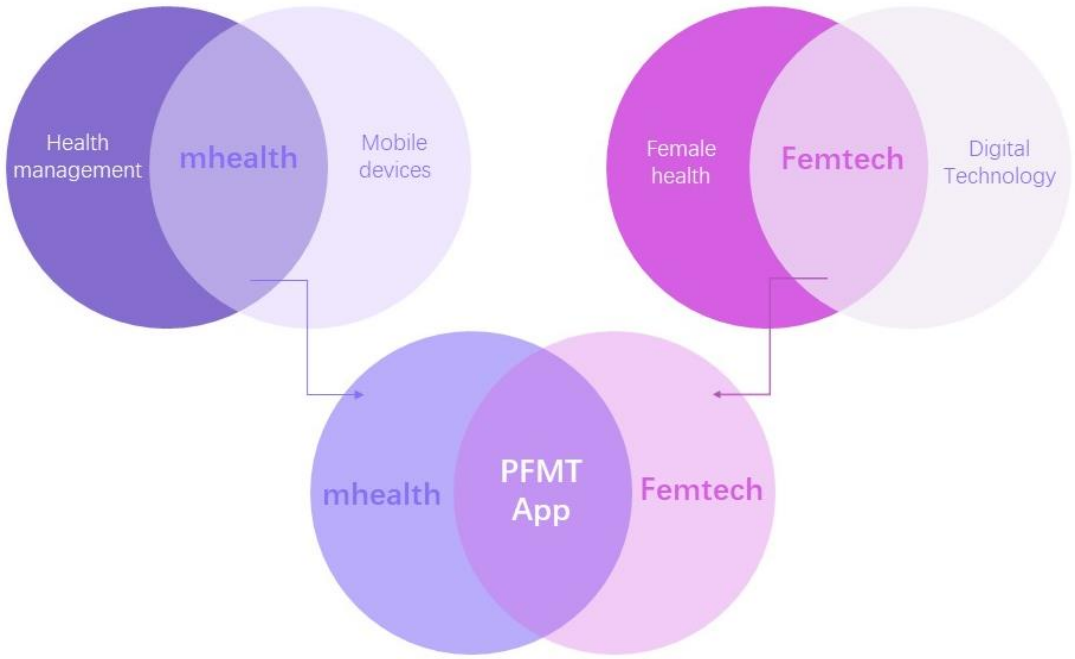

Figure 1.2 Relationship between mHealth and Femtech

1.1.3 Pelvic Floor Dysfunction (PFD)

The Pelvic Floor Muscle (PFM) is a group of muscles located at the base of the human pelvis that is adjacent to the pelvic organs, such as the bladder, rectum, and uterus, for support and control. PFD is a group of symptoms of abnormal pelvic organ position and function due to weak pelvic floor support tissues, including urinary incontinence, pelvic organ prolapses, fecal incontinence, abnormal sexual function, constipation, and chronic pelvic pain. The reported prevalence is 40-60% of the female population and has become a prominent social health problem (Wang X, 2013).

Urinary incontinence is the most common symptom. It is estimated that over tens of millions of women worldwide are affected by the disease. Although it does not threaten patients' lives, its high prevalence causes huge medical expenses. In the United States in 2002, women's urinary incontinence costs reached 16.3 billion US dollars (Minassian et al., 2003).

In contrast to the high prevalence of urinary incontinence, the consultation rate is relatively low. Numerous studies have analyzed that the low rate of consultation for urinary incontinence is mainly due to the perception that incontinence is an inevitable consequence of physical aging, in addition to the shame of talking about it. (MA L & Zhu L, 2019).

Most studies have shown that the incidence of urinary incontinence is related to age, race, pregnancy, delivery, obesity, constipation, isolation, and other related factors (Wang X, 2013). Pregnancy and childbirth are important risk factors for urinary incontinence (Sangsawang, 2013).

