Translational Behavioral Medicine

Development of the MedFit Application: A behaviour change theoretically informed mobile application for patient self-management of cardiovascular disease

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Corresponding Author:	Orlaith Duff Dublin City University Dublin 9, IRELAND
Corresponding Author Secondary Information:	
Corresponding Author's Institution:	Dublin City University
Corresponding Author's Secondary Institution:	
First Author:	Orlaith Duff
First Author Secondary Information:	
Order of Authors:	Orlaith Duff
	Deirdre Walsh
	Bróna Furlong
	Noel E. O'Connor
	Kieran Moran
	Catherine Woods
Order of Authors Secondary Information:	
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Abstract:	Background: The MedFit application is designed to facilitate people with cardiovascular disease (CVD) to participate in an exercise-based rehabilitation programme remotely. This paper details development of the formative research process outlined by the Medical Research Council. Purpose: To describe the development of the MedFit app, by following the early stages of the formative research process; development and feasibility/piloting. Methods: Following the creation of the first prototype of the app, the feasibility and acceptability of the prototype application was tested in focus groups. The focus group script was developed using a questionnaire (N=119 MedEx participants; 64.7% male; mean age 65 ± 8.86 years) based on usability theory (UTAUT2). Twenty-six cardiac rehabilitation participants took part in the five focus groups (65% male; mean age 64±8.2 years) to provide feedback on the prototype app. Focus groups were transcribed verbatim and in-depth content analysis was performed. Results: The results of the questionnaire revealed that performance expectancy, social influence, hedonic motivation, behavioural intention, effort expectancy and facilitating conditions all rated highly among respondents. These constructs were used to develop the focus group script. Following in-depth content analysis, four main themes were identified; support, app as a mentor/guide, translation of activity from gym to home and technology knowledge gap. Conclusion: The formative research process of the app development was undertaken to develop the MedFit app. This work will provide guidance for future research by

	incorporating a best practice framework for mHealth intervention development and a user-centered design approach.
Suggested Reviewers:	Ralph Maddison Professor of Physical Activity and Disease Prevention ralph.maddison@deakin.edu.au We believe Professor Maddison would be a suitable reviewer for this manuscript as he has published extensively in the area of e- and mHealth interventions, particularly relating to physical activity and chronic disease management.

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Title: Development of the MedFit Application: A behaviour change, theoretically informed mobile application for patient self-management of cardiovascular disease

Author names: Orlaith Duff[1,2,3], Deirdre Walsh[1,2,3], Bróna Furlong[1,2], Noel E. O'Connor[3], Kieran Moran[2,3] and Catherine Woods[1,4]

Affiliations:
1 MedEx Wellness, School of Health and Human Performance, Dublin City University, Dublin, Ireland.
2 School of Health and Human Performance, Dublin City University, Dublin, Ireland.
3 Insight Centre for Data Analytics, Dublin City University, Dublin, Ireland.
4 Department of Physical Education and Sports Sciences, Faculty of Education and Health Sciences, University of Limerick, Ireland.

Degrees:
Orlaith Duff B. Sc. (Sport Science and Health)
Deirdre Walsh PhD., MSc, BA (Psychology)
Brona Furlong PhD., B.Sc.
Noel E. O'Connor PhD., B.Sc.
Kieran Moran PhD., B.Sc.
Catherine Woods PhD., B.Sc. (Physical Education and English), NCEFT, BACR IV

Corresponding author: Kieran Moran, Kieran.moran@dcu.ie , Room A246 (Albert College), School of Health and Human Performance, Dublin City University, Dublin 9, Ireland. 00353 – 1 – 7008011

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Implications (explicitly state the impact of the findings for researchers, practitioners, and policymakers; ONE SENTENCE

Implications

Practice: mHealth interventions can be created following the mHealth development and evaluation framework; incorporating theory, literature review, user-centered design and technical expertise.

