Designing A Personalised Mobile Application To Improve Engagement With PFMT Amongst Women From Pregnancy Up to One Year After Delivery

by

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Abstract

Women who are pregnant, or have given birth are at high risk of developing Pelvic Floor Disorder (PFD) due to the physical stress placed on the pelvic muscles during this time. When left untreated, PFD can cause symptoms such as incontinence, organ prolapse and pelvic pain in sufferers. Pelvic Floor Muscle Training (PFMT) is a highly effective means of treating and preventing symptoms of PFD. However, adherence rates to PFMT remain low.

Amongst the biggest barriers to adherence are incorrect technique, lack of knowledge, memory, time, low motivation and stigma. As with the physical symptoms of PFD, these barriers impact sufferers in ways unique to each individual. Findings from the existing literature suggest that personalising the intervention to accommodate these varying factors may improve adherence.

This study focuses on the development of a personalised mobile application to improve engagement with PFMT amongst women from pregnancy, up to one year after delivery. The goal of the application is to improve engagement with PFMT through addressing key barriers to adherence, and guiding correct performance of PFMT.

An initial design criteria and five user personas were developed. The criteria and personas were used to develop prototypes, which were then user tested. The designs were then refined based on user feedback. Designs were also informed by feedback from interviews with clinicians and women.

The results of this study indicate that a mobile application is an ineffective means of guiding PFMT technique. However the application proved effective in addressing the barrier of memory through the use of context based triggers. The integration of the Hooked model in

the application design had a low to moderate effect on improving engagement with PFMT. Opportunities for a personalised design approach in the areas of instruction, facilitation of exercises and preferences for application features were identified.

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Introduction

Pelvic Floor Muscle Training (PFMT) is widely recognised as a highly effective method of treating or managing symptoms of Pelvic Floor Disorder (PFD). In a study by Dumoulin et. al. (2014, p. 2) it was found that women who engaged with PFMT were 17 times more likely to report either the cure of, or improvement of their symptoms of PFD when compared to women who did not undertake PFMT. Due to both its efficacy, and perception as a less invasive treatment option compared to surgery, PFMT is often recommended as the first line of treatment for symptoms of PFD (Norton & Brubaker, 2006, p. 62). The pelvic floor is responsible for the physical support and function of organs such as the bladder, bowel, uterus and vagina (Petros, 2010, p.18). PFD occurs when a woman's pelvic floor becomes weak or damaged, and can no longer properly assist with the functioning of these organs. This results in symptoms such as urinary or faecal incontinence, pelvic pain, urinary tract infections or pelvic organ prolapse amongst others (Petros, 2010, p. 2-3).

PFD is prevalent across the population. It is estimated 1 in 4 people in New Zealand experience some form of pelvic dysfunction (Physiotherapy New Zealand, 2018). Women who are pregnant or have given birth are at highest risk of developing symptoms of PFD, due to the trauma endured by the pelvic muscles during these processes (Baessler and Schussler, 2008, p. 37). Along with physical symptoms, people with PFD often experience additional psychological/emotional complications, due to feelings of shame and stigma associated with the condition.

Despite the efficacy of PFMT, and the symptoms associated with PFD, engagement rates remain low. Estimated rates vary, however a study by Borello-France et. al. placed 12-month adherence rates at 32% (2013). Addressing these low adherence rates is a major point of focus for those within the field of pelvic healthcare. A number of factors have been identified that

contribute to overall adherence behaviour. Amongst the biggest barriers to adherence are incorrect technique, lack of self-efficacy, memory, low motivation and stigma. The experience of PFD is considered to be one that is unique and personal to the individual, with the attitudes, motivation and ability to engage with treatment differing between each woman. Various personal, lifestyle, physical and socio-cultural factors influence women's willingness and/or ability to engage with PFMT, in ways specific to each woman (Bradway, 2005). Adherence and PFD literature suggest that personalising the intervention process to accommodate these varying factors may be an effective approach to improve engagement with treatment (DiMatteo, 2012).

This study focuses on the development of a personalised mobile application to improve engagement with PFMT therapy, amongst women from pregnancy, up to one year after delivery. This study has two main outputs. The first is the production of a functional mobile application, and the second is the development of a list of recommendations for the design of a mobile application to improve engagement with PFMT.

This study begins with the identification of key barriers to engagement with PFMT. These barriers are identified through literature, semi-structured interviews with clinicians and survey data collected from women. From here strategies to address barriers and improve engagement are explored, such as the use of Persuasive Technology (PT) principles, and the integration of engagement frameworks such as the Hooked Model (Eyal, 2014). Five user personas were also developed to help guide the designs. The design process was structured by the Research Through Design Model (RTD) (Rodriguez-Ramirez, 2017) under which, designs went through a cycle of iteration, prototyping, testing and refinement. Throughout development, prototypes were evaluated against an evolving design criteria, which was refined throughout each stage of the study. Development concludes with the production of a functional mobile application. This application was tested with women via a semi-structured user testing session, and a questionnaire. This study concludes with an evaluation of the mobile application against the

final design criteria, a discussion of the results from this study and a list of recommendations for improving engagement with PFMT.

This study is part of a larger research project in conjunction with the Auckland Bioengineering Institute, which is centred around the development of a system to facilitate the performance of PFMT. The proposed system consists of an internal device with 8 sensors, which when paired with a mobile application provides users with biofeedback to assist with proper exercise technique. As the internal device is still in development, this study focuses on the development of a standalone mobile application.

Literature Review

Pelvic Floor Disorder

The pelvic floor facilitates the function and physical support of a number of vital organs located in this region, such as the bladder, bowel, uterus and vagina (Petros, 2010, p.18). It is responsible for maintaining continence, preventing pelvic organ prolapse, urination, defecation and the process of childbirth (Ashton-Miller & Delancey, 2007). As the pelvic floor is integral to a number of biological functions, maintaining the health and strength of these muscles is essential.

Pelvic Floor Disorders (PFD) occur when the pelvic floor muscles become weak or damaged. A 2010 joint report between the International Urogynecological Association (IUGA) and the International Continence Society (ICS) identified six common forms of pelvic floor dysfunction. The forms of dysfunction listed included stress incontinence, detrusor overactivity, bladder oversensitivity or urge frequency, voiding dysfunction, pelvic organ prolapse and recurrent urinary tract infections (Haylen et. al, 2010, p.17-19). These forms of dysfunction typically present themselves in common symptoms including involuntary leakage, painful urination, pain during sex, etc. (Petros, 2010, p. 2-3).

PFD is prevalent across the general population. Physiotherapy New Zealand states that issues with incontinence affect up to 1.1 million people in New Zealand (Physiotherapy New Zealand, 2018). Ageing, pregnancy and childbirth are amongst the most significant risk factors for the development of symptoms of PFD. It is estimated that 50% of women develop some form of genital prolapse after pregnancy, with 11% of women requiring surgery within their lifetime (Tinelli et. al, 2010, p. 205). Pregnancy and childbirth are particularly damaging to the pelvic floor, due to hormonal changes during pregnancy which alter the structure of the pelvic

floor in preparation for delivery, and the mechanical trauma endured by the pelvic region during childbirth (Baessler and Schussler, 2008, p. 37). The damage inflicted during pregnancy and childbirth often results in long term dysfunction with the pelvic floor (Viktrup et. al, 2006).

In addition to physical complications, a number of people with PFD experience psychological/emotional ramifications as a result of their condition. Due to the taboo nature of incontinence in society, PFD is a condition associated with a high degree of stigma (Ashworth & Hagan, 1993, 1419). As a result, many PFD sufferers internalise this stigma, resulting in a negative impact on self-esteem, psychological wellbeing, social life and personal relationships (Priddis et. al, 2013, p. 752-756; Ozkan et. al, 2015, p. 3-4). Larger societal taboo placed on the condition has resulted in an inhibited general awareness on PFD. This lack of awareness is believed to potentially impact women's ability to seek adequate treatment, or engage in preventative measures to mitigate the development of PFD (Almeida et. al, 2016, 1811).

The experience of pelvic floor disorder is considered to be very personal, and largely shaped by the personality, cultural and lifestyle factors specific to the individual experiencing the disorder. Ashworth & Hagan (1993) conducted interviews with 28 women who suffered from non-geriatric urinary incontinence. When asked about their feelings towards their pelvic floor exercises, the women identified a range of feelings from fear, self-blame, guilt, laziness and apathy. Bradway (2005) also identifies the different attitudes and experiences of women have toward their condition. In her study, Bradway conducts in-depth interviews with 17 women in relation to their experiences with urinary incontinence. From these interviews, 3 dominant narrative types are identified - restitution, redemption, and victim. Bradway identifies attitudes and coping mechanisms specific to each narrative type, such as a "matter of fact" identification of the condition, using humour when discussing their condition and an overall sense of pessimism. These studies suggest it is important to consider the individual

experiences/attitudes of sufferers during treatment interventions, as these factors are likely to impact engagement with treatment.

Pelvic Floor Muscle Training

Pelvic Floor Muscle Training (PFMT) is widely acknowledged as a highly effective treatment for symptoms of PFD. A study by Dumoulin et. al which looks at twenty-one trials involving 1281 women found that women who undertook PFMT therapy were 17 times more likely to report cure or improvement of PFD symptoms, as opposed to women who did not undergo PFMT (2014, p.2). PFMT is widely recommended as the first line of treatment for PFD (Norton & Brubaker, 2006, p. 62). This is due to both its efficacy, and it being viewed as a less invasive alternative to other treatment options such as surgery.

PFMT involves the repeated performance of voluntary contractions of the pelvic floor muscles. The general principle behind PFMT is to improve the ability of the pelvic floor to function and provide support, through increasing the strength and tone of the pelvic muscles (Bo, 1995, p. 283). Laycock (2008, p. 178-179) describes the three principles of overload, specificity and reversibility as key components of any PFMT regimen.

The frequency at which PFMT exercises should be performed is not well established. In 1948, Kegel originally suggested a training regimen consisting of 300 repetitions a day (as cited in Mason et. al, 2001, p. 662). A review by Dougherty of PFMT training protocols states that any training regimen that requires over 100 repetitions a day results in a decrease in motivation. A target of between 30-45 repetitions is suggested (Dougherty, 1998, p. 80). A more recent review of training protocols by Wilson et. al. noted a vast range in the recommendations provided by different training protocols. The recommended daily repetitions ranged from 36 to 200. The review recommends that PFMT programs should include 3-4 daily sets of 8-12 contractions, lasting between 6-8 seconds each (Wilson et. al, 2010, p.581). The ideal regimen

also varies between patients according to differing needs, levels of strength, physical makeup etc.

Adherence

Despite the efficacy of PFMT, and the risks of leaving PFD issues untreated, women fail to engage with treatment, with adherence to PFMT regimens remaining low. Mason et. al found that only 17% of women within their study undertook daily PFMT during pregnancy (2001, p. 662). Borello-France et. al. identified 12 month adherence rates amongst UI patients at 32% (2013).

Non-adherence refers to the failure of a patient to comply with treatment as specified by the health professional who administered the regimen. Non adherence can be intentional/conscious such as ignoring medical advice, or unintentional such as failing to perform a treatment regimen as specified due to factors such as miscommunication (DiMatteo et. al, 2012, p.74).

Non-adherence/failure to engage with PFMT is recognised as one of the biggest barriers to successfully treating PFD across the general population. There are a myriad of factors which influence adherence behaviours. These can be factors that are more specific to the individual woman such as attitudes towards treatment (Moossdorff-Steinhauser et. al, 2015), stigma (Almeida et. al, 2016, p.1811), lifestyle, severity of symptoms (Dehlendorff & Tibaek, 2014, p. 666) etc. Or more external factors such as societal attitudes/discourse around PFD, lack of PFD related information available to women, or miscommunication between the patient and health professionals. The combination of some or all of these barriers can result in a low level of motivation to engage with PFMT exercises. Some of the biggest barriers and/or factors that influence engagement with PFMT therapy are outlined below.

Memory

Memory or failing to remember to perform exercises is commonly identified in studies as a significant barrier to adherence to PFD. A study by Borello-France et. al. focused on a group of women engaging with PFMT therapy over a 12-month period. 'Trouble remembering to do the exercises' was the most significant predictor of adherence at the end of the 12-month study period (2013, p. 766-767). In another study by Holley & Varner women identified both a lack of time and the interference of PFMT with daily activities, and family responsibilities as reasons for non-adherence (Holley & Varner, 1995). The difficulty some women have of integrating PFMT into daily life may contribute to forgetfulness.

Incorrect Performance of Exercises

Bump et. al. revealed that after brief verbal instruction, only 49% of women could perform a correct voluntary contraction of their pelvic floor (Bump et. al, 1991). Women with low pelvic floor strength were even less likely to perform PFMT correctly, with the majority of those women being unable to perform a correct voluntary contraction (Dehlendorff & Tibaek, 2014, p. 666). Uncertainty around proper technique in relation to PFMT can result in incorrect performance.

Self-Efficacy

Self-efficacy, or women's confidence in being able to carry out the treatment regimen is a significant predictor of adherence. A study by Chen & Tzeng identified high self-efficacy in women as a factor with a strong association to adherence with PFMT (2009, p.88). Alewijnse et. al. also identifies self-efficacy as a significant predictor of adherence. The authors of the study recommend that building self-efficacy in patients

is a good starting point for PFMT treatment. Laycock also suggests that a focus on building self-efficacy in patients is a good strategy for promoting PFMT adherence (2008, p.182).

Perceived Severity/Susceptibility

Women's perceived severity of their own symptoms, and perceived susceptibility to PFD, has also been identified as a predictor of adherence to PFMT. In a study by Mason et. al. following women undertaking PFMT during and after pregnancy, women who reported experiencing more frequent issues with incontinence or leakage were more likely to engage with their exercise regimen (2001, p. 666-667). A survey conducted by Moossdorff-Steiner et. al. also identified that women who experienced more pronounced symptoms of PFD such as frequent wet episodes, or organ prolapse were also more willing to engage with PFMT therapy (2015, p.186).

Health Behaviour Change Frameworks

One of the first frameworks developed to understand the factors that contribute to why health behaviours are undertaken by individuals is the Health Belief Model (HBM). Developed by Rosenstock et. al. (1974), the HBM identifies 6 key concepts that contribute to an individual's likelihood to adopt health behaviours. These concepts are: *Perceived Susceptibility*, *Perceived Severity, Perceived Benefits, Perceived Barriers, Cue to Action* and *Self-Efficacy*. This model has provided the foundation for a lot of health behaviour research, with many behaviour and intervention frameworks targeting the principles of change identified in the HBM.

One such framework is the Information, Motivation Strategy (IMS) model, developed by DiMatteo et. al. (2012). The IMS model is a three factor model designed to improve adherence rates to healthcare interventions, with a particular focus on chronic disease

management. The framework was developed based on an analysis of existing adherence literature and is an amalgamation of common findings and best practices. The first factor of the model is information. This factor asserts that the patient requires sufficient understanding of how to carry out the target health behaviour in order to adhere. The second factor is motivation, which states that the patient requires sufficient motivation to carry out their treatment. Motivation can be influenced by belief in the efficacy of treatment, negative attitudes towards treatment and social support systems that influence the patient's attitude toward treatment. Strategy is the third factor of the model. This factor states that patients need a strategy for addressing the practical barriers to treatment i.e. time, money. The model encourages the understanding of health behaviour as being the result of the interplay of attitudes, lifestyle factors and socio-cultural influences that are unique to each individual patient. The IMS model identifies tailored, multifaceted intervention approaches to be effective in promoting patient adherence.

Persuasive Technology

Persuasive Technology (PT) concerns the ways in which digital technology can influence behaviour change. B.J. Fogg is widely recognised as the founder of the PT field, with the publication of the book *'Persuasive Technology - Using Computers to Change What We Think and Do'* (2003). The book identifies 42 different persuasive strategies, which are utilised by digital/web based technologies to foster behaviour change. In another paper, he presents Fogg's Behaviour Model (FBM) which acts as a framework for persuasive design. The model consists of three factors necessary for a behaviour to take place. These factors are motivation, ability and a trigger/cue to action. Fogg argues that a behaviour can not take place unless all three of these of these factors are present (2009).

Fogg's work and theories have been influential within the PT field, with a number of persuasive design frameworks building upon his studies. One of these frameworks is the

Hooked Model (Eyal, 2014), which expands upon the FBM. The Hooked Model is a four step design framework for fostering habitual engagement with digital products. The four steps of the model are trigger, action, reward/variable reward, and investment. Each of these stages are outlined in more detail in Table 1.

[**Table 1 -** Hooked Model]

Hooked Model	
Step	**Description**
Trigger	The cue to action which triggers a user to engage in a behaviour. Triggers can be external e.g. an advertisement, a push notification, or internal, triggered by a feeling, desire or state of mind e.g. boredom (Eyal, 2014, p. 39-51)
Action	The action is the target behaviour that is initiated by the trigger stage. Fogg states that designs should enable the performance of this action to be performed 'without conscious thought' (Eyal, 2014, p. 61)
Variable Reward	This stage is where the product delivers on the need/desire that the user came to the product to fulfil. Rewards can be fulfilling more straightforward needs (e.g. opening gmail to view mail) or satisfying emotional desires (e.g. validation from a Facebook 'like'). Using variable rewards is a strategy established in motivational psychology to foster repetitive engagement with a behaviour. (Eyal, 2014, p. 95)
Investment	This stage is the process through which users invest time, energy, effort, data into a product, which incentivises use of the product in the future e.g. placing files into google drive, leading to future use of google drive as a

	storage system. (Eyal, 2014, p.135-144)

PT strategies have also been utilised within the healthcare domain. There is a growing body of research examining the application of PT strategies in technologies, such as games, to promote engagement with positive health behaviours (Oinas-Kukkonen, 2013, p.1229). The use of PT has been explored in contexts such as smoking cessation (Dijkstra, 2006), diabetes management (Kahol, 2011), obesity intervention (Ping et. al, 2012) and chronic disease management in older adults (Portz et. al, 2016).

More recent research within the PT and health domain focuses on tailoring the use of PT strategies to individual patients. Tailoring strategies to personality types is a common approach. Halko and Kientz found that users were more receptive to certain PT strategies based on their identification with the personality traits from the Big Five Inventory. For instance people with neurotic tendencies tended to enjoy strategies based on negative reinforcement (Halko & Kientz, 2010, p. 159). In a similar vein, Tan et. al. tailored in game feedback based on the levels of extroversion or introversion in users. Users in this study responded more positively to the feedback which was tailored to their level of introversion/extroversion (2013, p. 232). Alternatively, Orji et. al. separated users by gamer type, tailoring PT strategies in health games to users, based on the seven different gamer types identified in the BrainHex model (2014).

It is argued that tailored healthcare interventions are better positioned to target the specific needs of individuals, and therefore deliver a higher quality of care than a one-size-fits-all approach.