1.1.4 Pelvic Floor Muscle Training (PFMT)

In recent years, the innovation and reform of clinical treatment concepts have led to the diversification of PDF treatment. Pelvic Floor Muscle Training (PFMT) was the first-line treatment (Vickers & Davila, 2008). It was proposed by Dr. Kegel (1950) in the United States, also known as the "Kegel Exercise." PFMT refers to repeated voluntary contraction and relaxation of specific PFM groups to recover muscle group and periurethral muscle strength, reinforce its supporting capacity, and refrain from urine leakage, promoting pelvic floor health. Chinese Medical Association (2017) points out that the effectiveness of PFMT needs to follow two basic principles, one is the correctness of training methods, and the other is the adherence to long-term training.

1.2 PFMT App

mHealth reduces the obstacles for urinary incontinence patients to seek self-management due to its flexibility, convenience, and accessibility, which deliver their access to health information and adherence to treatment (Hamine et al., 2015). During the COVID-19 pandemic, the number of daily house calls was reduced to avoid crowding in clinics and to observe social distancing protocols. Therefore, well-designed digital health interventions (mHealth apps) have the potential to spread PFMT and improve adherence to these women's management of urinary incontinence (Jaffar et al., 2021a). Because of its advantages of independence, science, and privacy, mHealth has developed rapidly in the self-management application of female patients, providing better home rehabilitation care for female patients (Zhou Y X et al., 2019).

Relevant studies have shown that the combined use of electrical stimulation and biofeedback therapy on this basis is beneficial to improve the therapeutic effect (He G M, 2017). Therefore, an external device goes into the vagina to collect the data from users and provide biofeedback. At present, there are two main product forms of PFMT. One is app-only PFMT, and the other is to purchase an external device but still need to install an app for use. PFMT apps are tools that enable external device user visualization, including exercise frequency, intensity, posture, and method. They typically provide training plans, reminders, and feedback to help patients track their own exercise progress and results.

PFMT intervention effectiveness correlates with adherence. Adherence to PFMT refers to whether patients adhere to the frequency and duration of exercise. mHealth app can help patients to better self-manage. The PFMT app is designed to enable users to train at home in a personal setting and to provide guidance and supervision to ensure proper exercise. It is typically providing guidance and

demonstration, recording the user's training history and tracking progress, and reminding users to exercise on time. Thus, the PFMT apps promote compliance, improving the interventions' effectiveness, and achieving PFM rehabilitation. Therefore, the PFMT app is an effective tool for promoting correctness and adherence.

1.3 Problem Statement

As these mHealth apps proliferate, designing effective tools is becoming increasingly significant (Schnall et al., 2016). Despite numerous mobile health apps, a quarter of them are never used after installation. Many are of subordinate quality and are not cautiously measured when developing the characteristics of their target user group (Nouri et al., 2018). Users often don’t reuse apps that don’t appeal to them immediately, undermining the potential effectiveness of interventions (Mccurdie et al., 2012). At present, there are many PFMT mobile medical products in the market with varying quality, and there is a greater demand for high-quality, competitive products that require excellent UI design that can effectively progress the first impression of users and attract them to continue using them. Increase the stickiness of the user and improve adherence.

mHealth offers excellent flexibility and reproducibility than traditional healthcare approaches. Mobile devices can be used anywhere or even while users are walking, carrying something, or driving (Punchoojit & Hongwarittorrn, 2017a). Patients are more flexible in terms of time and location for self-health management, eliminating the necessary to travel to hospitals or clinics. This also means that users must perform a series of operations such as data monitoring, information uploading, processing, and intervention through the interface by themself. Thus, in the absence of direct guidance and supervision from professionals, attention needs to be paid to proper use and correct operation to avoid potential risks and adverse effects. Oyebode et al.,

(2020) research to identify the negative and positive themes assessed in mhealth's shortcomings or barriers to the effective delivery of expected services has shown that there is a strong correlation between aesthetics and usability, and that visually unappealing application interfaces may be perceived by users as unusable. Therefore, poor UI design will become a positive for users, and an excellent interface can help users reach their goals and achieve self-management smoothly.