Policy: Policymakers who want to address the barriers to participating in cardiac rehabilitation need explore the potential impact e- and mHealth technologies may play in the future of healthcare.

Research: Future research aiming to develop mobile applications should follow best practice frameworks for mHealth intervention development while also incorporating a user-centered design approach.

Development of the MedFit Application: A behaviour change theoretically informed mobile application for patient self-management of cardiovascular disease

Abstract

Background: The MedFit application is designed to facilitate people with cardiovascular disease (CVD) to participate in an exercise-based rehabilitation programme remotely. This paper details development of the formative research process outlined by the Medical Research Council.

Purpose: To describe the development of the MedFit app, by following the early stages of the formative research process; development and feasibility/piloting.

Methods: Following the creation of the first prototype of the app, the feasibility and acceptability of the prototype application was tested in focus groups. The focus group script was developed using a questionnaire (N=119 MedEx participants; 64.7% male; mean age 65 ± 8.86 years) based on usability theory (UTAUT2). Twenty-six cardiac rehabilitation participants took part in the five focus groups (65% male; mean age 64±8.2 years) to provide feedback on the prototype app. Focus groups were transcribed verbatim and in-depth content analysis was performed.

Results: The results of the questionnaire revealed that performance expectancy, social influence, hedonic motivation, behavioural intention, effort expectancy and facilitating conditions all rated highly among respondents. These constructs were used to develop the focus group script. Following in-depth content analysis, four main themes were identified; support, app as a mentor/guide, translation of activity from gym to home and technology knowledge gap.

Conclusion: The formative research process of the app development was undertaken to develop the MedFit app. This work will provide guidance for future research by incorporating a best practice framework for mHealth intervention development and user-centered design approach.

Key words: App development, cardiac rehabilitation, mHealth, focus groups, usability testing

Background

Cardiovascular disease is the leading cause of mortality worldwide, accounting for 17.3 million deaths per year, which is expected to rise to more than 23.6 million by 2030 [1]. With the prevalence of CVD on the rise, secondary prevention methods to battle this condition have never been so important. Cardiac rehabilitation (CR) is a secondary prevention programme. It is defined by the World Health Organisation (WHO) as the 'sum of activity and interventions required to ensure the best possible physical, mental, and social conditions so that patients with chronic or post-acute cardiovascular disease may, by their own efforts, preserve or resume their proper place in society and lead an active life' [2]. Cardiac rehabilitation involves exercise training, education on heart-healthy living and counselling to reduce stress and help return to an active lifestyle. As physical activity has been shown to improve quality of life and reduces mortality in patients with CVD, physical activity counselling and exercise training are the core components of the programme. A Cochrane systematic review of exercise-based CR found that cardiovascular mortality was reduced and there was a reduction in hospital admissions and improvements in health-related quality of life [3]. Cardiac rehabilitation has also been associated with improvements in psychological wellbeing and quality of life [4].

Although the benefits of CR have been well documented, adherence to these programmes is generally suboptimal. Across a number of surveyed countries only 14-43% of cardiac patients participate in rehabilitation programmes [5,6,7]. Poor uptake of cardiac rehabilitation has been attributed to several factors such as physicians' reluctance to refer some patients, particularly women and people from ethnic minorities or lower socioeconomic classes and a lack of resources and funding [8]. Furthermore, less than 50% of those who participate in CR maintain an exercise regime for as long as 6 months after completion of the programme [9,10]. Results from a Cochrane systematic review revealed that common barriers to adherence to CR programmes include accessibility and parking at local hospitals, a dislike of group environments and work or domestic commitment [11]. This suggests that current cardiac rehab programmes do not suit all patients and that alternative modes of rehabilitation should be available.