Findings From Previous Project Stage

Safety and Professional Support

According to the findings, designs should enable the safe practice of PFMT. Typically this means encouraging contact with a pelvic health clinician. The findings recommend that designs should provide access to some sort of screening/self-assessment tool to enable women to identify any symptoms of PFD. The findings also recommend that the design should assure women that feeling strange, or ticklish when they first start performing their exercises is normal (Barnard, 2017, p. 54-55).

Teaching PFMT With Metaphor

The design should educate women on PFD, PFMT, and general pelvic floor anatomy. The design should offer some form of visualisation of the pelvis which communicates the location of the pelvic floor within the body. The design should also assist women with correct exercise technique, communicating the 'squeeze and lift' action of a contraction. The findings also suggest communicating technique through metaphor.(Barnard, 2017, p. 55-57).

Integrating PFMT Into Daily Life

The findings suggest that designs should also encourage integration and awareness of PFMT in daily life. Teaching functional exercises, such as 'The Knack', which involves the performance of a contraction while coughing to prevent leakage is suggested. The exercises should also enable women to retrain their muscles to behave as they did before pregnancy. Designs should encourage women to engage their muscles during daily activities that place strain on the pelvic floor (e.g. lifting up a baby, light exercise etc.).

The findings also provide strategies to assist with memory/integration of PFMT into women's daily life. Additionally designs should encourage women to use routine activities as cues/reminders to perform their exercises (i.e. breastfeeding). Designs should also encourage an awareness in women to perform their exercises both with or without the design (Barnard, 2017, p.57-59).

Methodology

The central research question of this study is "How Can The Design of a Personalised Mobile Application Improve Engagement With Pelvic Floor Muscle Training Amongst Women From Pregnancy to up to One Year After Delivery?"

This study has two central aims:

1) Develop design criteria, which identifies user requirements for improving engagement with PFMT for a mobile application
2) Produce a fully functional prototype of the mobile application, which implements the criteria

The end goal of the research is to produce a mobile application, and a set of design recommendations to guide the development of designs that seek to improve engagement with PFMT. The study seeks to identify specific design strategies that are effective in improving engagement with PFMT and why they are effective.

This study has two main stages. First is the research stage. The purpose of this stage is to develop an understanding of the needs and experiences of women this study focuses on. Women's needs are shaped by various social, cultural and medical factors. It is important that these factors are understood in order to produce a successful design. Second is the design stage. This involves engaging in a process of iteration to arrive at the final design. Through this process, the study aims to identify strategies which improve engagement with PFMT. The testing needs to be able to identify the most effective components of the design and the reasons why.

The Postgraduate Research Through Design model (RTD) provides the framework for this study. The RTD model is a criteria based design research model, developed to allow designers to engage in the practice of design, in the systematic manner of enquiry that is expected in an academic research context (Rodriguez Ramirez, 2017). The RTD model consists of four steps:

1) *Situating the research within the body of knowledge of the discipline*

2) *Experimental discovery through making*

3) *Designing as systematic enquiry*

4) *Assessing the design based on the final criteria*

The RTD model was selected as the framework for this study, as it provides a method for knowledge to be created through design. The design process is subjective in nature, as it requires intuition and creativity to formulate solutions. It requires that these solutions be implemented within the context of a fully designed product, alongside other variables. Due to these factors it can be difficult to derive explicit knowledge at the conclusion of the design process. The RTD offers a solution to this through assessing design outputs produced via the subjective in nature design process, against criteria formulated through more objective means, such as research and testing. Through this method, knowledge can be extracted from design research.

This project is part of an ongoing research project with the Auckland Bioengineering Institute. The larger project focuses on the development of a system, consisting of an internal biofeedback device which works alongside a mobile application. This system provides women real time biofeedback to guide the performance of PFMT. The internal device has an array of

eight pressure sensors, which allows it to detect the incorrect performance of PFMT. As the device is still in development, this project focuses on a stand alone mobile application, which guides PFMT without the use of an internal device. This project builds on findings from earlier stages of the project.

The stages of the design process, and the methods used are outlined below.

Persona Development

User personas are a widely accepted practice for the development of products which potentially have multiple, and diverse target audiences (Nielson, 2013). This application is one instance. Utilising user personas can help focus the design process, as the study attempts to understand the differing needs of the target audience.

This study began with five user personas which were originally developed as part of a research project over the summer in 2016-17. These personas were based off the Five Factor Model (FFM) (Goldberg, 1992), and a paper by Bradway (2005). This project reduces the original design into three different personas, basing the personas more on the 3 types discussed in Bradway's paper, and engagement barriers. These personas helped guide the development of application prototypes.

Iteration and Prototyping

Designs were developed through a process of iteration, testing, evaluation and refinement as described in the RTD. Initial prototypes were developed in the first stage of the project. These prototypes were designed to meet the initial criteria developed from the literature and design reviews. These prototypes were then user tested (description below) and evaluated against the updated design criteria. This cycle of iteration and user testing was carried out for the rest of the study, concluding with the final design and criteria.

Clinician Interviews

Three clinicians were interviewed for this study. Interviews took between 30-45 minutes and were conducted in a semi structured interview format. Clinicians were contacted via email. Clinicians were asked questions regarding engagement barriers, women's knowledge, and design recommendations for the application. The interviews were processed via thematic analysis (Lapadat, 2010).

Survey

An online survey was conducted for this study which asked participants questions on barriers, beliefs, knowledge and features they would like in an app. The survey had 41 questions in total. The participants were aged between 32 and 55, all with a history of childbirth/pregnancy. Participants were recruited via mother/pregnancy related facebook groups and online forums, as well as email. The survey had a total of 4 respondents, with only 3 completing the survey (1 participant's survey was cut short by a malfunction in the survey software).

User Testing 1

The first user testing session involved 2 participants. The participants were female university students aged 22 and 24. Neither of the participants had a history of pregnancy. The user testing session involved three components. First, the participants were presented with a range of metaphors used by clinicians to communicate the correct technique for performing a pelvic floor contraction. These metaphors were taken from clinician interviews conducted in an earlier stage of the larger research project (Barnard, 2017). Participants were asked to identify which metaphors they found the most helpful/easy to understand. Secondly, the participants were given 3 existing pelvic floor applications to test. Participants were asked to evaluate the

usability of these applications, how helpful they were in guiding PFMT, and give any general feedback. Thirdly, participants were given 2D visualisations of the pelvic floor and asked to evaluate their efficacy in communicating the location of their pelvic floor. The user testing session was conducted in a semi-structured interview format. The results from the session underwent a thematic analysis (Lapadat, 2010) to extract key themes and findings.

User Testing 2

The second user testing session was conducted with 3 participants. Participants were women in their mid twenties to late forties. Two had a history of pregnancy, with one having given birth in the last 12 months. Participants were recruited via email, using the snowballing method. Participants were asked to evaluate fifteen different animations, in terms of their ability to communicate the 'squeeze and lift' motion associated with PFMT. Participants reviewed two representations of the pelvic floor (2D and 3D). They were also shown rough wireframes of the application, which illustrated a tutorial stage, and a gamification feature. The results from the session underwent a thematic analysis (Lapadat, 2010) to extract key themes and findings.

User Testing 3

The third user testing session involved 5 participants. The participants were aged from their early thirties to late forties. Of the 5 participants, all but one had given birth. Participants were recruited via email. The participants were asked to evaluate a functional version of the mobile application. The user testing session took place in a semi-structured interview format, lasting approximately 50 minutes. The results from the semi-structured interview questions underwent thematic analysis (Lapadat) to extract key findings.

Participants were asked to fill out a questionnaire at the end of the user testing session. The questionnaire presented descriptions of 4 user personas. Participants were asked to identify which persona they related to the most, and why. Participants assessed usability via the Systems Usability Scale (SUS) (Brooke, 1986), and which features they found most engaging/useful.

Design Phase 1

Design Criteria 1

The design criteria for the application can be broken into three aims: 1) provide information and guidance on PFD & PFMT, 2) address barriers to engagement with PFMT and 3) facilitate habitual engagement with PFMT. Each of these aims are outlined in more detail below.

1) *Provide Information and Guidance*

   The application should provide women with information and guidance in order to enable them to perform their PFMT safely and confidently. The application should *provide some form of guidance/instruction to women assist them with correct PFMT technique*. This instruction can be delivered through metaphors, that explain the physical action of a pelvic floor contraction.

   Helping women understand their anatomy is important as it can aid in the performance of PFMT. *Utilising imagery of the pelvic floor in instruction* can assist with this.

   Additionally, it is important that *women are encouraged to visit a pelvic health professional.*Here they can get an assessment and receive treatment that is most suitable for them. The *inclusion of a screening tool* can help women identify the presence of symptoms.

2) *Address Barriers To Engagement*

Improving user's self-efficacy should be a focus of the application. Another factor that contributes to low self-efficacy is the difficulty of integrating PFMT in to a busy lifestyle. The application can help women overcome this barrier through helping identify opportunities to perform PFMT in daily life.

The application should also *create reminders and triggers*, and *reduce stigma*.

If possible the application should accommodate individual differences and address needs specific to each woman.

3) *Facilitate Habitual Engagement With PFMT*

Facilitating habitual engagement with PFMT is crucial. Utilising engagement strategies identified within the literature such as the Hooked Model (Eyal, 2014) can help engagement with PFMT.

Integrating various PT strategies into the design and tailoring them to individual users is another tactic to improve engagement according to literature (Orji et. al, 2014).

[**Table 2** - Design Criteria 1]

1) Provide Information and Guidance	1.1 Guide correct performance of pelvic floor contraction 1.2 Educate women on condition and anatomy 1.3 Utilise imagery of the pelvic floor in instruction

	1.4 Encourage women to get assessed by a pelvic health professional 1.5 Include self assessment/screening tool to help women identify symptoms of PFD
2) Address Barriers to Engagement	2.1 Improve self-efficacy in users 2.2 Create reminders through triggers 2.3 Reduce stigma 2.4 Help integration of PFMT into daily life 2.5 Accommodate individual differences in needs/barriers
3) Facilitate Habitual Engagement With PFMT	3.1 Utilise engagement framework in application design (i.e. Hooked Model) 3.2 Employ PT strategies to promote engagement

Design Review

The search terms "pelvic floor app", "pelvic floor fitness app" and "kegel app" returns multiple pages of results on the Google Play Store. The most popular apps such as *Elvie* have 10,000 downloads on the Google Play Store. Generally, they contain some kind of workout component, usually a timed visualisation to assist with contractions. Applications vary in a number of ways such as price, aesthetic, features, exercises, level of guidance/instruction etc. Applications also split between ones paired with an internal device, and ones that are standalone.

Below is a review of 11 different mobile applications that are designed to assist with pelvic fitness. 10 of the 11 applications were found through the Google Play Store by typing in the search terms "pelvic floor app", "pelvic floor fitness app" and "kegel app". The other application, *Labella*, was the developed as part of a study (Almeida et. al, 2016). The applications are discussed in relation to how well they satisfy the design criteria outlined in Table 2. Three of the apps that integrate a device (*Skea*, *PeriCoach* and *Elvie*) required the possession of the device in order for the application to be used, therefore some aspects of the criteria can't be evaluated. The same is true for *Labella,* which is not publicly available for download.

[**Table 3** - Applications In Design Review]

	Uses Device	Free/Paid	Other Notes
Magic Kegel	*No*	*Free*	
Squeezy NHS	*No*	*Paid*	

Labella	*No*	*n/a*	*Not available for public download/distribution*
MyPff	*No*	*Free*	
Kegel Trainer	*No*	*Free, but has a paid version with more features*	
PeriCoach	*Yes*	*Free*	
K-Workout	*No*	*Free*	
Kegel Kat	*No*	*Paid*	
kGoal	*Yes*	*Free - but requires purchase of device*	*Requires purchase of device to use app*
Skea	*Yes*	*Free - but requires purchase of device*	*Requires purchase of device to use app*
Elvie	*Yes*	*Free - but requires purchase of device*	*Requires purchase of device to use app*

1) Information and Guidance

Most of the applications reviewed provided users with information on pelvic floor health and anatomy. Of the applications reviewed, only 3 (*Magic Kegel, Kegel Kat* and *kGoal*) did not provide an FAQ or feature dedicated to providing information on pelvic health. However, both kGoal and Kegel Kat did provide links to sites where further information was available. In the applications that did provide an information

section, the level of detail varied. Of these apps, *K-Workout* provided the least comprehensive information section, as it only briefly covered how to perform a pelvic floor contraction, and how many times a day exercises should be performed.

NHS Squeezy and *Labella* both had a strong focus on pelvic health education and information. *NHS Squeezy* had a comprehensive information section which covered not only PFMT technique, but also details on the function of the pelvic floor, physiotherapist contact information and information on "The Knack" exercise. *NHS Squeezy* was developed by medical professionals, explaining the comprehensive information section. Education was the central focus of the *Labella* application. Labella was the only application to utilise methods of instruction/education that was not text based. *Labella* is an augmented reality (AR) system, which uses an application in combination with underwear. Women put on the underwear and it projects an interactive 3D model of the pelvic floor on top. Users explore different parts of pelvic anatomy while the app provides information. Using novel methods like these may be more effective in communicating pelvic health information, requiring users to actively engage with the content.

All of the applications provided some form of guidance regarding the technique of a pelvic floor contraction. Most applications described a contraction as a "squeeze and lift" action. The exception is *Magic Kegel* which instead used the phrase "tense and hold". Many of these apps used metaphors to describe the action in more detail.

All of the applications provided a guided workout. Each of these workouts utilises some form of timed animation to help guide the length of contraction. For instance, the *Elvie* app offered women six different types of exercises, each targeting a different component of pelvic floor function. *Magic Kegel* offered different workouts which were

categorised by the potential needs of the user. Most apps offered two types of exercises - quick contractions, and long, tightly held contractions.

Of all the applications, 6 out of 11 utilised imagery of the pelvic floor to aid instruction (design criteria 1.3). Four of the applications - *NHS Squeezy, PeriCoach, MyPff and Pelvic Floor Pregnancy Plan* encourage women to visit a pelvic health professional if they present with symptoms.

2) Addressing Barriers To Engagement

Point 2.1 of the criteria, improving self-efficacy in users, is a barrier that can be addressed through providing guidance on PFMT. Applications that use biofeedback devices, are better positioned to deliver a sense of self-efficacy. Applications that do not use biofeedback devices, are disadvantaged in this sense. Focusing on providing users with information that enables them to understand how to perform PFMT, why exercises are effective, common mistakes, and signs that the exercises aren't working. Empowering users with information is a strategy for promoting self-efficacy for apps that don't use a device. This strategy is reflected in *NHS Squeezy* and *Labella*, both of which are heavily information focused.

Self-efficacy is also improved through the use of progress tracking features. Logging progress over time can promote self-efficacy in a kind of 'proof of improvement' way. This feature was included in a most of the applications, except for *Kegel Kat* and *Labella*. Other tactics such as providing messages of praise throughout the workout (i.e. "You got this!", "Well done keep going!") could also boost self-efficacy. This strategy is used by a few of the apps. Kegel Kat and MyPff feature the use of praise most heavily out of the applications reviewed.

The ability to set reminders was one of the core functions that featured across all of the apps. This suggests that reminding users to exercise is considered to be a function essential to PFMT apps.

Some applications handled stigma through the selection of language and tone. Of all the applications in this review, *Labella* perhaps makes the most effort to ease the taboo and stigma associated with the pelvic floor. The paper states that using humour in healthcare as a mechanism for addressing taboos is effective, as it provides relaxation and ease (Almeida et. al, 2016, p. 1819). *MyPff* also utilises humour, using humorous euphemisms for the pelvic floor e.g. 'Your Lady Garden'. *Kegel Kat* uses a similar strategy, with its playful cartoonish graphics. The association between this visual style and the performance of pelvic floor exercises is unexpected, bringing an element of levity and humour which can help reduce stigma.

A few of the apps include the option for a discreet mode. *Kegel Trainer* allows for users to customise notification text. K-Workout allows for a discreet workout mode.

3) Utilising Engagement Techniques

The applications in this review utilise a wide variety of engagement strategies (3.2 of criteria). Examples of many of the strategies outlined in Fogg's book Persuasive Technology (2003) can be found in these apps. There were differences in the kinds of strategies that were favoured in applications. The *NHS Squeezy* application is heavily focused on providing information, and emphasises its association with the NHS. The app establishes its persuasive power through focusing on the use of strategies that build credibility and authority. Alternatively, Kegel Kat has a very fun and playful aesthetic which engages users through fun and humour. The app builds engagement

through PT strategies that are driven by engaging people on a personal level. These principles include attractiveness, similarity and praise. The application also uses the principles of virtual reward and conditioning through its gamification aspects. The other applications in this review seemed to fall somewhere on the spectrum of the more medical, information focused approach to the more playful, fun, aesthetically driven approach.

The Hooked model structure, or at least elements of it, could be identified in the all of apps in this review (3.1 of criteria). Trigger, the first component, in the majority of these apps, takes the form of an alarm/push notification scheduled by the user. The second component, action, for all of the applications in this review would be the performance of PFMT exercises.

Reward and investment were present in varying ways. For a pelvic health application, the reward would be the alleviation of symptoms. While the alleviation of symptoms is dependent on the correct performance of PFMT, some of the apps in the review still manage leverage the engagement power of the reward component. Progress tracking features help users visualise improvement in muscle strength and function, highlighting the payoff of regularly performing PFMT. Exercise progress is also rewarded with in app achievements in the *Kegel Trainer*, and *Skea* apps. Messages of praise during is another example of reward in these apps.

The fourth component of the model is investment. The most common way these apps fulfil investme is the progress tracking feature, which stores the user's exercise and progress data. Other apps have additional functionality, like a period tracker (*Magic Kegel*) and a general fitness planner (*Pelvic Floor Pregnancy Plan*). The integration of these other features gets users to invest other data (menstrual data, fitness data), which greater incentivises the user to engage with the application, and by extension PFMT

more frequently.

Summary

The applications included in this review all shared the same core functionality (except for *Labella*), including a workout component with timed animations, and a reminder function. However, there was a great deal of variation in other aspects such as tone/aesthetic style, level of guidance and information provided, features included etc.

It was notable that applications with biofeedback support seemed better equipped to provide users with guidance while performing PFMT. However, *NHS Squeezy* and *Labella* which do not come with biofeedback devices provided comprehensive information and education sections. Focusing on informing and educating the user is likely a good approach to increase users sense of self-efficacy while performing exercises, despite the lack of direct biofeedback.

From the applications reviewed here, there is room to be more creative with approaches to improving user engagement. For example, *Labella* utilised an interactive AR component to educate users on anatomy. Both *Skea* and *Kegel Kat* incorporated gamification into their workout. Methods such as these could prove useful in making the workout experience more engaging for women.