A proper interface design can help users better understand and utilize the data through data visualization. Asklund et al. (2019a) noted that users particularly appreciated how the app visualized training by providing moving graphs for each contraction. mHealth apps are often required to collect and record individual metrics and exercise data to provide more personalized medical services and advice to users. The PFMT app’s interface displays the user's training data and reports. It is essential that designed to be visualized through charts or graphs, making the information more intuitive and easier to understand, improving the user's understanding and acceptance of the information, and reducing misunderstandings and misinformation. To help patients better understand their training progress and results and motivate them to actively participate in training.

Femtech products are often related to women's reproductive health, pregnancy management, and other aspects that involve sensitive data and information(Rosas, 2019b). Since the PFM are located in deeper and cannot be displayed with videos or photos, many users may not be able to find out the exact location of the muscles and how difficult it is to grasp the feeling of training. Therefore, visual design is needed to help users clearly understand the knowledge of PFM and help them train correctly. Most of the Femtech users are women and have higher requirements and aesthetics for UX, so the excellent UI design is more in line with women's psychological and

advances the user satisfaction and usability of the products. This study takes the mHealth based on Femtech as the starting point, selecting the PFMT app as a UI design research case. Aims to identify and improve the interface design of the PFMT app that can promote user satisfaction and engagement and help women with PFD symptoms to recover through the mHealth app.

The Chapter 3 of this study uses the Systematic Literature Review (SLR) research method to literature study, and the results of SLR are a powerful supplement to the problem statement. First, as mentioned in the previous introduction, PFMT, as a first-line treatment for PDF, needs to meet two principles, adherence and correctness, which can be met in order to achieve effective intervention, so as to enable patients to recover. Second, the emergence of mHealth can help implement these two principles. The findings of SLR in this study have been confirmed in numerous medical studies that the app of PFMT has indeed helped users improve adherence, reduce costs, and obtain effective results. Finally, through the study of the latest research on PFMT apps, it is discovered that there are some problems in the UI design at present. Perfecting and improving the interface design of the app can promote user compliance and stickiness, which will be valuable.

1.4 Research Gap

The research gaps in this section are concluded from the findings and discussion of the systematic research review (SLR) in Chapter 2, please refer to the detail described in Chapter 2. Although the integration of the medical field and mobile technology has been relatively deep, many mobile medical apps have been researched and developed from a healthcare perspective, but few studies have been conducted from a mobile tool app UI design perspective. Most of the research on the PFMT app is focused on the clinical and medical fields, with the most central international studies

concentrating on treatment effectiveness, feasibility, and impact on improving adherence. Studies have shown that the PFMT app is indeed effective in helping women recover from PFD symptoms and plays a good role in fostering user adherence. However, the discussion of PFMT interface design has only been mentioned in the context of app development and testing, evaluation, and user satisfaction. It is indeed providing some feedback and suggestions for improvement, but no specific research has been conducted. In China, although there is a large amount of medical literature showing that PFMT apps can be effective in helping patients to alleviate PDF symptoms, there is little discussion on the interface of such apps. Most of the current research mentions the functional frameworks and clinical effectiveness of the PFMT app, and there is no research on the app's development and interface design. Therefore, there is a gap in this area of research in China.

1.5 Research Questions

Based on the above problem statement, how to iterate a better UI design? To design a decent interface, essential to understand and investigate several basic information. Firstly, understanding the current interface design of the PFMT app in the market is the basis for improvement, and then getting comprehensive information and enough experience from the user's feelings to facilitate the current UI design to iterate. The research questions are presented below.

1. What is the current research on the UI design of PFMT apps?
2. What is the UI design problem with existing PFMT apps?
3. How to solve the problem and improve the UI design for PFMT apps?

1.6 Research Aims and Objectives

The purpose of this study is to identify the UI design of the PFMT app and to improve UI design. This research plans to achieve the following 3 objectives:

1. To understand the UI design of current research on PFMT apps.
2. To identify existing UI design problems on the PFMT apps.
3. To solve the problem and improve the PFMT apps.