mHealth (mobile health) technologies may hold the key to this new mode of CR delivery. mHealth is a component of eHealth defined by the Global Observatory for eHealth (GOe) as "medical and public practice

supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDA's) and other wireless devices" [12]. According to Kailias and colleagues (2010) there are more than 7000 documented smartphone health apps available to the public [13]. mHealth technologies use techniques and advanced concepts from a multitude of disciplines such as computer science, electrical and biomedical engineering, health sciences and medicine [14]. Technology-enabled health behaviour change interventions are designed to engage people in health behaviours that prevent or manage disease [15]. Literature in the area of internet and mobile-based health interventions has found that such tools can be useful in supporting the self-management of chronic disease [16][17]. The Institute of Medicine's has called to increase the design and testing of health technologies [18], while Michie and colleagues called for the identification of intervention active components so that the effects and mechanisms of behaviour change interventions can be better understood [19].

MedFit Theory and Development

MedFit is an mHealth application and is designed to allow people with CVD to participate in an exercise-based rehabilitation programme remotely through an Android App. MedFit offers the potential to make exercise-based rehabilitation programmes more effective by making them more accessible, more personalised and more interactive, by providing real-time support and feedback for participants.

The development of the MedFit app has been underpinned by social cognitive theory and the behaviour change wheel. These models of health behaviour change have been used to design how the best practice guidance and content will be delivered to the end user.

Social Cognitive Theory

Social cognitive theory (SCT) is multi-component theory, whereby individual self-efficacy works in conjunction with knowledge, goals, outcome expectations, perceived environmental impediments and facilitators in the establishment of behaviour [20]. The core determinants of SCT include knowledge of health risks and benefits of different health practices, perceived self-efficacy that one can exercise control over one's health habits and the outcome expectations about the expected barriers and benefits for different health habits. Other key determinants include health goals and the concrete plans and strategies for realizing them, and the

perceived facilitators and social and structural impediments to the changes they seek [20]. These core factors of social cognitive theory work together to initiate and subsequently maintain a target behaviour.

The COM-B and Behaviour Change Wheel (BCW)

The COM-B model and behaviour change wheel were developed by Michie, Atkins and West (2014) as a systematic method of understanding behaviour and linking this understanding to behaviour change techniques. The COM-B model is a behaviour system whereby an individual's capability, opportunity and motivation interact to generate behavior and in turn that behaviour influences these components [21]. This model provides a basis from which interventions aimed at behaviour change, such as the MedFit app can be designed. The model ensures that an individual's capability, opportunity and motivation are targeted in order to initiate behaviour change.

The BCW is an approach to developing behaviour change interventions, beginning with identifying a target behaviour needed to change. The intervention is then designed to consist of intervention functions and behaviour change techniques, as well as the delivery mode, which takes into account policy categories. The BCW consists of three layers. The hub of the wheel is formed by the COM-B model, which identifies the sources of behaviour which may be prime targets for the intervention. The next layer comprises of nine intervention functions to choose from depending on the particular COM-B analysis one arrives at. The outer layer is made up of seven types of policy that can be used to deliver the intervention functions [22].

Michie and colleagues (2013) also developed a behaviour change technique taxonomy that links to the behaviour change wheel, identifying 93 hierarchically clustered techniques that are the active components of behaviour change interventions. The core components of these techniques are 1) shaping knowledge, 2) comparison of outcomes, 3) comparison of behaviour, 4) self-belief, 5) natural consequences, 6) social support, 7) antecedents, 8) goal setting and planning, 9) feedback and monitoring, 10) associations, and 11) repetition and substitution. The use of behaviour change techniques forms a crucial part of the current evidence based development and delivery of mHealth interventions. It provides researchers with a systematic way of developing and characterizing interventions that enables their outcomes to be linked to mechanisms of action and it can also help to diagnose why an intervention may or may not have achieved its desired outcome [19].

The mHealth development and evaluation framework has been used to guide the development and evaluation process applied to the MedFit app. This framework follows an iterative process for developing technology-based interventions, it facilitates and encourages end-user engagement and has been used in previous research of this nature with CVD patients [23][24]. The purpose of this paper is to detail the development work through the early stages of the formative research process. This process is important to undertake as it provides a best practice framework for mobile application design and development, allowing the app to be developed in an iterative process with users central to the design.