The apps seemed to be lacking in the use of triggers and establishing an awareness of performing PFMT in everyday life. Most apps used a simple notification alarm which was set up by the user. There is an opportunity to consider how these reminders/triggers could be used to help identify opportunities to perform PFMT in the daily lives of users.

Based on the review above, there are still some key needs, and areas for opportunity to address, within the market of pelvic health applications.

Personas

This study starts with a foundation of five different user personas. For this project, these personas were modified and grouped in to three user groups to be designed for. These modifications were made to narrow the scope for this project, and to focus on identifying user groups by specific barriers and lifestyle factors that influence engagement with PFMT, rather than FFM factors.

Amy

Amy is a 35 year old mother of two who has gave birth to her second child 5 months ago. Amy's a stay at home mother with her main priority being her children. Amy is also responsible for general household duties such as cleaning, buying groceries etc.

Amy first began experiencing symptoms of pelvic floor disorder roughly 4 years ago while she was pregnant with her first child. PFMT was first brought to her attention while attending antenatal classes. Amy performs her exercises on and off - roughly once a month. Occasions where she experiences leakage often trigger her to perform exercises again. She often forgets to perform her PFMT in the midst of her busy schedule as a mother.

Amy experiences a mild amount of embarrassment regarding her condition. However, she knows other women experiencing similar issues from her eldest child's daycare which has helped alleviate negative feelings associated with her condition. When she discusses her symptoms of she does so with a sense of humour. Previously, Amy has put off treatment due to a lack of concern.

Anna

Anna is a 28-year-old graphic designer who is currently 2 months pregnant with her first child. Anna first learnt about pelvic floor disorder her female relatives who have also experienced symptoms during their pregnancies. Anna wishes to prevent herself from developing the same condition.

While not working, Anna enjoys an active lifestyle, swimming, cycling and playing netball. She is considered a very cheerful and outgoing person, with a large support network of friends and family.

As Anna has yet to experience any symptoms of pelvic floor disorder, she finds herself less inclined to engage with PFMT. Additionally, Anna is not overly sensitive with topics of this nature, openly and comfortably discussing taboo topics such as sex and incontinence with her friends and family.

Debbie

Debbie is a 45 year old executive who gave birth to her second child 9 months ago. Debbie is a high earner, and the majority of her time is spent working. This makes her life busy and stressful, especially when she juggles her family life with her workload. Her schedule keeps her constantly occupied.

Debbie experiences some degree of embarrassment around her symptoms, they do not preoccupy her thoughts or her daily life. Debbie's mainly views her condition as an inconvenience, getting in the way of her priorities of work and family.

Debbie neglects her health putting off treatment for her symptoms, believing they were not severe enough to warrant taking time out of her schedule. Debbie seeks a

treatment plan that will enable her to quickly address her symptoms and resume her life as normal.

Shannon

Shannon is a 24 year old single mother of two, who lives in a rural area. Shannon began experiencing symptoms after the birth of her second child 5 months ago. Shannon wishes connect with other young mothers, however due to her town's small population, there are few whom she can befriend.

Shannon's condition has led her to experience feelings of embarrassment, uncleanliness and low self-esteem. Shannon experiences a great deal of stigma, believing that she is too young to be suffering from such a condition. As a result, Shannon does not like to openly discuss her condition, preferring to ignore/hide it and only ever discussing her symptoms when prompted.

Shannon has only recently begun to seek treatment for her symptoms. Her location has contributed to her ability to seek treatment. Shannon was referred to a specialist in the city, however, she can rarely go. Shannon has searched for information online but still feels lost as to how to address her condition.

Elizabeth

Elizabeth is a shop manager in her late twenties, who began experiencing symptoms of PFD after a stillbirth a few months ago. Since then, Elizabeth has been experiencing feelings of grief, pain and sadness. She has another child with her husband Mark.

Elizabeth's condition is associated with a lot of sensitive emotions. For Elizabeth, her

condition is tied to the experiences of grief that she associates with her stillbirth. After her stillbirth, Elizabeth has a level of distrust towards medical professionals.

Elizabeth has only recently sought treatment for her incontinence. She has attempted to manage or ignore her symptoms, however they are beginning to cause her feelings of stress and anxiety. The pain she associates with her condition contributed to her reluctance to seek help.

For this study, the personas have been divided into 3 groups to design for. The groups are based on the narrative types identified in Bradway's 2005 paper. The persona groupings and corresponding narrative types are outlined below

Amy and Anna

The Amy and Anna personas are based on the 'UI Restitution Narrative'. This narrative type is characterised by openness about the condition, an overall positive attitude to treatment and the discussion of symptoms with humour. Amy and Anna share a more extroverted and open personality, strong social networks and low levels stigma associated with the condition. Strategies for these two focus on appealing to their more social, extroverted tendencies, as well as increasing their perceived susceptibility/severity of symptoms.

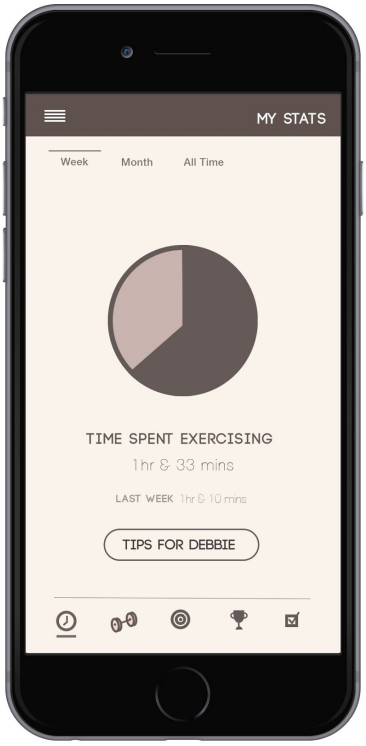
Debbie

The Debbie persona is based on the 'UI Quest Narrative'. This narrative type is characterised by a matter-of-fact attitude to the condition. This narrative type acknowledges UI symptoms, and finds ways to manage them so they can move forward with their life. Debbie is characterised by a straightforward, 'let's get on with it' mentality. Her attitude and busy lifestyle causes her to seek out a quick fix solution

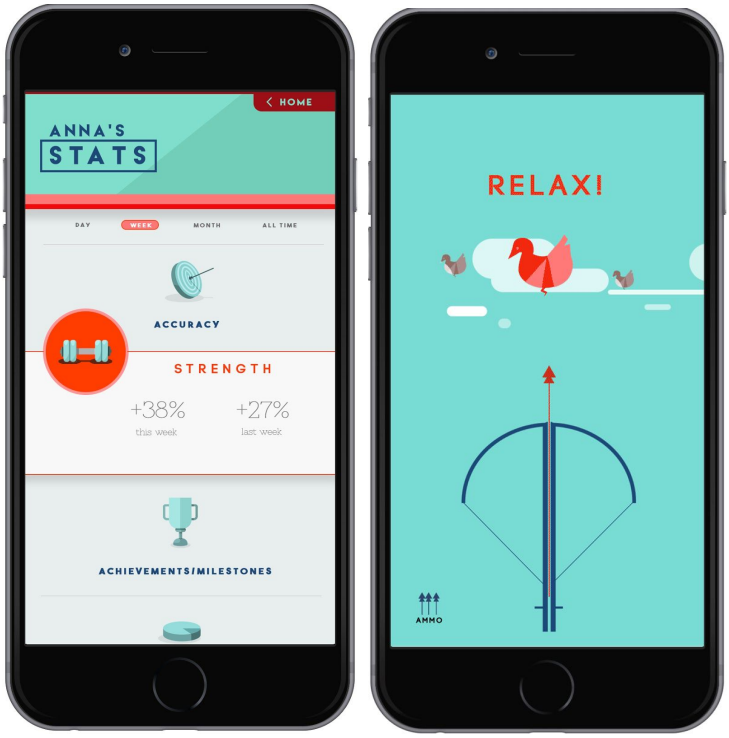
to her symptoms, preferring that to taking the time she needs to address her symptoms. Strategies for Debbie focus more on addressing time barriers, making engagement with treatment is efficient as possible, and emphasising the importance of addressing symptoms.

Shannon and Elizabeth

The Shannon and Elizabeth personas are based on the 'UI Victim Narrative'. This narrative type is characterised by a pessimistic attitude toward treatment, a high perceived impact of UI on living and generally more negative feelings associated with condition. Shannon and Elizabeth both share more reserved/introverted characteristics, high levels of stigma, social isolation and a low sense of efficacy in regards to treatment. Strategies for these two focus on alleviating feelings of stigma, establishing belief in the efficacy of treatment, and establishing self-efficacy in relation to PFMT.



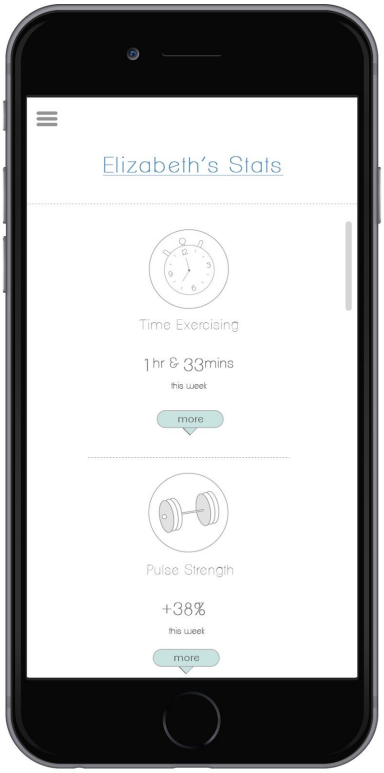
[**Figure 1** - Mobile application mockup for Debbie produced over the summer research project]



[**Figure 2** - Mobile application mockup for Anna produced over the summer research project]

[**Figure 3** - Mobile application mockup for Amy produced over the summer research project]

[**Figure 4** - Mobile application mockup for Shannon produced over the summer research project]



[**Figure 5** - Mobile application mockup for Elizabeth produced over the summer research project]

User Testing Session One

Metaphors

Of the metaphors given to the participants, the favoured ones seemed to reference some form of familiar body action. For instance, one of the favourite metaphors of the participants was

> *"Squeeze your muscles as if you are squeezing around a tampon"*

The participants went on to state they liked this one as the sensation was one they were already familiar with. With one of the participants stating

> *"I like this one, because it's like relatable. Like it's a sensation that's easier to understand than the others [metaphors]"*

The other favourite metaphor was

> *"Squeeze your muscles as if you are trying to stop the flow of urine."*

As with the previous one, participants noted that they liked this one as the sensation was familiar to them. However, this logic did not hold up with all metaphors, as one referencing the passage of wind was not popular. The metaphor was

> *"Tense your pelvic floor muscles so it feels like you are gathering your muscles together to stop yourself from letting out a flatulent."*

One of the participants explained she felt as if she was activating the wrong muscles stating

"Don't like that one. It feels as if I am activating the wrong muscles with that action."

This is perhaps due to the reason that the anal muscles are not typically associated with the pelvic floor, being more commonly associated with the vagina.

The participants' least favourite metaphors tended to be vague or confusing. One of the metaphors was

"Imagine you are lifting up like a plunger"

One of the participants stated that this one kind of worked, as it *"gives you that sense of resistance as if you need to pull"*. However they also noted that the metaphor does not give enough guidance as to where you should be lifting.
One of the participants mentioned that it would perhaps work alongside another description. Similar feedback was given for the metaphor *"Squeeze and lift",* with participants stating that the metaphor was too vague. Similar to the plunger metaphor, participants thought it would work better with the addition of another description.

A couple of the metaphors divided the participants. One of these was

"Think about where your pubic bone is and think about where your tailbone is, and imagine the muscle sitting in between those two points just lifting up the entire pelvic floor. So just draw your coccyx to your pubic bone and lift!"

One of the participants stated she liked this one as it helped her locate the muscles she should be contracting, stating

> *"It makes sense as a metaphor. Because it's like the inbetween and gives you the idea of where to place the tension."*

However, the other participant found the metaphor confusing. The other metaphor that divided the participants was

> *"Imagine the pelvic floor as being like a sling. Now imagine a point in the centre of that sling and draw that upward."*

One participant stated that she liked this metaphor, however the other participant explained that she found it confusing, and believed it would be easier with the aid of visuals.

Visualisations of The Pelvic Floor

Four images depicting the pelvic floor and surrounding anatomy were created [see Figures 6-9]. These images are designed to communicate the location of the pelvic floor, situating it in the surrounding anatomy. The arrows and accompanying descriptions are there to help communicate the technique of the contraction and the location of the muscles contracting.

The participants both struggled with the 2d representations of the pelvic floor. The participants were having difficulty relating their own pelvic floor muscles to the ones depicted on the illustrated visualisation. One participant stated she found it confusing saying

> *"With the anatomical visuals it's difficult understanding which muscles are meant to be activated."*

When asked about the possibility of an interactive 3d model of a pelvis, both participants agreed that a 3d model might be better at communicating the location of the pelvic floor.

Review of Existing Pelvic Health Mobile Applications

Participants noted that the applications seemed to lack clear instruction and guidance. *Kegel Kat* and *K-Workout* only featured a small FAQ section which provided a brief overview of what the pelvic floor is, and instructions on how to perform a contraction. *Magic Kegel* provided no information section. The participants noted that they would like more instruction, especially while performing the workout, with one participant stating

> *"I need the information to be there while I am doing it"*

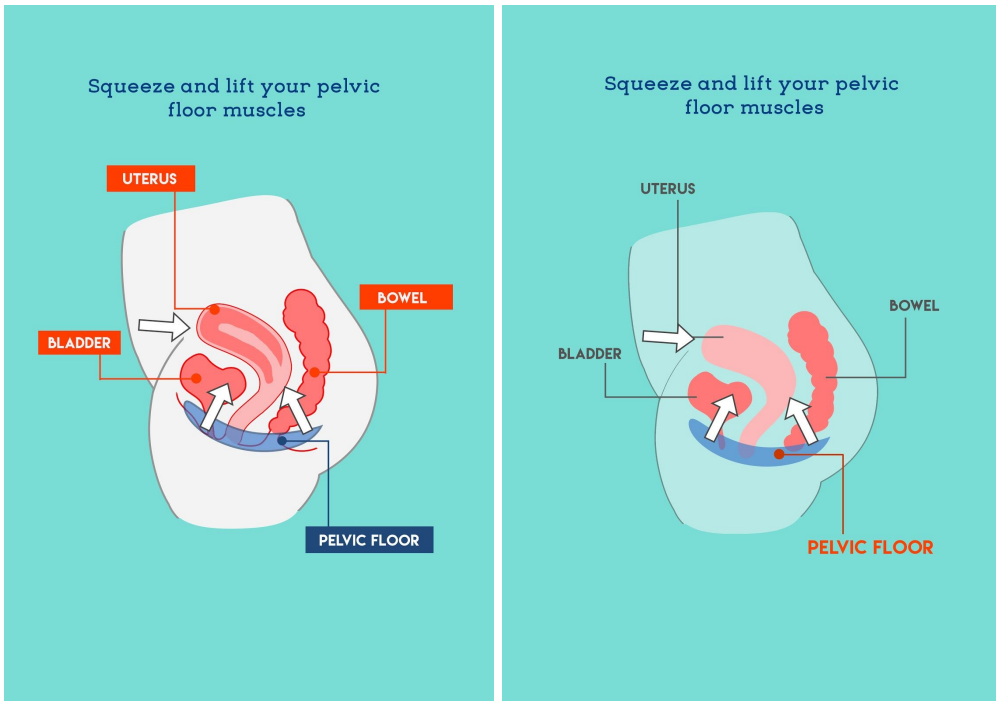
Both participants expressed the desire for a tutorial at the beginning, that would run them through a workout.

Participants also noted that some of the designs had features that made them come across as *"cheap and untrustworthy"*. *K-Workout* was called out for its lack of visual appeal. Participants stated that the aesthetic lacked colour and was overly masculine, describing the visual style as *"ugly"* and one stating *"it looks like it was made by an engineer instead of a designer"*. On the other hand, participants praised both the visual style of *Magic Kegel,* stating that it was *"very pretty"*.

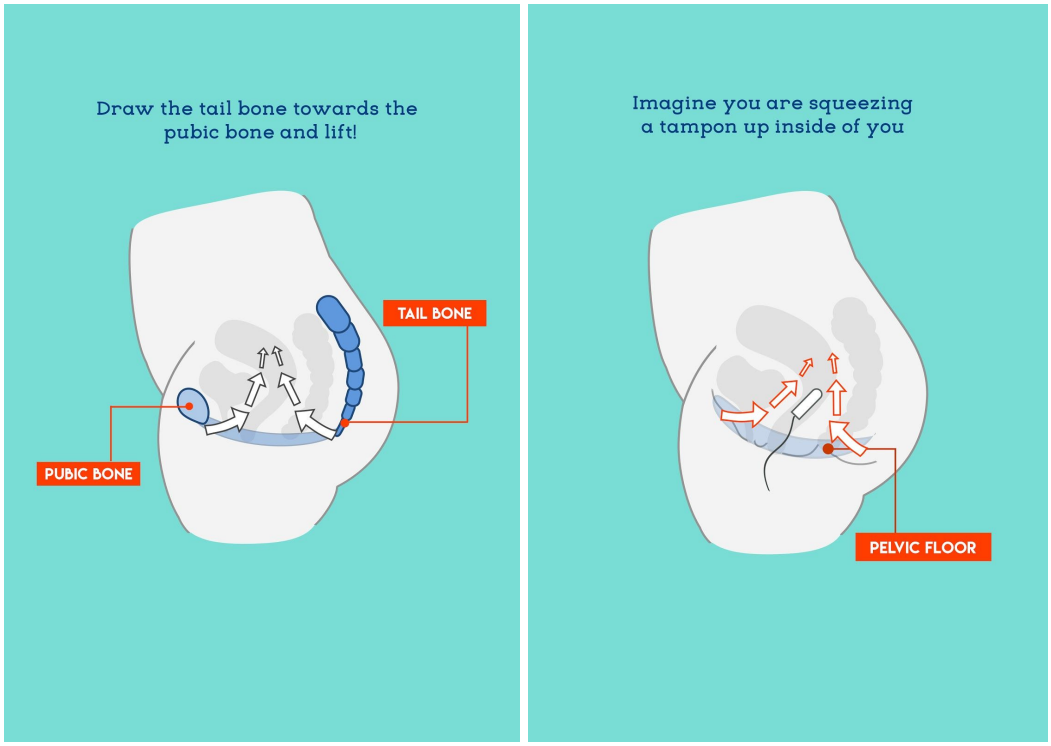
In the workout component of the applications, participants stated that they would prefer the animations to be less rigid. One participant stated that *"when I think of a contraction I think of like a more organic curved motion"*. Both participants preferred the more curved motion in the *Magic Kegel* app, which represented a contraction as a coloured line following along the edge of a circle.