1.7 Significance of the Study

This study aims to improve and iterate the quality of the interface design by studying the UI design of the PFMT app. Designing an attractive UI can help to improve UX, improving their comfort and satisfaction by easily understanding and better aesthetics. A good interface design can effectively attract users' attention, increase their willingness to use, and promote their persistence in using. Therefore, this study can improve user satisfaction and engagement. This study fills the gap in the research on the UI design of Femtech products, explores the market survey of apps, and puts forward the design principles that will promote the development of the Femtech industry and have guiding significance for Femtech products.

The UI design of the PFMT app should be able to help users understand and master the exercise method correctly and be able to record the user's exercise, provide timely feedback and adjust the user's exercise plan. A good interface design can improve the user's compliance and accuracy, thus effectively improving the effectiveness of PFMT intervention and promoting the user's recovery through mHealth. Therefore, interface design is indeed one of the key factors for the success of a mHealth app and deserves in-depth study.

This study takes women's health technology products as a case study, and through the investigation and research of female users, the characteristics and deep needs of female users are explored, and through the refinement and improvement of the app interface, it helps female users to better self-manage their health and improve the development of female health industry for the benefit of global women.

This study supplies a new perspective for the development of mHealth from the interface design, promotes the exchange and cooperation between the health industry and digital industry, and accelerates the transformation of digital technology and medical and health achievements in industry, academia, and research. The study of UI design principles and prototypes promotes the improvement and iteration of the PFMT app, enriches the design practice cases, and affords systematic research support for the subsequent iteration of UI design of similar products.

1.8 Scope and Limitation

This study has limitations for sample selection and the scope of the products analyzed. For the selection of the samples, there are the following aspects. Since the biggest factors causing PDF are pregnancy and childbirth, the sample of this study was selected from women who are during pregnancy or postpartum. The patients with other causes of PFD were not studied. The sample scope of this study was limited to Chinese. Based on the selection of the sample, the age of women in this study was set between 22-45 years old which is the age of peak pregnancy and childbearing.

The limitations of the study for the products in the market are as follows. In this study, downloaded PFMT apps are only from the Chinese market. The apps were selected to be used by female users only, excluding male and other specific users. The number of apps for competitive analysis will be limited due to insufficient funding.

1.9 Summary

This chapter introduces the background and concepts of mHealth and Femtech and the reason the PFMT app was chosen as a case study for mHealth. PFMT is a first-line treatment to help patients' treatment PDF and must fulfill two principles: one is the correctness of training, and the other is the adherence to long-term training. The PFMT app is a good tool to help users self-manage the intervention by facilitating the two principles to help improve the effectiveness of the intervention. Interface design is one of the key factors in whether a mHealth app works well. This chapter focuses on the problems of interface design in mHealth apps, mainly focusing on the lack of attractiveness and visualization design. This can cause a poor sense of user experience, thus failing to attract users to persist in using the app for a long time. The study of UI design helps to solve the problems of mHealth, and the improvement and iteration of UI design promote the generation of high-quality apps, help users to solve practical problems in the process of using the app, and better assist the users in self-management. At the same time, female users have higher requirements for user experience, and UI design can help improve satisfaction with Femtech products. At present, there is a gap in the research on the UI design of the PFMT app, this study's goal of designing the UI of the PFMT app. This study proposes three research questions and objectives; understanding the market situation and identifying user feedback to summarize the UI design principles, and developing the UI design of prototypes for the PFMT app.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This Chapter introduces the key concepts and research theory. The following part reviewed the characteristics of products and current areas of research concentration on Femtech. The important role of user-centered design (UCD) principles in the mHealth interface design process is proposed, the design thinking (DT) approach used to conduct the study is identified, and five specific steps of this study are developed based on the DT. The second section reviewed the definition of user experience (UX) and classical theory. The 5-level theory of user experience elements (5S) is introduced to explain the relationship between UX and UI. Finally, the definition of user interface (UI) design is present. The main components of UI and the evaluation criteria of UI design are emphatically introduced.