Methods

The mHealth development and evaluation framework has been used to develop the app [24]. The framework begins with the conceptualization phase. This phase in the MedFit applications development involved conducting a systematic literature review. The systematic review aimed to identify what BCTs are used in physical activity eHealth interventions for people with cardiovascular disease. From this review, the app content was designed and developed in line with the most frequently used groups of BCTs in the effective interventions. Another phase of the app's development involved recruiting an advisory panel to review the proposed course of action and to make recommendations. Regular brainstorming sessions on how to best translate the theory and evidence into practical methods and techniques were also held.

MedFit App Alpha Version Description

Following the conceptualization phase, the first/alpha version of the app was developed with expertise in app design from the technical team (Figure 1). The app was created to work in conjunction with a FitBit watch and was comprised of three central sections; 'exercise', 'progress' and 'my healthy lifestyle'. Within the exercise section of the app, preset exercise programmes were incorporated into the app. These programmes consisted of a warm-up, main phase and cool down, all of which can be performed in the comfort of the user's own home. Local muscular endurance (LME) exercises as well as stretches were also incorporated into the programmes. The exercise section contained a 'test yourself' function whereby users could do a 6-minute walk test to test their progress. The 'progress' section of the app contained user feedback displayed in charts and graphs so that the users could track their progress over time e.g. track step count. The 'my healthy lifestyle' of

the app provided tips and recommendations on lifestyle factors, such as healthy eating, alcohol consumption, physical activity, stress management, medication adherence, smoking cessation and sexual functioning. The alpha version of the app was then tested in focus groups to ascertain the usability and acceptability of the app among potential end-users.

Figure 1: Screenshots of the alpha version of the MedFit app as shown to participants in focus groups

Design of Current Study

The aim of the current study was to explore the usability and acceptability of the MedFit app in line with the mHealth development and evaluation framework. This study has received ethical approval from the Dublin City University (DCU) ethics committee (DCUREC/2015/038). Following initial development of the MedFit app, further work on individual acceptance and use of information technology was conducted. An explanatory sequential design was used, whereby the quantitative questionnaire results informed the qualitative focus group script [25]. Specifically, a questionnaire was used to identify the core constructs which impact the

acceptance and use of apps by participants. Following this, focus groups were held to further explore these constructs in relation to the MedFit app and to collect usability feedback. This use of mixed methods research (i.e., questionnaire and focus groups) has numerous benefits. This approach gives a voice to participants and ensures that the findings are grounded in the participants' views and experience [26]. While the quantitative results from the questionnaire allowed the research team to identify the constructs which are deemed important to participants acceptance and use of technology, the qualitative focus group work allowed participants to expand their views on the constructs. This ensured that very specific and tailored app content can be created based on the users' needs and wants.

Material Development

Focus Group Script Development

To develop a theoretically informed focus group script the 'Unified Theory of Acceptance and Use of Technology 2' model (UTAUT2) was used [27]. This model outlines the critical factors and contingencies related to the prediction of behavioural intention to use a technology and technology use. The core constructs related to this model include:

- Performance expectancy: The degree to which an individual believes that using the system will help him or her to attain gains in job performance.
- Effort expectancy: The degree of ease associated with using a given technology system or application.
- Social influence: The degree to which an individual perceives that people who are important to them should use the new system.
- Facilitating conditions: The degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system [28].

Further development of the predictors of behavioural intention led to an extended UTAUT2 incorporating three new constructs: hedonic motivation, price value and habit.

- Hedonic motivation is defined as the fun or pleasure derived from using a technology. It has been previously shown to play a role in determining technology acceptance and use [29].
- Price value: The degree to which an individual perceives the technology as good value for money has

a significant impact on whether an individual uses a given technology.