Other feedback participants gave on the applications was the desire for more visual feedback during workouts. One participant commented *"I would just like it if there were some kind of sparkle, or fun little ding during the workout part. Like it's a little plain at the moment."*

[**Figures 6 & 7** - Visualisation of the pelvic floor given to participants in the first session of user testing]



[**Figures 8 & 9** - Visualisation of the pelvic floor given to participants in the first session of user testing]



Design Phase 2

Design Criteria 2

Additions to Criteria

Design Review

- Create trigger features that establish contextual awareness for performing PFMT in daily life (i.e. location based reminders)

- Empower users with information on pelvic floor health and PFMT as a strategy for promoting self-efficacy

- Use humour as a strategy to reduce stigma

User Testing Session One

- Educate women on PFMT technique using metaphors that refer to familiar bodily sensations (i.e. "stopping the flow of urine midstream")

- 2D visualisations of the pelvic floor are difficult to understand, use of a 3D model may be better

- Provide instruction/guidance on PFMT in the initial stages of app use and during workouts

- Consider aesthetic properties of the application, this has a significant effect on users perception of the app

- Ensure the graphic style of the app is aesthetically appealing, and does not come across as "cheap and untrustworthy"

- Stay away from rigid movements in the guided PFMT visualisation animations

[**Table 4** - Design Criteria 2]

Design Criteria 2		
1) Provide Information and Guidance	1.1 Guide correct performance of pelvic floor contraction	• Educate women on PFMT technique using metaphors that refer to familiar bodily sensations (i.e. "stopping the flow of urine midstream") • Provide instruction/guidance on PFMT in the initial stages of app use and during workouts • Stay away from rigid movements in the guided PFMT visualisation animations
	1.2 Educate women on condition and anatomy	
	1.3 Utilise imagery of the pelvic floor in instruction	• 2D visualisations of the pelvic floor are difficult to understand, use of a 3D model may be better
	1.4 Encourage women to get assessed by a pelvic health professional	
	1.5 Include self	

	assessment/screening tool to help women identify symptoms of PFD	
2) Address Barriers to Engagement	2.1 Improve self-efficacy in users	• Empower users with information on pelvic floor health and PFMT as a strategy for promoting self-efficacy
	2.2 Create reminders through triggers	• Create trigger features that establish contextual awareness for performing PFMT in daily life (i.e. location based reminders)
	2.3 Reduce stigma	• Use humour as a strategy to reduce stigma
	2.4 Help integration of PFMT into daily life	
3) Facilitate Habitual Engagement With PFMT	3.1 Utilise engagement framework in application design (i.e. Hooked Model)	
	3.2 Employ PT strategies to promote engagement	
	3.3 Tailor PT strategies to individual users	

Miscellaneous criteria	• Consider aesthetic properties of the application, this has a significant effect on users perception of the app • Ensure the graphic style of the app is aesthetically appealing, and does not come across as "cheap and untrustworthy"

Designs For Second User Testing Session

Animated Visualisations

14 different animation prototypes were developed [see Table 5] to visually communicate the "squeeze and lift" technique of a PFMT muscle contraction. These visualisations were prototypes for the workout component of the application. Animations attempted to capture a range of different visual possibilities for representing a pelvic floor contraction. The prototypes included animations with more figurative imagery and animations that were more abstract. The prototypes are meant to capture a range of aesthetics styles and animated movements, to establish both, the preferred visual style of the animation, and the most effective means of depicting the "squeeze and lift" technique of a pelvic floor contraction.

Instructional Tutorial

Feedback from previous user testing indicated that participants preferred having more guidance when using a pelvic floor app for the first time. The tutorial wireframe prototype was developed to provide that guidance (design criteria 2, point 1.1). The tutorial first runs the user through some information on pelvic floor disorders (design criteria 2, point 1.2) and information on pelvic floor anatomy. The tutorial then provides users with an initial workout, instructing them on correct PFMT technique. The app then provides the user with an exercise plan based on how difficult they found the workout. Users are then asked to set a workout goal for the day, after which the tutorial concludes. This tutorial had two purposes. The first was to provide users with information and guidance on PFMT. The second was to guide users through a process of investing data into the application, to incentivise their repeat use of the application. The tutorial here implements the "investment" stage of the Hooked model (Eyal, 2014) as per point 3.1 of the design criteria [Table 4]

3D Model of Pelvic Floor

Also in response to the feedback from the previous user testing session, a 3D model of the pelvic floor was developed [Figure 6]. This model was built in Maya and rendered in Unity. The model was not able to be implemented into a mobile device so for the purposes of the user testing session, the participants interacted with the model in the unity editor.

Wireframe Prototypes of Features

Also developed in this round of prototyping was a couple of mockups of features to improve engagement in the app. One wireframe depicts a mockup of a gamification feature [Figure 7]. A gamification feature would be implemented in the workout component of the application, with the user contracting in time with the bird avatar. The other feature wireframe is an exercise and goal setting feature [Figure 8]. When they set a goal, it gets them to identify places where they will perform their exercises, and times they will perform their exercises to establish everyday activities as triggers for PFMT (criteria point 2.2).

User Testing Session Two

Animated Exercise Visualisations

Participants were presented with a set of 14 different animated visualisations. These visualisations are designed to help guide the performance of a pelvic floor contraction, and were to be used in the workout component of the final application design. The participants were asked to evaluate these visualisations on the basis of their ability to communicate the "squeeze and lift" motion of a pelvic floor contraction. Participants were also asked to give their feedback on the aesthetic properties of the animations.

The animations that used more figurative imagery seemed to be the least popular with participants. The yo yo animation [no. 6, slide 13, Table 5] was one of the figurative animations that the participants did not like. One of the participants noted

> *"I see what you're trying to do but it's kind of like I feel like I should be going to sleep. And I think it's because it's a metaphor that's used in other places. You know whereas try and create your own visual thing."*

Many of the figurative animations evoked imagery that the participants did not like having associated with their pelvic floor, or the performance of exercises. For example, animation 5 [slide 12, Table 4], depicted a fish which would jump out of its bowl on the squeeze action. The participants did not like the association of pelvic floor exercises with water, with one participant stating

> *"I'm not sure if you want any form of liquid or water… it's beautiful, but now I need to go to the toilet."*

This aversion to water like imagery was extended to animation 12 [slide 19, Table 5], which was a more abstract image, yet was perceived to have a "liquidy" animation. In a similar vein, imagery that was too pointy was also not well received by participants. Animation 9 [slide 16, Table 5] depicts a paper crane folding (squeeze), then unfolding (relax). Participants noted that they did not like associating anything sharp whilst thinking about the contraction of their pelvic floor muscles, with one participant stating

> *"Ouch! It's too sharp … it doesn't make me want to squeeze."*

Animation 11 [slide 18, Table 5] was also criticised for being too pointy. Participants also criticised animation 12 [slide 19, Table 5] and animation 14 [slide 21, Table 5] for *"lacking personality"*.

Participants also expressed a preference for organic movement in the animation. Participants all expressed a strong preference for the curved motion of animation 3 [slide 10, Table 5], agreeing that it conveyed the squeeze and lift technique well. On the flip side, the straight up and down motion of the elevator animation [no. 2, slide 9, Table 5] was regarded as too rigid. One participant commented

> *"Okay so first off I really struggle with this because it feels so mechanical. And yeah it's like my body does not operate you know it's yeah, it's interesting."*

The participants also gave a suggestion that users could choose their own visualisations in the app. Or alternatively, the visualisations changed as the user progressed, with one participant suggesting

> *"You could start more literal, like you have a new user and your being more literal with these but as you progress, it's more of just a timing based thing. Cause as you get better at doing them you'll know what you're doing and you'll just need it for timing, not for instruction.*

Feedback on tutorial

Participants were also shown a paper prototype of a tutorial stage which would feature at the beginning of the app, and were asked to give their feedback.

One of the participants noted that she thought there were too many screens before the tutorial got to the portion where the user sets their own workout routine.

Continuing along this line, another participant brought up the fact that she often downloads apps she has already been shown by friends. In that situation, she has no need for an introductory tutorial, explaining

> *"You know so when I think about my experience using apps often sometimes you've already been shown an app before… so I wonder if yeah if there is that option, to just say 'yeah I just want to get started/I just want to set up my plan.'"*

Another participant noted that she is already familiar with pelvic floor health and anatomy, and therefore would not be interested in the information provided by the tutorial. However she acknowledges that some women may be different, and would like the guidance.

She then suggests that this tutorial stage should be optional, with the choice to skip straight to the app.

Visualisations of Pelvic Floor

Participants were also asked to evaluate the 2d and 3d representations of the pelvic floor.

Like in the first user session, participants were confused by the 2d representations of the pelvic floor. Participants mentioned they had trouble understanding the visualisations quickly, one participant stating

> *"Like so I don't know what we're looking at. And I don't know whether it's because it is the view."*

Participants wondered if it was the side on view which was making it difficult, speculating that a front on view of the pelvic floor would be more intuitive.

Participants preferred the 3d model over the 2d visualisations, stating that it was easier to understand as you can see the anatomy. Participants also liked the idea of the visualisation animating, to show how the muscles contract when performing the exercises.

General Suggestions For Application Features

Participants also gave some general suggestions about considerations and features for the mobile application.

Participants noted that different women may desire different levels of intervention from the application. One of the participants said that she would want an application that would only have a notification to do exercises. However she went on to acknowledge other women may have different needs.

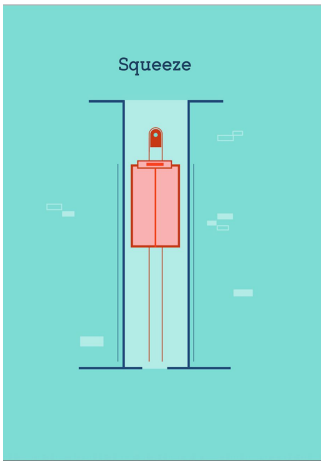
> *"I would want you to give me an option that would simply be a notification... I'm low maintenance and I operate like that, where you know there are other people that like to have a really, you know, good hand held experience. So you need to consider there's probably two or three different people."*

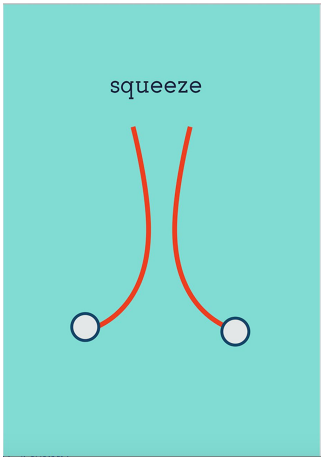
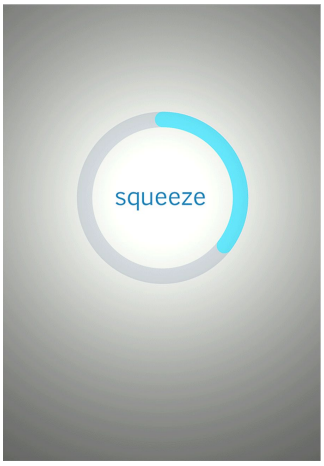
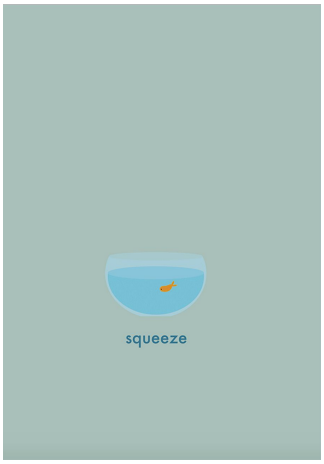
One of the participants mentioned that it would also be a good idea to consider the privacy of notifications, mentioning

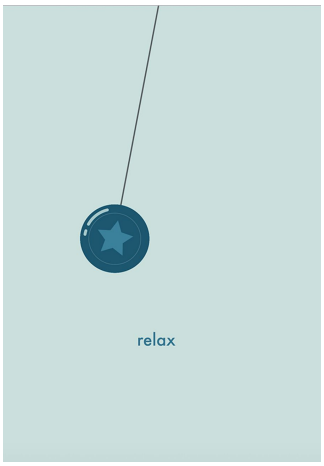
> *"One thing that could be interesting with notifications being sent around this as well is actually the privacy of that notification because it's a bit of a sensitive issue. Like your phone could go off like 'Hey Emily! Do your pelvic floor exercises now!', and you're in a meeting'"*

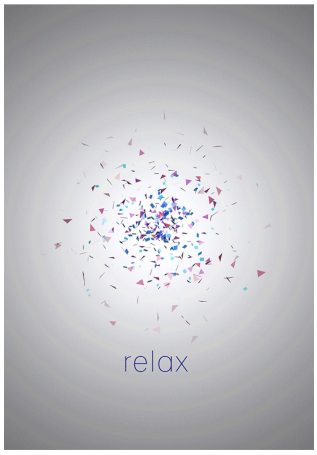
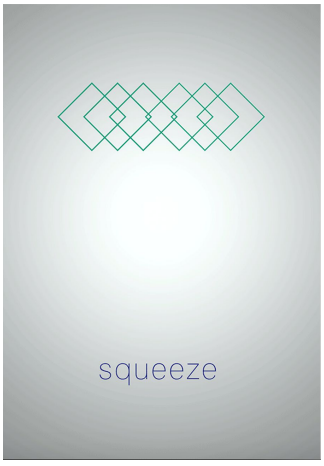
The participants also mentioned that it's important to avoid overly 'medical' and 'scientific' language at the risk of coming across sterile. It was also noted by one of the participants that the term 'kegel' is quite American, and that a New Zealand audience may be more familiar with the term 'pelvic floor exercise'.

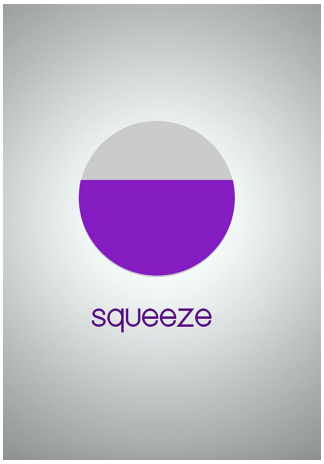
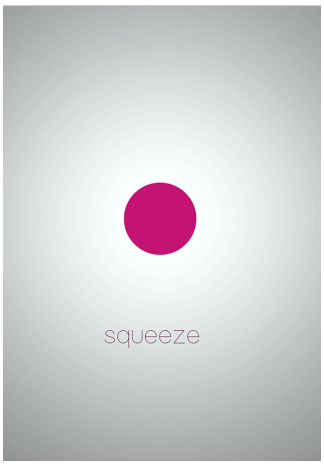
[**Table 5** - Animated visualisations to communicate PFMT technique]

1. (Slide 8)	
2. (Slide 9)	

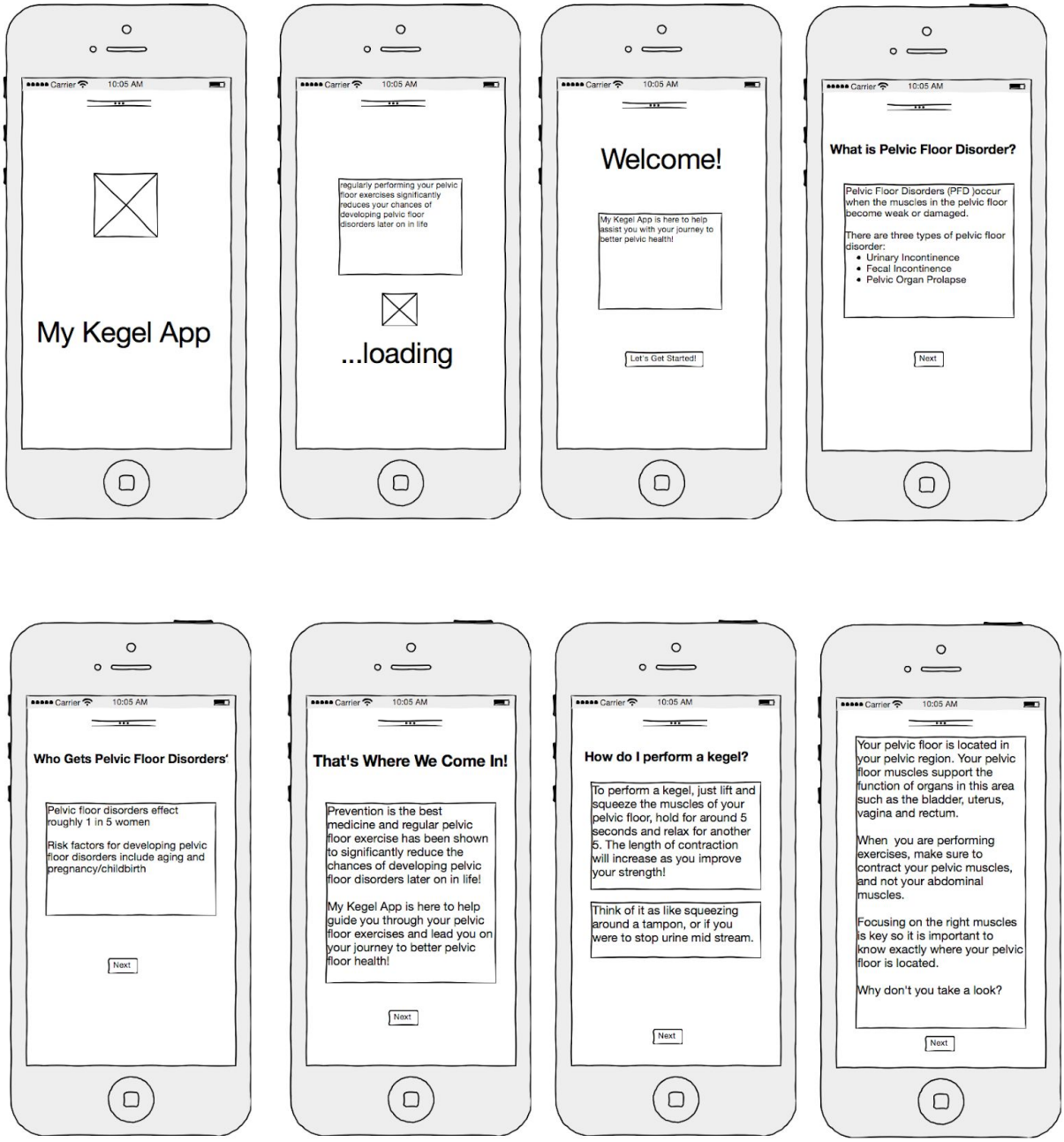
3. (Slide 10)	
4. (Slide 11)	
5. (Slide 12)	

6. (Slide 13)	
7. (Slide 14)	
8. (Slide 15)	