2.2 Femtech

This section is the second part of the literature review of the current research area and features of Femtech. Femtech is a digital health product and service dedicated to women's health, reproductive health, sexual health, nursing, etc. (Hendl & Jansky, 2022). The specificity of the Femtech product and the fact that the end user is the female population, there are the following aspects that take special attention.

2.2.1 Privacy and Security

Femtech involves more private data than other mobile apps. It needs to collect users' personal information which involves processing and storing personal information. If the data is not stored properly, it will cause the leakage of personal information. Most systems and architectures ignore information security issues, the

authentication scheme of the device is simple, and the user's awareness of prevention is weak, so it is easy to cause information leakage.

Since Femtech products on the market rely on sensitive information related to personal health, Roses, n.d. (2019) notes that the current law does not regulate personal health privacy and data security for Femtech. The privacy policies of technology companies are not faultless, and users may face the risk of data leakage, so it is necessary to pay attention to the user privacy and data security issues of technology companies in the future, and it is imperative to reform the technical legal supervision.

2.2.2 User Empowerment

Femtech has been marketed as a tool for women's empowerment. Hendl & Jansky (2022) point out that within a broader social and tech-industry context structured by systemic gender and other inequalities, the promise of women's empowerment through period and fertility apps deserves scrutiny. A complete understanding of how application companies empower users and how they frame user authorization is especially vital to ask the application provider about the authorization discourse used.

2.2.3 Stigmatization

Users of such products are women, including some female users who are experiencing extraordinary things, such as menstruation, pregnancy, postpartum, sexual, etc., which determines that Femtech has different physiological and psychological needs distinguished from other mHealth. Due to these products involving their intimate parts and reproductive organs, they often create a psychological burden and stigma on women, so they cannot talk boldly and actively face treatment and medical help. When designing these products, it is necessary to find

ways to diminish and release these stressors and help them manage their health more easily and free of burden. Ramirez et al., (2019) focused on the topic of how female users can help users reduce stigma during the use of PFMT apps. Based on the findings of stigma, directions were found to address the difficulties in the design and advancement of products and apps. The most successful designs from the perspective of consumer preferences and stigma were humorous, fun, and potentially sexual.

2.3 User-Centered Design for mHealth

User-centered design (UCD) is an evidence-based approach that is closely related to and prioritizes the needs of the end user during the development of a service or artifact (Farao et al., 2020). According to McCurdie T (2012) experience, UCD plays a crucial role in achieving user engagement when designing mHealth and other apps, thereby increasing the likelihood of intervention effects. WHO Global Observatory for eHealth (2011b) endorses this approach and recommends that it be integrated into the life cycle of mHealth interventions to ensure effective results.

UCD is a broad term to describe design processes in which end-users influence how a design takes shape. It is both a broad philosophy and a variety of methods. There is a spectrum of ways in which users are involved in UCD, but the important concept is that users are involved in one way or another (Chadia Abras et al., 2004). UCD is a methodology and philosophy that emphasizes user needs and user involvement throughout the design process, and it follows a flexible and iterative design lifecycle that covers the planning, design, implementation, and testing phases (Ashana et al., 2021).

The hallmark of UCD is good UX. Ashana et al. (2021) believe that UX is more valuable than usability principles during the process and decision-making. Some empirical results suggest that users who sometimes prefer poorly designed UIs don’t

always prefer the most effective and efficient design. Therefore, app development should consider the UX.

Currently, many electronic health (eHealth) and mHealth interventions are designed based on existing healthcare system constructs and may not be as effective as those that involve end users in the design process (Mccurdie et al., 2012). mHealth implementation without end-user engagement might constrain the desired outcomes, leading to unmet health objectives and possible adverse results (Farao et al., 2020). In the context of mHealth-mediated care, UCD represents a systematic process that is key to ensuring applications remain patient-focused (Mccurdie et al., 2012).