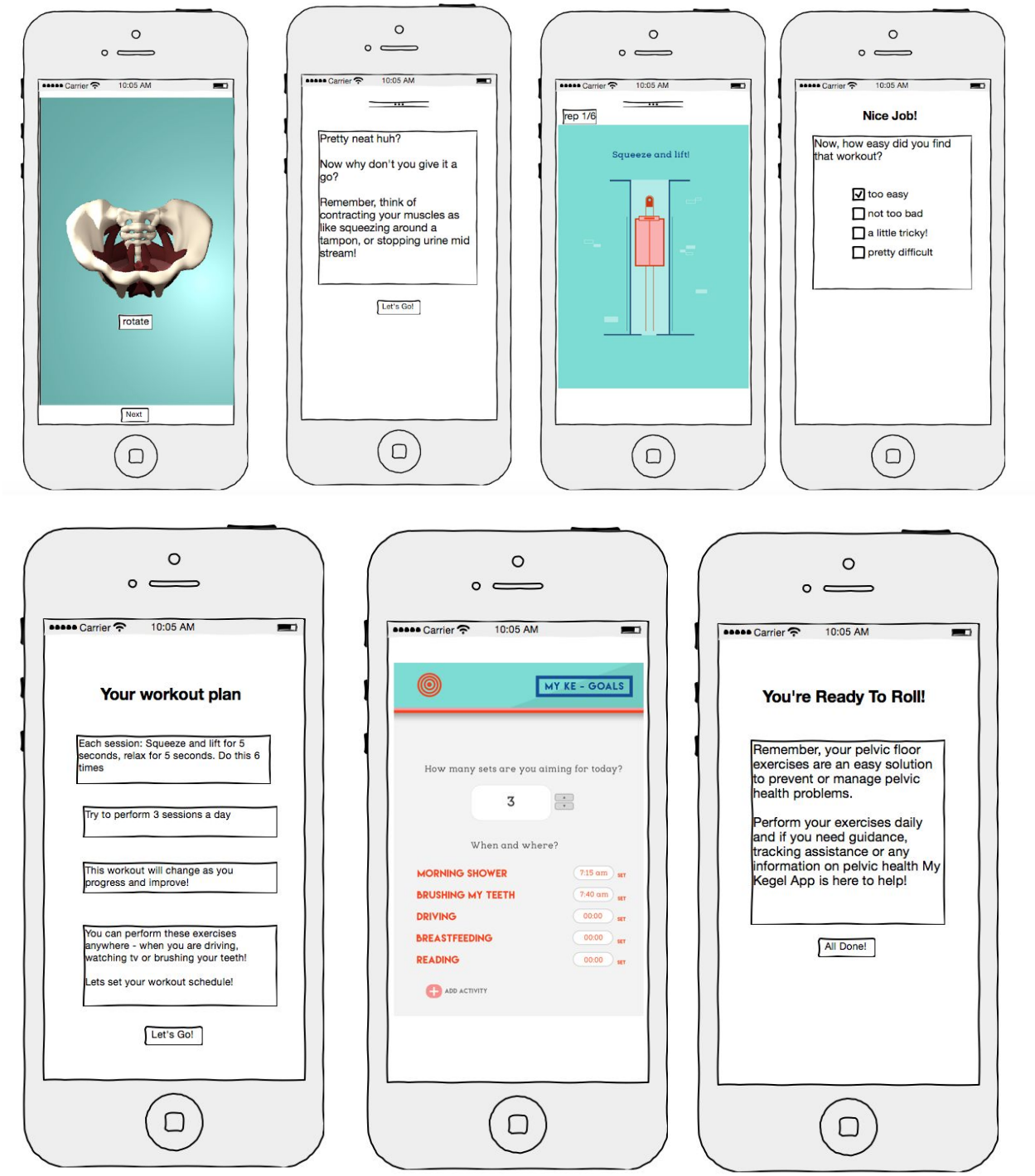
9. (Slide 16)	
10. (Slide 17)	
11. (Slide 18)	

12. (Slide 19)	
13. (Slide 20)	
14. (Slide 21)	

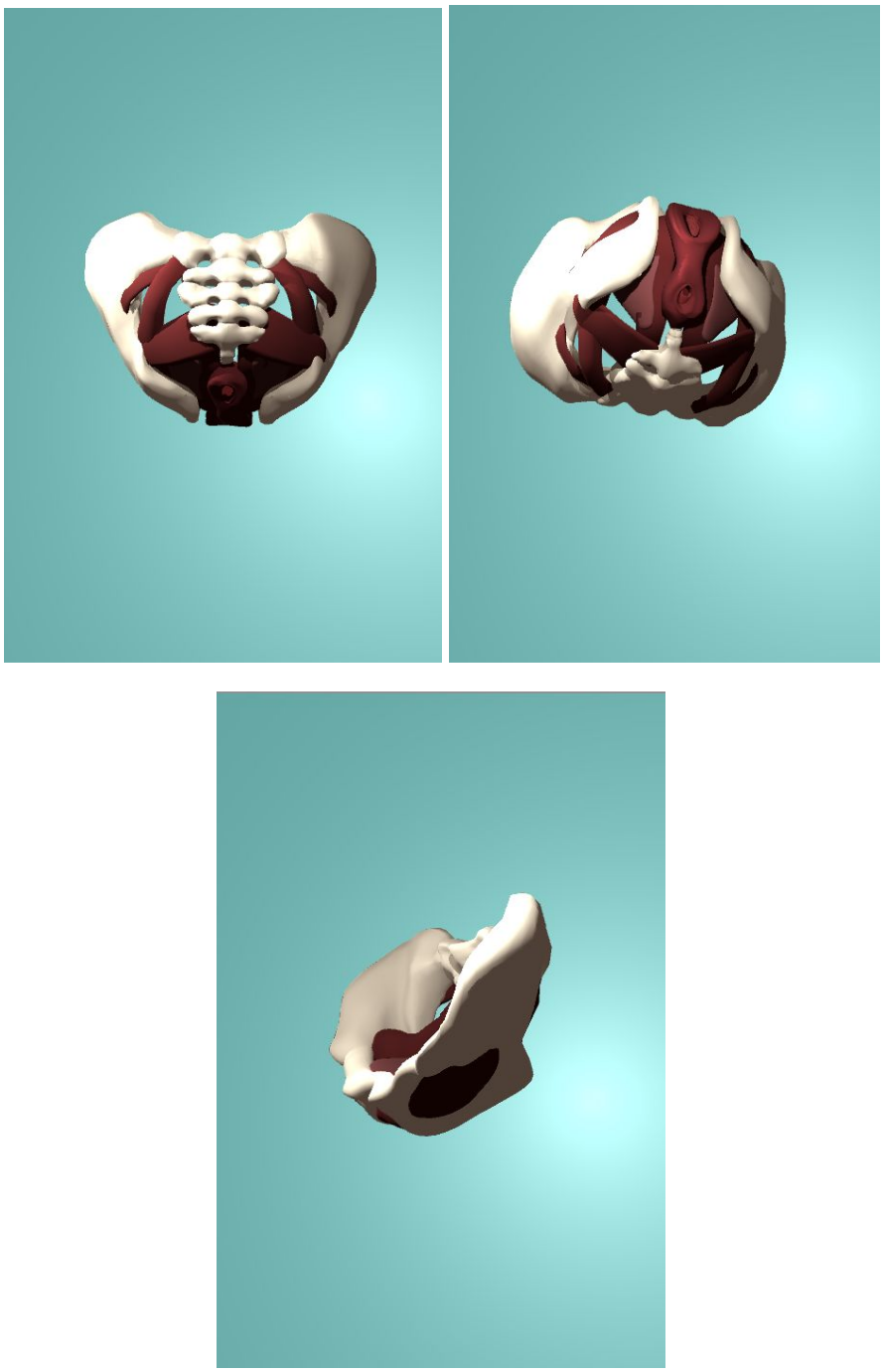
[**Figure 10** - Tutorial Wireframe Initial Prototype]



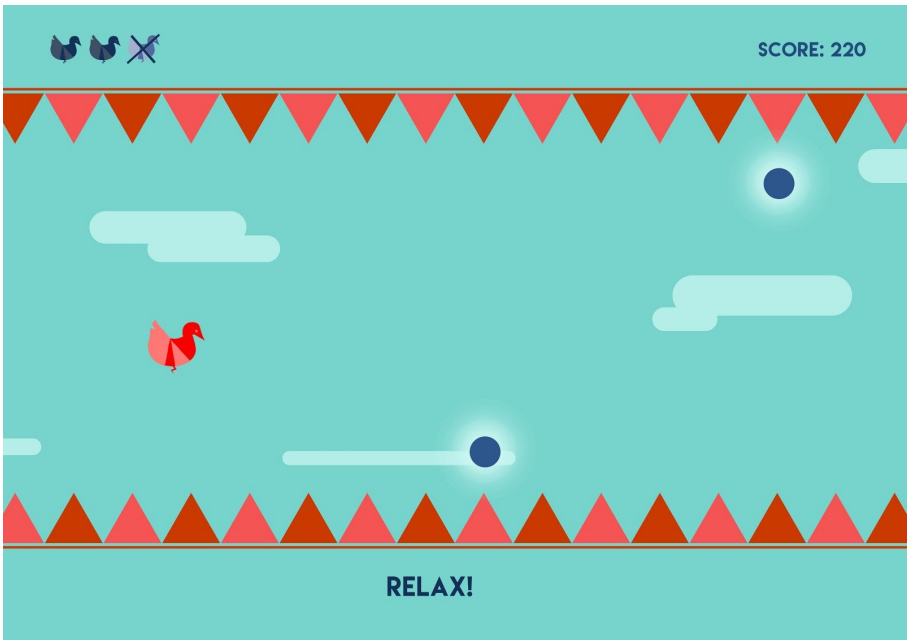
[Figure 10 cont. - Tutorial Wireframe Initial Prototype]



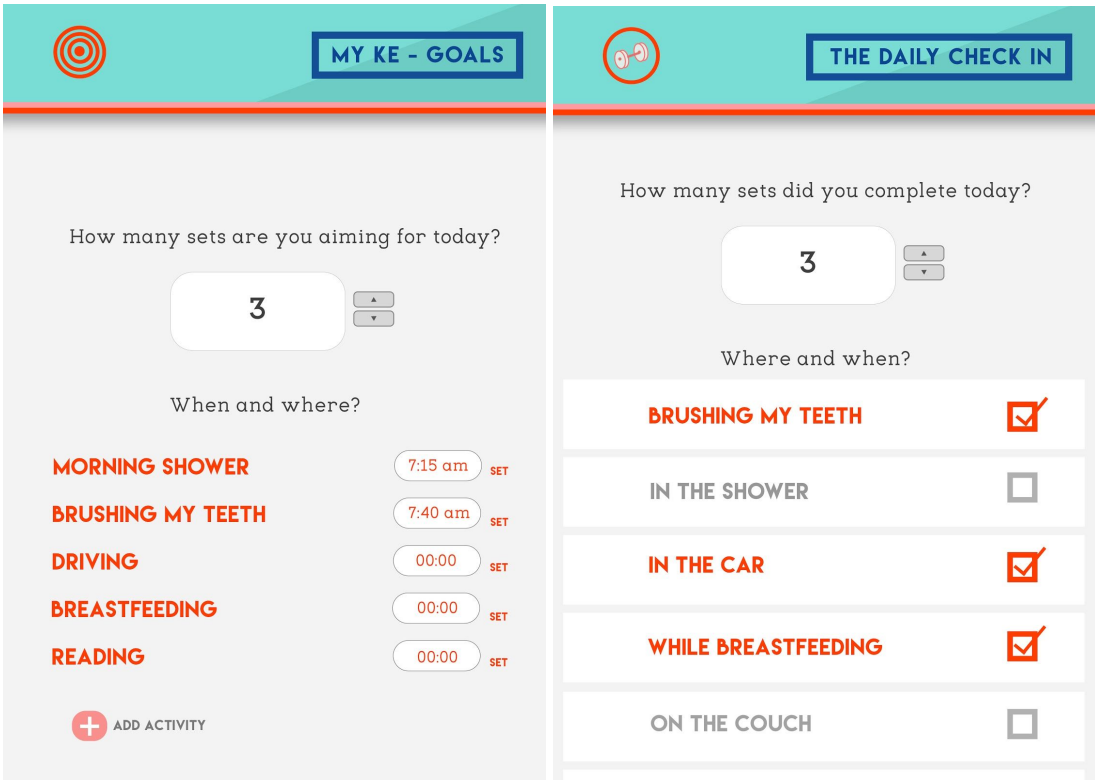
[Figure 11 - Pelvic Floor 3D Model]



[Figure 12 - Wireframe of gamification component]



[Figure 13 - Goal setting feature]


MY KE - GOALS
How many sets are you aiming for today?
3
When and where?
MORNING SHOWER
7:15 am
SET
BRUSHING MY TEETH
7:40 am
SET
DRIVING
00:00
SET
BREASTFEEDING
00:00
SET
READING
00:00
SET
ADD ACTIVITY
THE DAILY CHECK IN
How many sets did you complete today?
3
Where and when?
BRUSHING MY TEETH
IN THE SHOWER
IN THE CAR
WHILE BREASTFEEDING
ON THE COUCH

Clinician Interviews

Information and Guidance

In the interviews the clinicians highlighted women are generally poorly informed about pelvic health. The level of knowledge/awareness varies between the population of women. One clinician states that as there are no consistent guidelines in terms of the information is given, and the information women receive can often depend on the quality of midwife or healthcare practitioner treating them.

The clinicians mentioned that many women typically seek out information online when they first present with symptoms. It is explained that this is an issue, as they often find advice that is unsafe or misleading.

One clinician discussed the importance of teaching women about anatomy. She states that she always begins treatment with a discussion of the anatomy, as many women are uneducated about this area.

On the topic of instructing exercise technique, clinicians emphasised that verbal instruction was not an effective means of educating women on pelvic exercise technique. All three clinicians cited the statistic that 50% of women who receive verbal instruction will perform their exercises incorrectly. One of the clinicians describes the importance of seeking out a clinician for guidance, stating

> *"There are some pretty awful stats saying that 50% of people will still do pelvic floor exercises wrong when they've read it off a pamphlet. The best way to actually learn is by seeking professional assistance."*

Another clinician mentioned that receiving an internal exam is important for making sure women are performing contractions correctly, stating

> *"I think they need to have some sort of internal exam to check if they are doing it correctly. Otherwise because if they have just been given verbal or written instructions, then 50% of them will do it wrong."*

Barriers to Engagement

Normalisation

One of the clinicians mentioned how the societal normalisation of pelvic floor issues can prevent women from seeking out treatment for their symptoms. She states

> *"And the other from a society point of view, the idea that you have issues with your pelvic floor, after childbirth is very normalised in society. So I think women think 'a lot of things happen as a part of childbirth so too bad. I gave it a go"*

Perceived benefits

One clinician mentions that it is common for women to perform exercises incorrectly, which leads to their symptoms either not improving, or worsening. This leads to women no longer engaging with their exercises as they do not feel any benefits. She says

> *"They don't feel any benefits, so there is no reason for them to continue. So that's quite a common scenario that I see - 'Oh, I've been doing my pelvic floor exercises for years and I*

> *don't feel any benefits'...So part of it is a lack of efficacy, like they don't feel like they are getting any benefit."*

Stigma

Clinicians identified the wider stigma associated with pelvic health issues as a barrier to treatment, especially in terms of women gaining awareness of pelvic health to identify issues. The clinician stating

> *"And it's not something our culture deals with in the family environment, so it's not something your mother would teach you … most people only become aware of it when they start having symptoms."*

Another clinician discusses the impact stigma has on some women's willingness to engage with treatment, stating

> *"The other thing is for a lot of women it's quite an embarrassing part of their body. They don't really want to know too much about it, or think it's shameful."*

Memory

One clinician describes memory as the biggest barrier for women stating

> *"Remembering to do them is the number one...it's mostly memory and time, people just get busy"*

Another of the clinicians states that the 'ease' at which exercises can be performed lead to many women putting them off and ultimately forgetting to do them. She mentions

> *"Because they're so easily done they just keep getting put off all the time - oh I'll just do them later, if that makes sense. So like I think they just sort of forget about them."*

Self-Efficacy

Self-efficacy is brought up by the clinicians stating that women engage with PFMT initially, but then they are unsure if they are performing the exercises correctly and will stop all together. One clinician states

> *"One of the barriers is that women don't know if they are doing them correctly or not. So then they give up. So that's another big one, they do them and don't know whether it's correct or not so they just give up and stop"*

App recommendations

No 'One-Size-Fits-All' Approach

Clinicians stated that an application needs to accommodate the needs of each woman as an individual. All clinicians emphasised that there is no one size fits all exercise regimen for women. Clinicians stated that exercises they prescribe a woman is based on a host of factors. One clinician explained

> *"So everyone's completely different. You know, you got different age, different weight, different parity you know how many babies they've had. What kind of damage they've got ..."*

When asked another clinician explained that the application should allow for women to input their own exercise settings. She described how this could be implemented in the app by stating

> *"Exercises should be individualised for each person. Let's imagine they download the app and they are putting all their details in there might be an assessment or a testing, where they trial how long and how strong they can perform, And then that can then form the guidance of the program."*

Exercises

In terms of the specific exercises the app should facilitate, clinicians explained that there are no 'exact' exercises, but rather a regimen should focus on building strength and endurance in the muscles.

Clinicians explained that it was also important to make sure participants are exercising safely and correctly. One clinician explains that the application should remind women to not hold their breath, or over activating their glutes. She recommends the app make sure women are not tucking in their stomach muscles, or using their abdominal muscles. She also explains that women should not try and hold their contractions for longer than they can.

General Recommendations For Application

One clinician stated that an application without the use of an internal device, would likely be an ineffective means of guiding PFMT. She states

> *"So the issue is we've known for thirty years that giving someone a leaflet or verbal instructions on how to do a pelvic floor contraction, 50% of people will do it wrong. So an app is the same, an app without a device is to me just like verbal instructions. It's not really going to help you it's just a way of giving you verbal instructions. You need a device that's going to show you what to do, rather than just an app on your phone."*

The other clinicians mention that it is important for the app to recommend the user get assessed by someone.

When asked what to include in the app, one clinician answered

> *"I would probably scare them with some statistics. Like 1 in 3 women who have ever had a baby will wet themselves, and 50% of women who have had a vaginal delivery will have had a prolapse."*

Another clinician mentioned that including reminders would be important, as well as giving the user feedback and encouragement as they exercise.

Survey Results

Engagement With PFMT

Participants indicated that they were interested in engaging with a regular PFMT regimen, however they did not perform exercises as regularly as they should.

Participants were asked if there were any activities or places where they remember to perform their pelvic floor exercises. A couple of the women mentioned they perform them in the car. One participant mentioned she performs them when she is on the floor playing with her child. Another stated she performs them while waiting around.

Information

Doctors, antenatal groups, and online websites were participants main sources of information on pelvic floor health. Participants rated the online sources as only slightly effective in terms of improving pelvic floor health knowledge. Antenatal groups and doctors were rated as very effective.

Barriers

Overall, participants expressed a moderate to high perception of efficacy in PFMT as an effective treatment for symptoms of PFD.

When asked about their confidence in performing PFMT correctly, without the supervision of a clinician, participants rated their overall confidence as moderate to high. However, when

asked about their confidence in their ability to practice PFMT regularly, over a long term period, two of the three women rated their confidence low.

The most common barriers to adherence identified in the survey were memory/forgetting and not having enough time. A lack of motivation to perform exercises was also identified by two of the participants as a barrier.

App Features

When asked how likely they were to use some sort of mobile application to assist with their PFMT, participants indicated that they were somewhat to moderately likely.

Participants were asked to rate features based on how interested they would be in having them in an application. The features that were highly ranked amongst all participants were the reminder function and the inclusion of instructions to help guide exercises.

There was some disparity in terms of interest for other features included in the survey. There were features that were rated highly in terms of interest by one, or two participants, but not by the others. These features included the integration of a period tracker into the app, the ability to track exercise progress, the ability to compete against friends for high scores in workouts and being able to set exercise challenges/goals.

Design Phase 3

Design Criteria 3

Additions to Criteria

Second User Testing Session

- PFMT guided visualisations should use abstract imagery, and organic movements for animation
- App should offer different levels of guidance/intervention to women (i.e. a reminder function for some women, vs a handheld step-by-step experience for others)
- Include a discreet mode for notifications should be included for women who may feel self-conscious about people knowing about their condition
- Language used should be tailored to a New Zealand audience (i.e. 'pelvic floor' over 'kegel')
- Use an interactive 3D model to instruct pelvic floor anatomy
- Introductory tutorial should be optional
- Application should use calming colours and a feminine aesthetic

Clinician Interviews

- Exercises should be individualised to cater to the treatment needs for each person

- Forgetting to perform exercises is a big barrier and the application should make sure to address it

- Exercises in the app should focus on building strength and endurance

- The app should make sure women are exercising safely and instruct them to not
    - hold their breath
    - over activate their glutes
    - use their abdominal muscles or stomach muscles

- Motivate women by providing them with statistics/information on the risks of not engaging with PFMT (i.e. 50% of vaginal deliveries result in prolapse)

Survey

- App should really focus on providing users with reminders and instructions/guidance as these were the identified by women as the most useful features

[**Table 6** - Design Criteria 3]

Design Criteria 3		
1) Provide Information and Guidance	1.1 Guide correct performance of pelvic floor contraction/PFMT	• Educate women on PFMT technique using metaphors that refer to familiar bodily sensations (i.e. "stopping the flow of urine midstream")

		• Provide instruction/guidance on PFMT in the initial stages of app use and during workouts
		• PFMT guided visualisations should use abstract imagery, and organic movements for animation
		• Exercises in the app should focus on building strength and endurance
		• The app should make sure women are exercising safely and instruct them to not
		  ○ hold their breath
		  ○ over activate their glutes
		  ○ use their abdominal muscles or stomach muscles

	1.2 Educate women on condition and anatomy	
	1.3 Utilise imagery of the pelvic floor in instruction	• Use an interactive 3D model to instruct pelvic floor anatomy

	1.4 Encourage women to get assessed by a pelvic health professional	
	1.5 Include self assessment/screening tool to help women identify symptoms of PFD	
2) Address Barriers to Engagement	2.1 Improve self-efficacy in users	• Empower users with information on pelvic floor health and PFMT as a strategy for promoting self-efficacy
	2.2 Create reminders through triggers	• Create trigger features that establish contextual awareness for performing PFMT in daily life (i.e. location based reminders)
	2.3 Reduce stigma	• Use humour as a strategy to reduce stigma • Include a discreet mode for notifications should be included for women who may feel self-conscious about people knowing about their condition
	2.4 Help integration of PFMT into daily life	

3) Facilitate Habitual Engagement With PFMT	3.1 Utilise engagement framework in application design (i.e. Hooked Model)	
	3.2 Employ PT strategies to promote engagement	• Motivate women by providing them with statistics/information on the risks of not engaging with PFMT (i.e. 50% of vaginal deliveries result in prolapse)
	3.3 Tailor PT strategies/app features to individual users preferences and needs	• App should offer different levels of guidance/intervention to women depending on their preference (i.e. a reminder function for some women, vs a handheld step-by-step experience for others) • Introductory tutorial should be optional • Exercises should be individualised to cater to the treatment needs for each person
Miscellaneous criteria/notes	• Consider aesthetic properties of the application, this has a significant effect on users perception of the app • Ensure the graphic style of the app is aesthetically appealing, and does not come across as "cheap and untrustworthy"	

	• Language used should be tailored to a New Zealand audience (i.e. 'pelvic floor' over 'kegel') • Application should use calming colours and a feminine aesthetic • App should really focus on providing users with reminders and instructions/guidance as these were the identified by women as the most useful features • 50% of women who receive verbal instructions on PFMT perform contractions incorrectly

Design Stage 3

This stage saw the completion of the first version of the working mobile app [see Figure 13]. The application was built in android studio and is compatible with android devices API 17 and above. Due to the long period of development, a version of the application for each user persona was not in the scope of this project. However, the application integrates features that address barriers and needs specific to each of the personas.

The Hooked model (Eyal, 2014) provided the main structure for the design of this application. The reasoning behind the implementation of this model is to increase engagement, as per point 3.1 of the design criteria [Table 6]. As the Hooked model serves as a framework for fostering habitual engagement, theoretically the successful implementation of this model into the application's design will increase women's engagement with PFMT. A breakdown of the application is given below, listed under each component of the Hooked model.

Trigger

The trigger component of the model is implemented through the notification and reminder functionality of the app. While many existing pelvic floor applications implement some kind of alarm/notification function, the key point of difference for this app is that the reminders can be triggered both by times input by the user, and the location of the user. The geolocation feature [Figure 14] can detect when a user is in a certain area (i.e. work, outside their child's school). The user can input into the app certain locations where they would like to receive a notification. The app will send the user a reminder to perform exercises whenever they are in that area. The purpose of this function is to encourage an awareness of opportunities to perform PFMT in

everyday life, by establishing everyday activities as triggers to perform exercises. This serves points 2.2 and 2.4 of the design criteria [Table 6].

Other aspects of the design also serve to establish everyday activities as triggers for PFMT. This is mainly done through text prompts in certain opportunities during the app. For instance, the pause dialog screen which shows up when the user pauses the workout will feature some kind of prompt along the lines of the one in Figure ##.

Action

The performance of PFMT is the action component of the model. In the app, this is facilitated by the workout function.[Figure 16] The workout consists of four different exercises, each included for the purpose of building either strength or endurance in the pelvic floor muscles (criteria point 1.1). The exercises in the app include a round of 3 long contractions, a round of fast contractions over 15 seconds (pulse), the knack (squeeze and cough) and a final round of one long contraction.

The app provides the user with a brief set of instructions before the performance of each exercise.

Reward

Reward is described in the model as the reason the user engages with a product - the need which they expect to be satisfied. In this context, the reward is the alleviation/prevention of symptoms of PFD. The reward in this sense is not provided directly by the app, rather the app facilitates the 'reward' of the alleviation of symptoms of PFD.

While the alleviation of symptoms is dependent on whether the user engages with PFMT both regularly, and correctly, there are aspects of this app that can still function like a reward, through expressing the positive benefits of regular engagement with PFMT to the user. These features include the progress tracking feature, which can help the user to visualise their progression, and by extension their improvement over time. Additionally, high score achievements in workouts and the attainment of workout goals are all expressions of the user's efforts towards alleviating their symptoms.

Other aspects of the app that function as rewards include the visual feedback and praise utilised throughout the app, particularly in the workout section. When users perform a contraction for a certain amount of time, the app launches a wee animation that reads "great!" or "keep going!" or something similar. The animations that launch do so unpredictably, utilising the 'variable reward' principle described in the model, which is stated to be psychologically more effective. The app also rates the user's workout out of three stars once completed. [Figure 17]

Investment

The investment component in this application mainly manifests in the introductory tutorial feature of the app [Figure 18]. The introductory tutorial launches when the user first opens the application. A prompt dialog opens which asks the user whether or not they would like to complete a tutorial. If the user selects yes, the tutorial runs the user through the entire app experience. The tutorial starts off by teaching the user how to perform a PFMT contraction. The user is then taken through a workout, after which they set alarms for their next session and the tutorial concludes. The tutorial guides the user through a process of investment, where they enter workout/exercise data and set up times for next sessions. The Hooked model suggests that getting users

to invest data in to the application when they first use it is a way of hooking people in early. The model's argument is that the more data someone invests in a product, the more incentive they have to use the product again.

Investment is encouraged in other areas of the app. At the end of the workout, users are prompted to set up their next session [Figure 17]. This prompt gets the user to set up their next session, and thereby set up the next cue to action/trigger. This creates an cycle of interaction for the user of *receive trigger, perform exercises, set up next trigger, receive trigger, perform exercises* etc. The app also stores users custom workout data, exercise progress, workout goals etc.

Aside from the Hooked model, the application also implements other aspects of the design criteria [Table 6]. The recommended information on PFMT, including the description of contraction technique, the instructions for safe exercise, inclusion of statistics (criterion 3.2), referral to pelvic health professional etc. are all included in the app. Most of the information is found in the introductory tutorial, which is accessible at any time from the main menu. The application also makes use of an informal, relaxed tone of language. The phrasing used in places in the app such as "Kegel Kween" and "Get Squeezin!" is meant to add a bit of levity and humour to the application, a strategy identified in point 2.3 of the criteria to curb stigma. The app also allows for the customisation of workout routines i.e. setting numbers of reps, length of rest period etc. as recommended by one of the clinicians (criterion 3.3).

There were a few features that would have ideally been included if it were not for time/technical constraints. The interactive 3d model of the pelvic floor could not be implemented when building in android. A placeholder image was put in the place of where the model would have been inside the tutorial. The application also would have ideally included a discreet mode for notifications and workouts, and a feature that sent users reminders to perform exercises while they were driving.

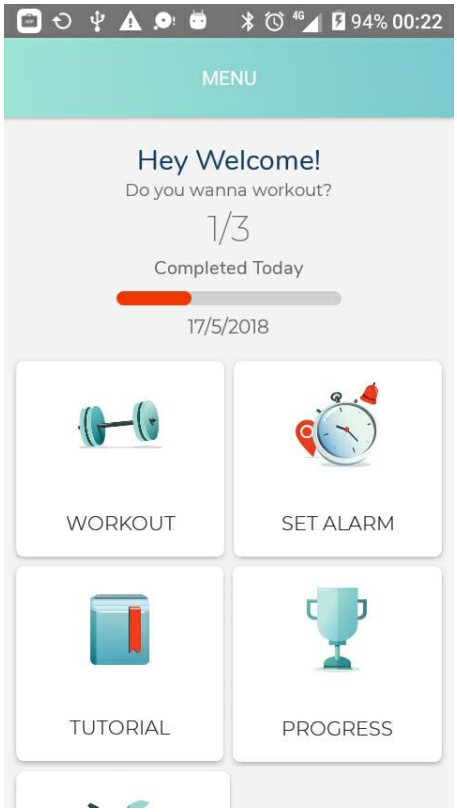
The application integrated features that catered to the needs and predicted preferences of each of the persona groups. For Shannon & Elizabeth, an emphasis on building self-efficacy through education, guidance and progress tracking is a feature targeted at them. The application provides a lot of guidance on PFMT technique, especially in the workout stage where there are explanations of how to perform each exercise before the round begins. The progress tracking features were also catered more toward Shannon & Elizabeth as they focus on illustrating the user's improvement over time, comparing their previous statistics with their current statistics [Figure 19]. Clearly visualising progress is a strategy for improving self-efficacy and perceived benefits (Rosenstock et. al, 1952) in the user. Ideally the discreet mode would be implemented in the app, as it would help address the stigma barriers for these personas.

For Anna & Amy, the use of casual, sometimes humorous, light hearted language and tone was catered to them. The fun, vibrant, almost sporty aesthetic was also cultivated with these personas in mind. The intent was to increase engagement with the design through establishing likability - getting the user to identify and connect with the design through appealing to their personality. Another strategy to cater to them was the inclusion of competitive elements and rewards in the app. For example, the praise animations and high scores inside the workout is included to create an element of motivation and fun, almost gamifying the workout experience. The integration of a feature that would allow users to compete against friends on facebook, would have been a good way of improving engagement for these personas by catering to their social natures.

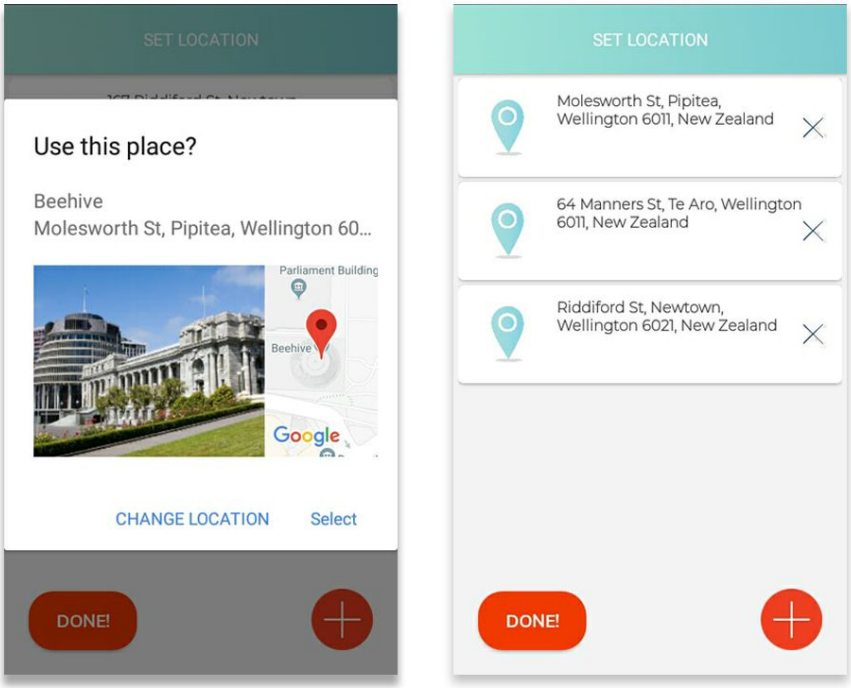
For Debbie the main features included to appeal to her were the alarm/notification features. Helping establish contextual triggers, and identifying opportunities to integrate PFMT in her everyday life is a key strategy for dealing with her time/memory barrier. Additionally, the integration of statistics and facts such as "50% of women will experience prolapse after a

vaginal delivery", "symptoms tend to get worse with age" etc. serve as a strategy to increase her perceived susceptibility (Rosenstock et. al, 1952), which in turn should increase her willingness to engage.

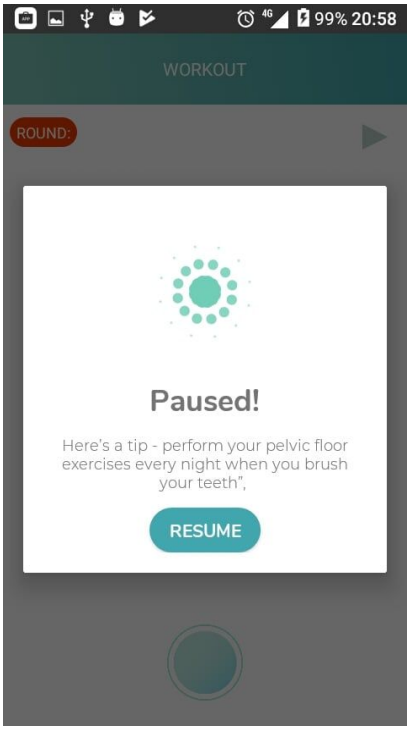
[**Figure 13** - Menu screen of first functional prototype of the app]



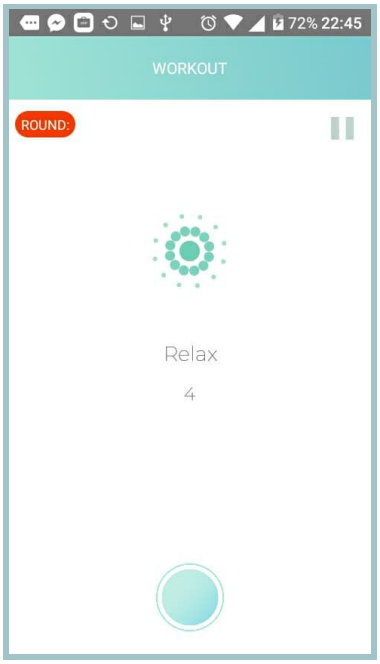
[**Figure 14** - Geolocation based alarm feature]



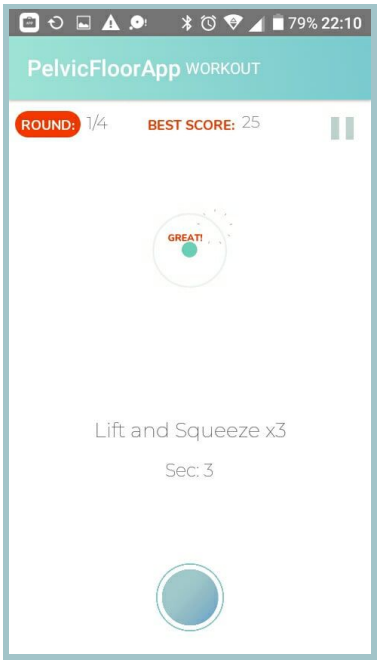
[**Figure 15** - Pause screen dialog text during workout]



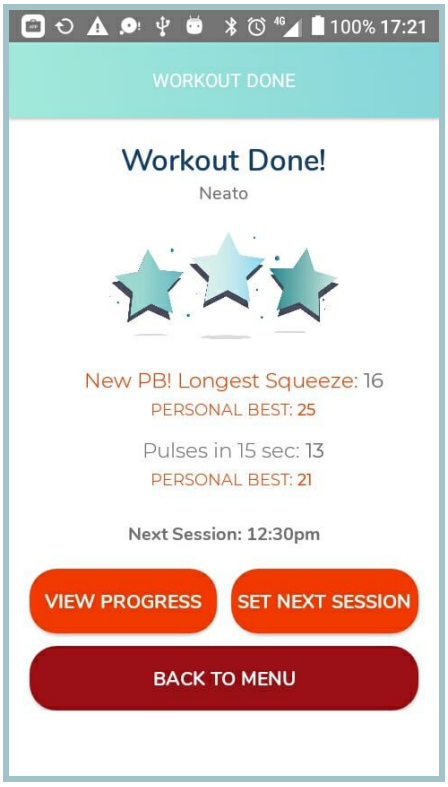
[**Figure 16** - App workout]