2.4 Design Thinking

DT provides a great way to implement the UCD principle. This study applied a DT approach, which strongly emphasizes end-user involvement throughout the design process. This approach makes the final product more user-friendly and tailored to the end user's needs. Huang & Breland (2018) point out that applying DT to health care can improve innovation, efficiency, and effectiveness by increasing attention to patient needs. DT is a promising approach to intervention development, implementation, and dissemination that can increase the acceptability and effectiveness of healthcare interventions by actively engaging patients and providers in the design process and rapidly iterating innovative prototypes to maximize success (Huang & Breland, 2018).

DT can be traced back as far as the 1960s when it was called Design Science (Darmawan et al., 2022). Design Thinking has evolved over the decades and finally became an independent concept when Peter Rowe published his book *Design Thinking* in 1987 (Ashana et al., 2021). Over 50 years of development, the most common methods and practices have emerged and converged in an evolutionary process. Design

thinking can be understood as a systematic, collaborative approach to identifying and creatively solving problems (Luchs, 2015).

Nowadays, DT has been applied in various disciplines and industries, with dozens of frameworks and tools. Each framework has its nuances and biases; however, there is a great deal of consistency between these frameworks. Luchs (2015) proposed a DT framework that aims to reflect the shared elements of existing frameworks, intending to preserve the most important elements and their distinctions while simplifying their descriptions and terminology. At the very least, this framework introduces the main elements of DT as effectively as possible. This framework will make it easier to quickly guide other DT frameworks and, by doing so, effectively explore tools, techniques, and suggestions beyond. Please see Figure 2-1, A Brief Introduction to DT below:

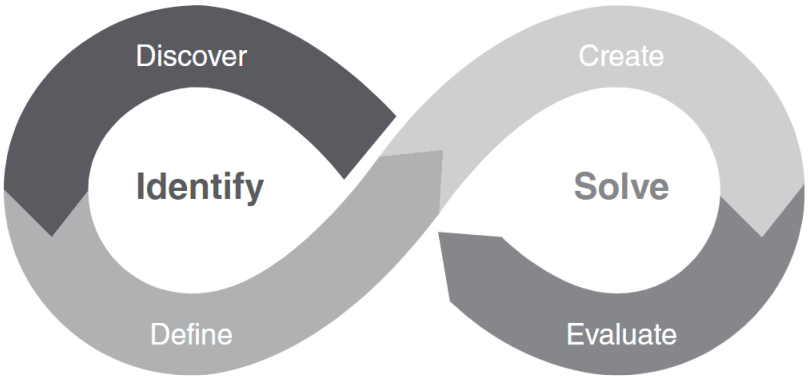

Figure 2.1 A Brief Introduction to DT

Luc's (2015) detail and explanation of the model argue that DT. It is a systematic and collaborative approach to problem discovery and creative problem-solving. In contrast to the linear relationship, DT tends to be circular, exploring and solving problems through iteration. Designers quickly generate possible solutions, develop simple prototypes, and then iterate on those initial solutions -- with significant

external feedback leading to a final solution. As a systematic and collaborative approach for identifying and creatively solving problems, DT includes two major phases: Identify and Solve; each stage has specific steps.

a) Discover

The first mode of discovering is to discover new customer insights. Many product development teams face challenges immersed in products and technologies that limit their vision and perspective; market information is often framed in terms of product specifications related to existing products. There are many specific ways to identify customer insights that inspire great ideas, but they are often qualitative and designed to help project teams immerse themselves in the customer's environment. This is often described as a process focused on gaining empathy with the client, that is, developing an understanding of their environment, experience, and behavior. Considering the qualitative nature of the data requires the ability to translate qualitative data into specific customer insights. There are many ways to do this, including writing a code, drafting a role and empathy map of the prototype customer, and a journey map that describes the customer's current or desired experience. An important principle of the discover model is to iterate between data collection and synthesis, that is, to try to synthesize insights throughout the process rather than waiting until all the data has been collected. Once the team is confident that they have identified a set of key customer insights that need to be considered, they can move into define mode (Luchs, 2015).