72% 22:45
WORKOUT
ROUND:
Relax
4

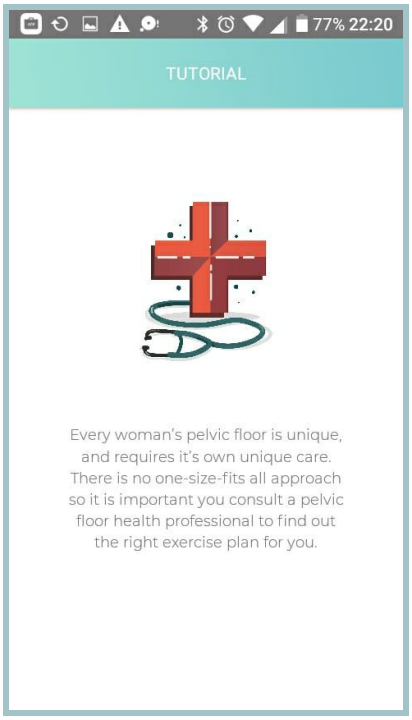

78% 22:11
PelvicFloorApp WORKOUT
ROUND: 2/4
Cough and Squeeze!
x3

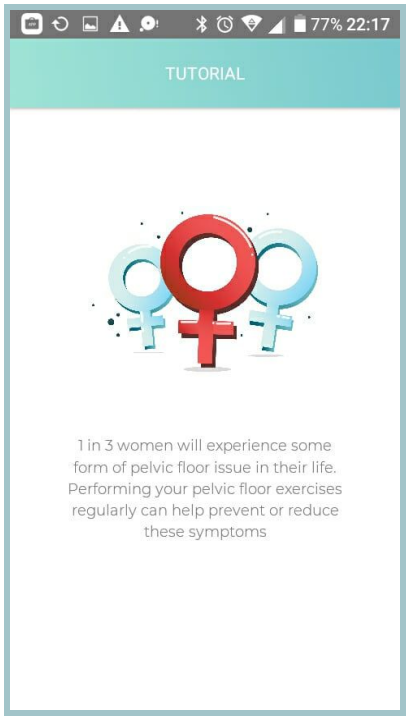

79% 22:10
PelvicFloorApp WORKOUT
ROUND: 1/4
BEST SCORE: 25
GREAT!
Lift and Squeeze x3
Sec: 3

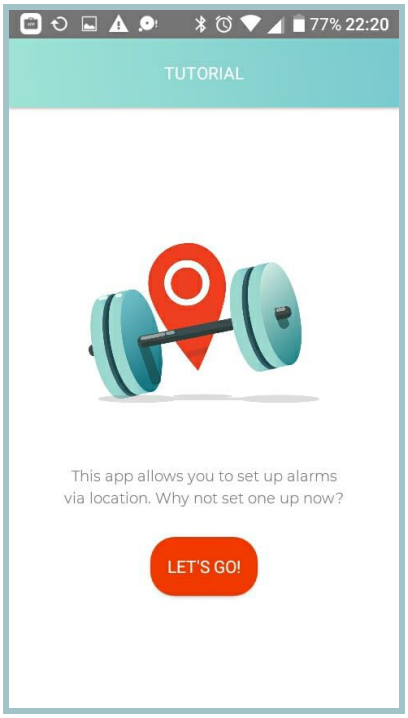
[**Figure 17** - End of workout screen]



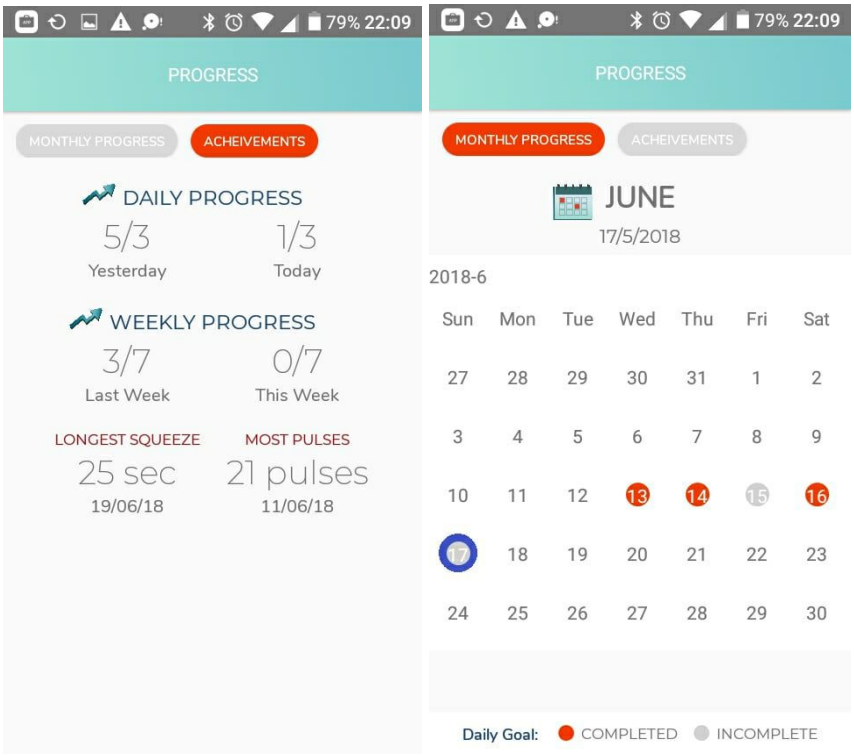
[**Figure 18** - Introductory Tutorial]


77% 22:20
TUTORIAL
Every woman's pelvic floor is unique, and requires it's own unique care. There is no one-size-fits all approach so it is important you consult a pelvic floor health professional to find out the right exercise plan for you.


77% 22:17
TUTORIAL
1 in 3 women will experience some form of pelvic floor issue in their life. Performing your pelvic floor exercises regularly can help prevent or reduce these symptoms


77% 22:20
TUTORIAL
This app allows you to set up alarms via location. Why not set one up now?
LET'S GO!

[**Figure 19** - Monthly Progress & Achievements]



User Testing Session 3

Usability

The scores of each of the participants from the SUS component of the questionnaire results were 35, 50, 50, 55 and 65 out of 100 indicating a relatively low usability rating.

One of the main issues was the lack of overarching navigation during the introductory tutorial stage. Participants noted that the tutorial stage needed some kind of progress bar to let users know what stage of the tutorial they are in. Additionally, participants stated they found the tutorial disorienting explaining having the tutorial launch into other activities within the app, such as the workout, was confusing without first seeing the overall navigation structure of the app.

Participants disliked the length of the tutorial. One participant suggested that the tutorial is separated out into smaller tutorials that appear when the user navigates to different parts of the app.

Participants took issue with the button which the user interacts with during exercises. They were not aware when they were meant to hold button, and when they were to tap. Participants noted that there was nothing to indicate to them how to interact with the button, nor that the functionality had changed when transitioning between different types of exercises. This caused confusion.

Some of the participants were confused as to how long they were meant to perform the long contraction, with one stating

> *"So it says squeeze and lift. And then it tells you to relax. But you have to long press on that button. But how long for? Because do I sit here for five minutes?"*

Participants also had feedback in relation to the action buttons [see Figure 18]. Participants stated the red colouring of the buttons came across as *'too threatening'*. Additionally, the text on the action buttons varies between screens (i.e. text alternates between 'Let's Go!', 'Okay', 'Sure Thing!' etc.). Participants did not like this inconsistency.

Engagement

The efficacy of the engagement strategies was difficult to measure, as participants only used the application over the period of the testing session.

In the questionnaire, the participants were asked to rate on a 5 point scale how likely they were to use the application to use the application again to help them with their PFMT. The scores sat in the middle range, with all participants indicating not likely, to somewhat likely. When asked to rate how much they agreed with the statement "I found using the app fun and engaging", the responses were more mixed. These results suggest that the app does not have a strong effect on engagement.

On the topic of engagement, one of the participants noted that while she would like to use the application regularly, but realistically she believes that she won't. She states

> *"I would like to use this app frequently, doesn't mean I would use this app frequently. Like I would like to use this app frequently, but the likelihood of me using this app frequently - low"*

Engagement Via The Hooked Model

Trigger

The use of reminders and location based alarms is the main form of the trigger stage in this application. These features were the most consistently highly rated across the participants, with four of the participants scoring the location based reminders and time based reminders either 4 or 5 for usefulness and motivation. The four participants also scored either 3 or 4 for the feature which sends a notification to the user while they are driving. The high scores for these features from most of the participants makes sense, as in both the literature and this study, women identify memory as one of the biggest barriers to PFMT.

The one participant who scored these features low states that she already performs her pelvic floor exercises regularly and wouldn't find these features useful.

However a couple of the participants noted that it would be easy for them to ignore notifications. One participant noted that despite wanting to engage with the app, she will likely ignore the notifications, saying

> *"My optimistic self would be like 'Yes I will set goals! And yes, I will set reminders!' and the realistic me would be like 'I will hit ignore'."*

Action

In the questionnaire, participants were asked to rate how useful they found the workout feature on a scale of 1 to 5. The workout component scored an average of 3, indicating it was somewhat useful.

Reward

The reward aspects of the app included praise, the end of workout star ratings and the personal high scores. Participants were asked in the questionnaire to rate on a scale of 1 to 5 how much these features would motivate them to perform their PFMT.

Beating personal bests had a range of responses in terms of its motivational power. The participants scores were 1, 2, 3, 4 and 5. This suggests that beating personal bests is motivating for some users, while other users do not care.

Like the personal bests, the end of workout star ratings had mixed responses. The participants scores again were 1, 2, 3, 4 and 5. This suggests that this feature as a reward strategy is more effective for some than others.

The praise feature was rated as highly by all but one of the participants. A couple of the participants named the praise animations as their favourite part of the application in the questionnaire.

Investment

The tutorial section of the application was the feature that was most designed to fulfil the factor of investment. The introductory tutorial was designed to use the PT strategy of tunneling (Fogg, 2003, p. 34) to guide users through the process of investing data into the app. This involves them engaging in a workout, inputting initial exercise data, and setting alarms and reminders.

In the questionnaire, participants were asked to rate on a scale of 1(low) to 5(high), how useful they found them in terms of helping them engage with a PFMT routine.

Four of the participants gave the tutorial section a score of 2, with the other participant scoring 4.

The tutorial section had the most feedback in terms of usability issues, as described above. It is very likely that these issues had an impact on the participant's responses to this question. It's possible that a version of a tutorial without these usability issues would be more successful. However, some of the participants did note that tutorials are usually something they ignore, preferring to explore the application on their own terms.

Other investment factor were features such as progress tracking, goal setting and beating personal bests were all rated in the questionnaires as somewhat useful, and somewhat motivating.

Personas & Personalisation

Participants were also presented with descriptions of four user personas. The participants were asked to rank the personas from highest to lowest in terms of how much they identified with each persona. Two of the participants had to leave the testing session early, and did not complete the persona section.

Of the three participants who filled out the persona section, two of the participants identified as Debbie, and the other identified as Anna.

There were a couple of noteworthy observations when comparing the responses. The participant who identified as Anna, is also the one participant without any children. During the testing session this participant explains she does not regularly perform PFMT as she doesn't believe she needs to, due to the fact she doesn't plan on having children. This

participant rated the application highly on the informational components in the questionnaire. Her responses indicated that the app provided her with new information on PFD and helped her better understand PFMT technique. This participant rated the app a 4 on fun and engagement on a 1(not fun) to 5(fun) scale.

Whereas the participant who identified as Debbie explained during the user testing sessions that she has dealt with endometriosis since she was 13. As a result she has kept on top of her pelvic floor health, performing PFMT regularly since a young age. This participant rated the informational components on the application low in the questionnaire. Her responses suggest that she already knew most of the information provided in the app, and it was of little assistance in her exercises. This participant rated the app 2 on fun and engagement on a 1 to 5 scale (1 being not at all fun and engaging, 5 being very).

Contrasting the responses of these two suggests that knowledge of pelvic floor health, and the history of the participant's pelvic floor health has an impact on the features that are most useful to a user. The participant who identified as Anna had a relatively low level of pelvic health knowledge, and therefore the information provided in the app would be of use to her. The participant who identified as Debbie had a lot of experience with pelvic floor health, and therefore the information provided by the app will likely already be known to her. The variation in knowledge levels amongst women who may use this app is worth consideration when designing. With this variation being a point of difference to be addressed through personalisation.

General Findings

The participants responses to the questionnaire indicated that the application was generally adequate at providing instruction/guidance for exercises, however more information on pelvic health and PFD could be included.

One participant pointed out the statistic used in the tutorial explaining that "50% of women perform their pelvic floor exercises incorrectly". She went on to explain that the application should provide women with more information on how to avoid this.

Another participant pointed out a part of the app that reminds the user to see a "pelvic health professional". They stated that the term was ambiguous, and there should be some clarification as to who that is (i.e. midwife, physiotherapist).

A suggestion was also made to include a section where the user was offered some form of reassurance if they were experiencing symptoms.

The participants identified the graphics, and the animations in the workout section as their favourite parts of the app. The participants all identified usability issues with the tutorial and the workout button as the weakest components of the app.

Final Design & Criteria

Final Design Criteria

Additions to Criteria

User Testing Session Three

- Tutorial stage requires a progress bar
- Tutorials should be broken into smaller sections so information is delivered to users at the moment it is relevant to their current interaction
- Tutorials should not contain any interactive elements
- Users should be provided with a sense of the overarching navigation of the app when they first use it
- Should be easy to navigate from tutorial back to the main activity
- Users should be provided with clear instructions regarding the functionality of the button in the workout component
- Use visual feedback and praise animations during the guided workout
- Aesthetically pleasing visual/graphic elements are appreciated by users

- Application should provide women with information on common mistakes women make while performing PFMT exercises

- The term "pelvic health professional" is ambiguous. Application should specify who this is (i.e. GP, midwife, physiotherapist)

- Application should offer women reassurance that they are not alone if they are experiencing symptoms

[**Table 7** - Final Design Criteria]

1) Provide Information and Guidance	1.1 Guide correct performance of pelvic floor contraction/PFMT	• Educate women on PFMT technique using metaphors that refer to familiar bodily sensations (i.e. "stopping the flow of urine midstream") • Provide instruction/guidance on PFMT in the initial stages of app use and during workouts • PFMT guided visualisations should use abstract imagery, and organic movements for animation

		• Exercises in the app should focus on building strength and endurance
		• The app should make sure women are exercising safely and instruct them to not
		  ○ hold their breath
		  ○ over activate their glutes
		  ○ use their abdominal muscles or stomach muscles
		• Application should provide women with information on common mistakes women make while performing PFMT exercises

	1.2 Educate women on condition and anatomy	
	1.3 Utilise imagery of the pelvic floor in instruction	• Use an interactive 3D model to instruct pelvic floor anatomy
	1.4 Encourage women to get assessed by a pelvic health professional	• The term "pelvic health professional" is ambiguous. Application should specify who this is (i.e. GP, midwife, physiotherapist)

	1.5 Include self assessment/screening tool to help women identify symptoms of PFD	
2) Address Barriers to Engagement	2.1 Improve self-efficacy in users	• Empower users with information on pelvic floor health and PFMT as a strategy for promoting self-efficacy
	2.2 Create reminders through triggers	• Create trigger features that establish contextual awareness for performing PFMT in daily life (i.e. location based reminders)
	2.3 Reduce stigma	• Use humour as a strategy to reduce stigma • Include a discreet mode for notifications should be included for women who may feel self-conscious about people knowing about their condition • Application should offer women reassurance that they are not alone if they are experiencing symptoms
	2.4 Help integration of PFMT into daily life	
3) Facilitate Habitual	3.1 Utilise engagement framework in	

Engagement With PFMT	application design (i.e. Hooked Model)	
	3.2 Employ PT strategies to promote engagement	• Motivate women by providing them with statistics/information on the risks of not engaging with PFMT (i.e. 50% of vaginal deliveries result in prolapse) • Use visual feedback and praise animations during the guided workout
	3.3 Tailor PT strategies/app features to individual users preferences and needs	• App should offer different levels of guidance/intervention to women depending on their preference (i.e. a reminder function for some women, vs a handheld step-by-step experience for others) • Introductory tutorial should be optional • Exercises should be individualised to cater to the treatment needs for each person
4) Usability	4.1 Ensure usability of application	• Tutorial stage requires a progress bar • Tutorials should be broken into smaller sections so information is delivered to users at the moment it is relevant to their current interaction

		• Tutorials should not contain any interactive elements • Users should be provided with a sense of the overarching navigation of the app when they first use it • Should be easy to navigate from tutorial back to the main activity
Miscellaneous criteria/notes	• Consider aesthetic properties of the application, this has a significant effect on users perception of the app • Ensure the graphic style of the app is aesthetically appealing, and does not come across as "cheap and untrustworthy" • Language used should be tailored to a New Zealand audience (i.e. 'pelvic floor' over 'kegel') • Application should use calming colours and a feminine aesthetic • App should really focus on providing users with reminders and instructions/guidance as these were the identified by women as the most useful features • 50% of women who receive verbal instructions on PFMT perform contractions incorrectly	

Final Design

This version of the app retains the core functionality and engagement framework as the previous app. The most significant changes were undertaken to address the usability issues identified in the previous user testing session.

The tutorial functionality underwent the most significant changes of any feature between the previous and current versions of the app. The tutorial is now broken into several parts, which correspond to different activities in the application. The length of these tutorials have changed significantly, with a maximum of about 6 screens per a tutorial, compared with the tutorial in the previous stage of the application which had roughly 30+ screens, not including the interactive components. The tutorials have also had their navigation issues fixed, with progress bars and exit buttons added to the tutorial windows. This allows the user the option of exploring the app at their own will if they wish. The app provides tutorials for first use, the workout feature, and for the alarms and reminders feature.

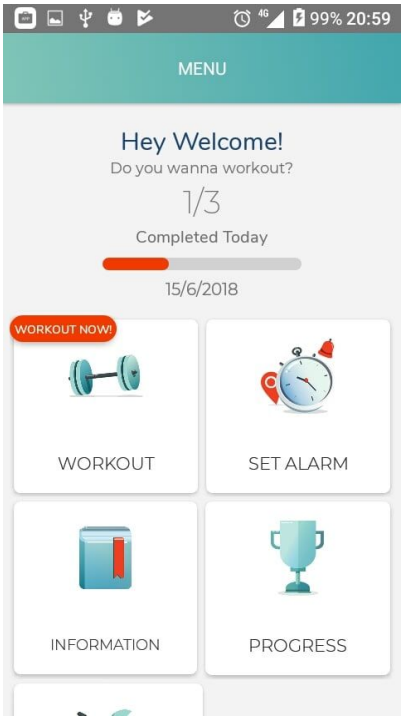
The app still utilises the investment phase of the hooked model in the same way as it did in the first version of the app. However in this version the tutorials guide users through the actual structure of the app as they invest their data, whereas in the previous version, the process of investing data took place entirely in the tutorial, with users working out and setting alarms inside the tutorial. When the user first opens this version of the app, the introductory tutorial launches which gives an overview of the purpose of the app [Figure 21]. When the user finishes/closes this tutorial, they get a view of the home screen. The 'workout' button has a red notification attached to it that says 'workout now' [Figure 20]. The purpose of this is to prompt the user to engage with the workout and thereby begin the process of investment.