b) Define

Define model has refined customer insights and built specific insights into well-defined problems to solve. During this process, the team should have synthesized information about the customer and their context. Identify the most desirable needs

and insights for the next phase of the process. To achieve these needs and insights are often framed as separate “problem statements” that serve as the basis for idea generation at the next stage. These problem statements are usually short statements that describe the type of customer, unresolved needs, and insights that explain why the identified needs are particularly worth solving. Next, the team needs to focus on these issues to be addressed in the next create pattern (Luchs, 2015).

c) Create

The purpose of the created pattern is to develop a concept or set of concepts, share it with the target market for feedback, and improve it through iteration. While customers can react to their ideas, the best feedback comes from a rough prototype concept they engage in because a good prototype can provide a responsive experience and another opportunity to observe actual behavior. The two main activities of create mode are idea generation and prototyping. A prototype of one or more main interfaces is generated before feedback is given to the user (Luchs, 2015).

d) Evaluate

The ultimate pattern of the DT framework is Evaluate. The purpose of the pattern is to acquire feedback on the prototype of the concept and the ideas and assumptions contained in it. We often assume that this feedback will be used to iterate and improve concepts, especially in the first iteration of the four patterns. The purpose of feedback was initially intended as a mechanism to learn more, not just validate. Share the prototype with potential customers to gather feedback. After the team has gathered enough feedback, they will continue with an integrated process to gather the most promising solutions and gain further insights (Luchs, 2015).

2.5 User Interface

Human-Computer Interaction (HCI) is the study of how humans interact with computer systems. Many disciplines contribute to human-computer interaction, including computer science, psychology, ergonomics, engineering, and graphic design. HCI is a broad term that covers all aspects of how people interact with computers. When users interact with a computer system, they operate through a User Interface (UI). A good UI is easy to use and understand, meets the user's intended needs, and supports the user in accomplishing the tasks they wish to operate. Inversely, poor UI design allows users to forget their needs and goals and instead stay in the process of interface operation and problem-solving (Debbie Stone et al., 2005).

An interface is the contact point between humans and machines. A UI on a computer, smartphone, tablet, or game console consists of a 'front-end' visually interactive face that communicates with a programmed delivery system 'back end.' In screen-based media, UI is called a Graphical User Interface (GUI). GUI creates visual visibility through graphic design, using visual metaphors to convey navigation, interaction, and content on interfaces. Through these visual components, users can interact and achieve the results they want. A successful UI design combines good usability, functionality based on user needs and expectations, and aesthetics that promote successful results (Wood, n.d. 2014).

2.5.1 Visual Components

The visual design of the interface includes layout and navigation design, icon and graphic design, font design, and color design.

a) Interface layout mainly refers to the design of the navigation and layout of the interface. Jeff Johnson (2010) mentioned that layout is easier for us to see

the structure after our vision is optimized, helping users have a better visual hierarchy and focus on relevant information.

b) Navigation is the basis for the reasonable differentiation of the app interface level. To make the user more understanding of the navigation operation, the navigation of different functions should be visually distinguished so that the user's use efficiency has been significantly improved.

c) Icon and graph design is the core element of interface design. As a visual symbol, the icon beneficially promotes the user's understanding of the concept, content, and function operation of the interface design. Excellent icon design should be easy to read and understand, with a high degree of recognizability. The effective information is quickly transmitted to the user, accelerates the user's understanding of the meaning of the icon, and extends the user's memory of the icon to improve the user's click-through rate.

d) Text is an essential element in UI, which is a special device to convey information to users through intuitive symbols. It is often used in titles, content, prompts, auxiliary information, text style, and typesetting design. It is very important for users to coordinate the text style and layout, which can speed up users' understanding of the content and then improve the high user efficiency. To eliminate the user's reading and visual obstacles, most designers choose high-quality Standard display fonts to enhance the UX.

e) Color is also a symbol in the field, and it is the soul of UI. Users' perception of color is different, mainly reflected in two aspects: intuitive perception and conceptual cognition. Color can bring users different physiological and psychological feelings. The use of good design can help the interface to