Other fixes included the button on the workout activity. There are now clearer instructions that indicate to the user its functionality at each point in the tutorial. There are now also visual prompts that invite the user to interact with the button if they haven't done so in a certain period of time.

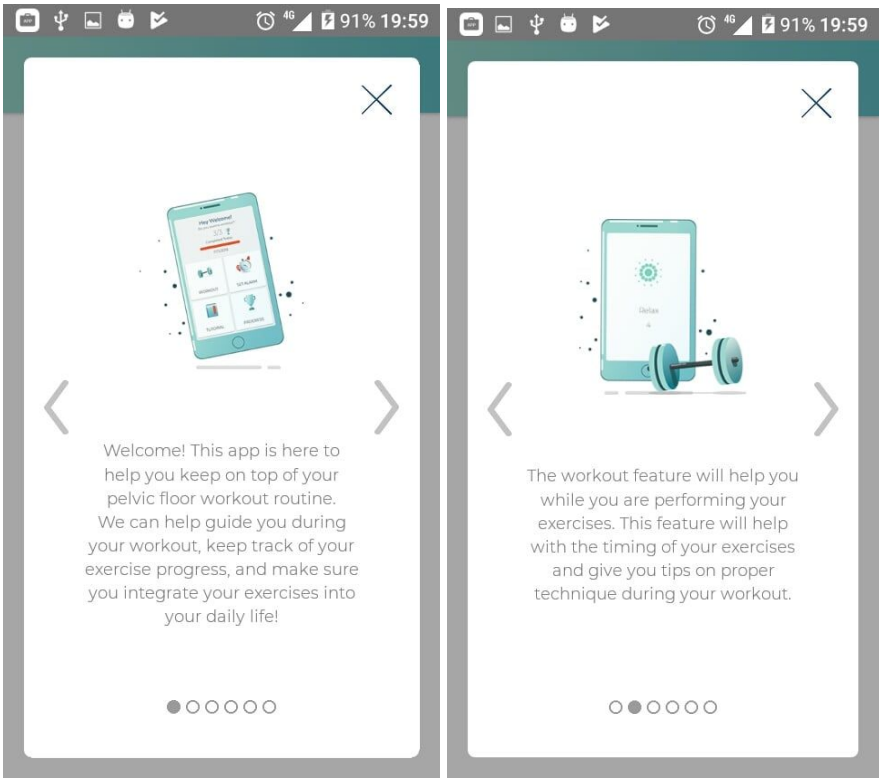
An FAQ/information section was added to the application to replace the tutorial [Figure 22]. The tutorial supplied most of the information for the last app. The FAQ now hosts all the important information that the criteria states should be included in the app. It also has added information based on the feedback from the previous user testing session, clarifying the term 'pelvic health professional' and giving women reassurance that they are not alone if they are experiencing symptoms.

A few changes have been made to the colour scheme too. The blue of the app header bar was darkened to improve readability, and the colour of the action buttons were changed to blue to appear less 'threatening'.

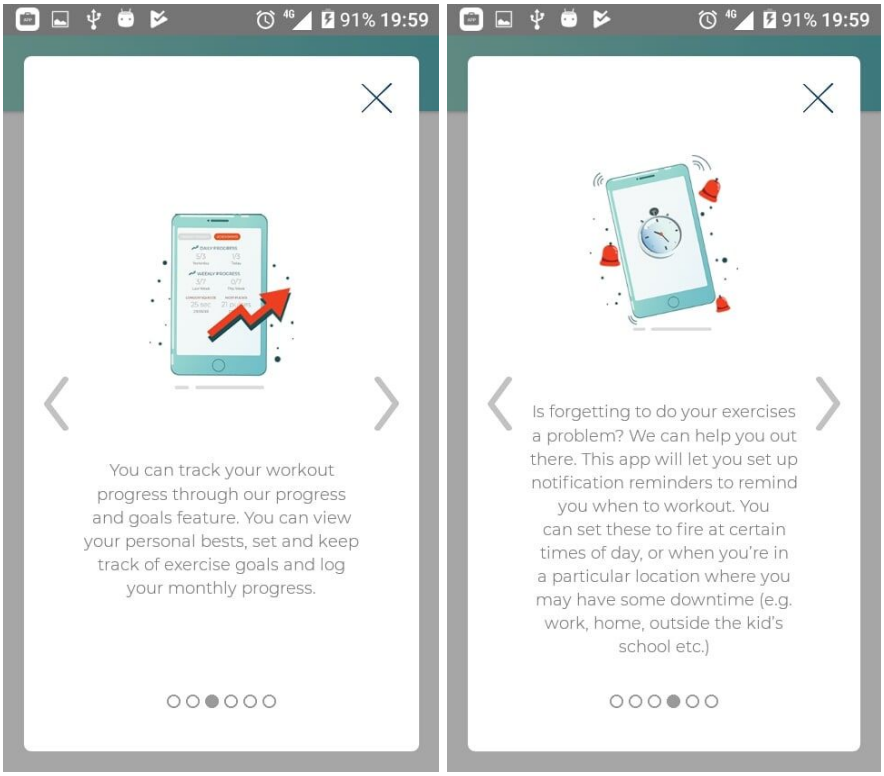
[**Figure 20** - Final application home screen]



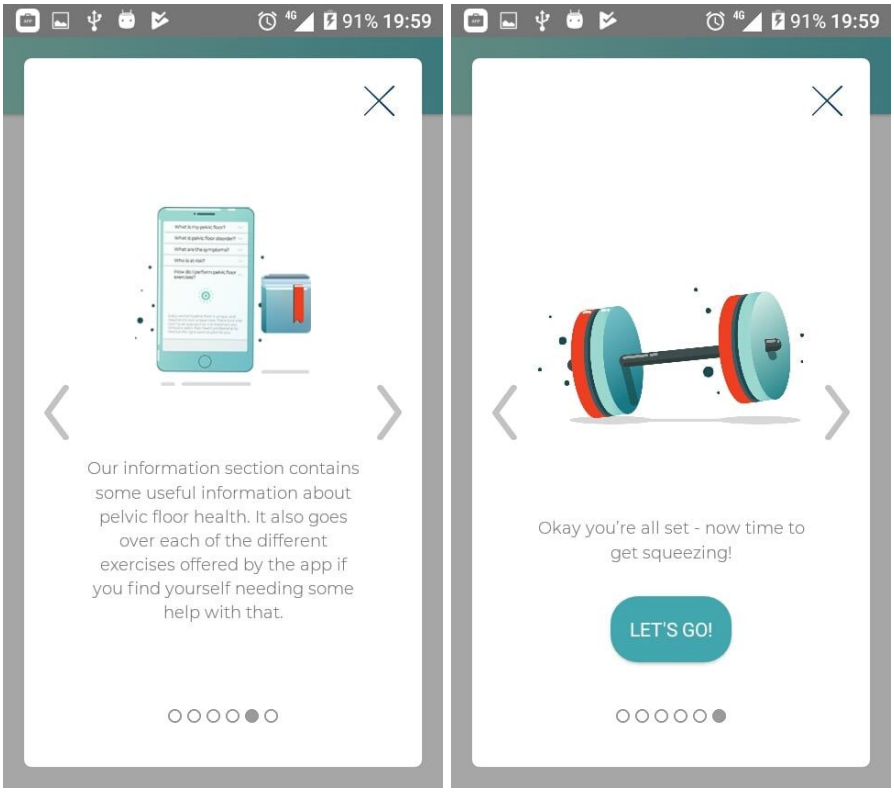
[**Figure 21** - Final app introductory tutorial]



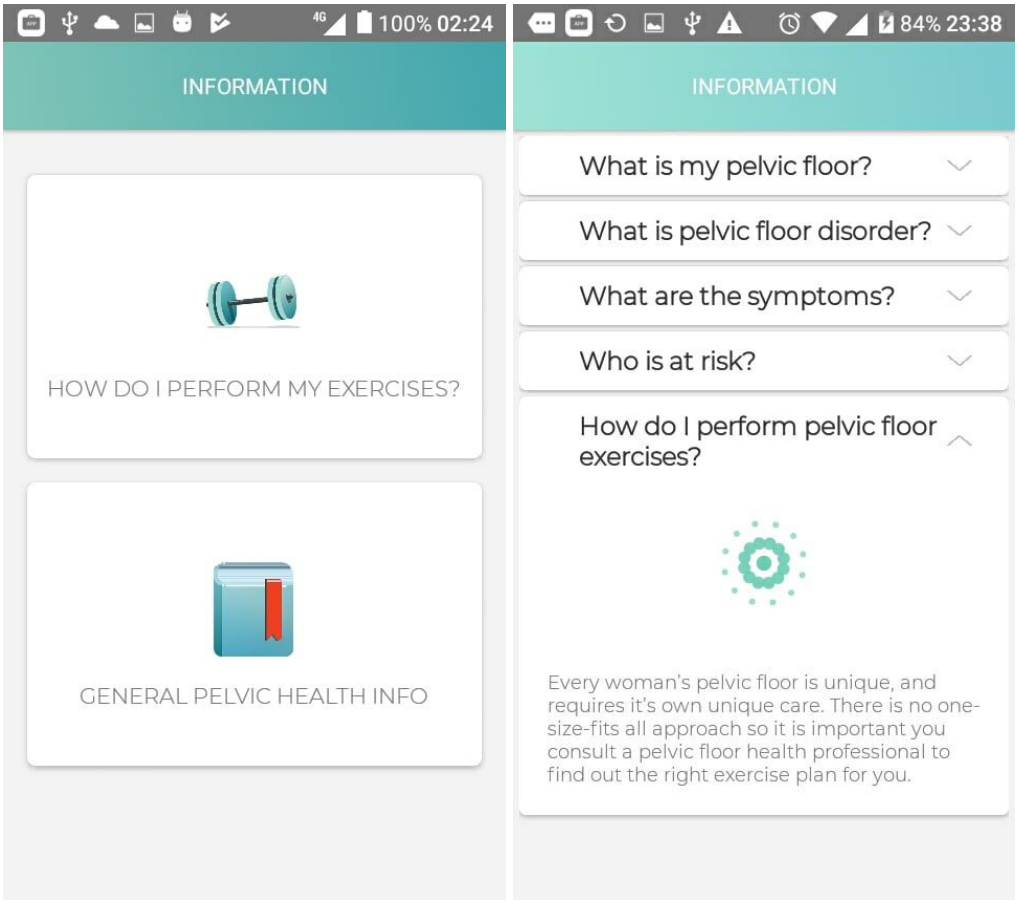
[**Figure 21 cont.** - Final app introductory tutorial]



[**Figure 21 cont.** - Final app introductory tutorial]



[**Figure 22** - FAQ & Information Section]


100% 02:24
INFORMATION
HOW DO I PERFORM MY EXERCISES?
GENERAL PELVIC HEALTH INFO
84% 23:38
INFORMATION
What is my pelvic floor?
What is pelvic floor disorder?
What are the symptoms?
Who is at risk?
How do I perform pelvic floor exercises?
Every woman's pelvic floor is unique, and requires it's own unique care. There is no one-size-fits all approach so it is important you consult a pelvic floor health professional to find out the right exercise plan for you.

Discussion

This project had two overall aims. The first was to identify a list of design criteria that identified key requirements for the design of a mobile application to improve engagement with PFMT therapy amongst women from pregnancy, to up to one year after delivery. The second of these aims was to produce a mobile application that implemented these criteria.

The final design criteria was established throughout this study by identifying common barriers to engagement with PFMT amongst women, formulating strategies through which these barriers could be addressed, and then testing those strategies amongst women. The final criteria [see Table 7] is a culmination of the findings from this study.

Provide Information & Guidance to Facilitate The Performance of PFMT

The provision of information and guidance was identified many times over the course of this study as an important factor for designs facilitating engagement with PFMT. The incorrect performance of PFMT contractions was identified in both the literature review and the clinician interviews as a significant issue. Women who participated in the study also indicated that they would feel as if they would benefit from more guidance/instruction in terms of performing PFMT.

Clinicians emphasised the importance of women seeking out professional assistance when undertaking a PFMT regimen. The information they recommended to be included in the application reflects this (criteria 1.2, 1.4) These three fairly information requirements were integrated into the final design easily.

The task of guiding PFMT technique proved more difficult. Early user testing sessions identified a couple of strategies/design features that women felt helped them better understand how to perform their pelvic floor exercises. One technique was through the use of metaphors. Participants highlighted that metaphors that referred to familiar bodily sensations (i.e "squeeze your muscles as if you are trying to stop the flow of urine") were better at helping them understand the action of contracting their pelvic muscles which was implemented into the final design.

Another strategy was through the use of guided visualisations. Participants identified the curved, organic motion of animation 3 [see Table 5] as being conducive to the action of 'squeezing and lifting' the pelvic floor. An animation similar to this one was included in the workout section of the final design, to help guide PFMT performance.

Despite participants identifying these strategies as being useful in helping them understand correct PFMT technique, the clinicians interviewed highlighted the fact 50% of women who receive verbal/written instructions for PFMT perform their exercises incorrectly. This statistic was brought up by each of the clinicians. One of the clinicians went on to comment that an application educating women on PFMT technique without a device would be no better than verbal instructions.

This information suggests that a stand alone mobile application is an ineffective means of educating women on correct PFMT technique. While the application can provide women with useful information on pelvic floor health and anatomy, it is unlikely that a mobile application will be effective in the instruction of PFMT. Applications such as this one should be thought of as one component in a larger treatment intervention involving a pelvic floor health professional. This makes a case for the utility of biofeedback devices in the practice of PFMT, as they are better equipped to provide guidance as opposed to a standalone mobile application.

Addressing Barriers and Improving Engagement With PFMT

The main influences/barriers to engagement with PFMT that were identified from the literature were memory, self-efficacy, incorrect technique and perceived severity/susceptibility. The results from the survey, and feedback from women during user testing sessions to confirm this. Of all the barriers, memory was most consistently identified, with most participants identifying it as their biggest barrier to engagement when asked.

A number of strategies were implemented in the design to address these barriers. To improve self-efficacy, the application provided users with information and guidance, with a particular focus on giving instructions to users during workouts. A more detailed breakdown of how barriers were addressed in the app is given in the previous chapters that detail the design of the applications.

Self-efficacy and incorrect technique were difficult barriers to address, due to limitations of a standalone mobile application to provide guidance to users on the correct PFMT technique, as described above.

Addressing the memory barrier was a core focus of the design. The solution provided was the geolocation/alarm feature, which reminds users to perform their exercises both through time based, and location based notification alarms i.e. work, their kid's school etc. The use of location based alarms is designed to help point out opportunities for the performance of PFMT in everyday life.

The hooked model was utilised as an engagement framework for the application. The implementation of this framework is described in more detail under the application design sections.

During user testing of the mobile application, participants all ranked the application moderate to low in terms of improving their desire to engage with PFMT. However, there were a number of usability issues with the application which may have impacted the participants perception of the app. When asked to evaluate the individual features of the app in terms of improving engagement, participants ranked the notification/alarm features as most useful.

The endorsement of reminder features was also echoed in the survey results, with the survey participants expressing the most interest in the reminder/notification features. The interest in notification/reminder features aligns with the identification amongst women of memory as the biggest barrier to PFMT.

Personalisation

The findings in this study supplied some evidence to support this study's hypothesis of the efficacy of a personalised treatment approach. The clinician interviews emphasised the different treatment needs of women, and that there is no 'one-size-fits-all' exercise regime. They mentioned the exercises regimens were based on factors such as height, weight, number of children severity of condition etc. It was recommended that the application facilitate the customisation of exercises. This feature was implemented in the application.

Another point of difference identified in the study was the level of instruction/guidance desired by women. Participants expressed a range of responses to the inclusion of information and guidance in the app. In the second user testing session, one participant stated that all she would really want from an application is a notification to remind her to perform her exercises, but went on to acknowledge she believed some women would really appreciate a more guided experience. This disparity was present in the third user testing session. The participants in the questionnaire were asked to assess how useful they found the information and guidance

provided by the app. One of the participants with no children, rated this component of the application highly, and indicated through her answers that the app had given her new information on pelvic floor health. Another participant who had been living with a pelvic floor condition since a young age rated this component low, stating she already knew most of the information it contained. This suggests that the level of familiarity with PFD impacts the level of information/guidance desired from an app.

There were also disparities amongst how women perceived the usefulness of certain features when included in an application. In the questionnaire at the end of the third user testing session, there was a great amount of disparity in the ratings participants gave a range of features.

Due to the low numbers of women in this study, validating the user personas against application features was difficult. However, the results from this study do indicate that there are some areas of difference in the needs and preferences of women undertaking PFMT. The findings suggest that women's different levels of experience with PFD, and the nature of their symptoms is a predictor of their needs from an application.

The low number of women participating in this project is a limitation. Due to this small sample size, making generalisable claims is difficult. Additionally measuring long term effects on engagement in the application was not within the scope of this project. Usability issues with the application in the third user testing session may have impacted the participants evaluation of the the design features effect on engagement. Performing another testing session with the final, updated design may produce different feedback. Future directions for this project could involve the integration of a biofeedback device with the application, as well as further exploration of user personas and personalised design.

Conclusion

This study followed the process of designing a personalised mobile application to improve engagement with PFMT amongst women from pregnancy to up to one year after delivery. The study involved the production of a design criteria/list of recommendations for the design of a mobile application to improve engagement with PFMT, as well as the production of a mobile application which implements the criteria. The main barriers to engagement identified in the literature review were memory, self-efficacy, incorrect performance of exercises, perceived and severity/susceptibility.

The findings from this study indicate that a stand alone mobile application, is not likely to be effective in providing women with instruction and guidance on PFMT. It is recommended that a design such as this be one part of a larger treatment intervention. Feedback from clinicians recommended that the application design emphasise the necessary role of pelvic health professionals in the treatment of PFD. Feedback regarding the efficacy of engagement strategies implemented in the app (i.e. Hooked model) indicated that they were generally not very effective in increasing engagement. However it is likely these results were impacted by the usability issues of the app tested in the final user testing session. The features that were most popular from user feedback in terms of improving engagement were the reminders/geolocation reminder features. This echoes the identification amongst women of memory as the biggest barrier to engagement with PFMT. The key differences found among women in personalisation aspects were, exercise needs, desired level of guidance/instruction and preferred app features. The sample size was too small to validate connections between user personas, and features to be implemented within the application. Future directions for this study could look at the integration of a biofeedback device with the mobile application.

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