- Habit is viewed as prior behaviour [30] and is measured as the extent to which an individual believes the behaviour to be automatic [31].

Compared to the original UTAUT model, the extensions proposed in UTAUT 2 produced an improvement in the variance explained in behavioural intention (56% to 74%) and technology use (40% to 52%) [32]. The role of the questionnaire within this study was specifically to develop a theoretically informed focus group script, which would pose questions relating to the core constructs identified as impacting on the acceptance and use of apps by participants.

A questionnaire [adapted from a questionnaire developed by Venkatesh and colleagues (2012)[32]] entitled the 'Acceptability of mobile phone applications among adults with chronic illness'. The questionnaire comprised of two sections (Additional file 1). Section 1 asked respondents about tablet computers and smartphones, asking if participants have either and whether they use mobile phone apps. Section 2 sought to obtain opinions regarding the importance of mobile applications using questions based on the UTAUT 2 model relating to participant opinions on factors such as 'facilitating conditions', 'effort expectancy', 'social influence', 'performance expectancy' and finally 'hedonic motivation'. Respondents were asked to indicate the extent to which they agreed or disagreed with statements using a seven point Likert scale response framework [(1) = strongly disagree; (2) =disagree; (3) = somewhat disagree; (4) = neutral; (5) = somewhat agree; (6) agree; (7) = strongly agree].

Focus Group Script Development Participants

An adapted version of the UTAUT2 questionnaire was completed by MedEx Wellness participants. MedEx Wellness is a community-based exercise rehabilitation programme for chronic illness located at DCU. It offers supervised exercise classes to individuals with a range of chronic conditions, including cardiovascular disease, pulmonary disease, diabetes, and cancer.

A total number of 119 MedEx participants completed the UTAUT 2 questionnaire. 64.7% of the respondents were male, with the average age of the group (n=116) 65 ± 8.86 years (range 38-84 years). The duration of

attendance in MedEx ranged from ≤ 1 month (12.7%), 2-5 months (22.9%), 6-12 months (15.3%), 1-3 years (27.1%), >3 years (22%).

Questionnaire Analysis

Analysis was conducted using SPSS 23 [33]. Correlations were carried out between behavioural intention and UTAUT2 constructs. In order to decipher what constructs were ranked most important to the participants, the research team set a criteria for inclusion whereby factors were rated positively if participants scored ≥15 on the three item constructs and ≥20 on the four item constructs on the positive end of the likert scale; somewhat agree (5) / agree (6) / strongly agree (7).

Focus Groups

Focus Group Procedure

Participants were recruited from the HeartSmart programme in MedEx Wellness, which caters individuals with cardiovascular disease. In total 26 HeartSmart participants took part in the focus groups (65% male; mean age 64±8.2 years). There were five focus groups. Each focus group lasted approximately 1.5-2 hours in duration with a maximum of six people per group. The researcher aimed to balance the groups in terms of gender. The focus group was led by a moderator, who guided the interview, while an assistant moderator took notes on the ensuing discussion. The focus group had two main strands. The first focused on the usability of the MedFit app where the researcher presented the different functions of the app and the participants could follow along using a Samsung Galaxy S5 Neo on which the app was downloaded. Participants were asked to give their feedback and opinions on the prototype app components. The second strand of the focus group concentrated on the acceptability of the app with questions relating to the main constructs identified in the questionnaire which impacted participant's acceptance and use of apps.

Focus Group Data Analysis

The focus groups were transcribed verbatim. The data was analysed using content analysis [34]. An initial list was generated of ideas about the data and what was interesting about it. An initial set of codes were generated

for each focus group based on the data. This coding was done manually by going through the content of the entire data set and linking the information to particular codes. The researcher was left with a list of codes identified from the dataset. Validation of the coding was undertaken whereby two members of the research team independently coded the same piece of transcription and then compared notes. The codes were sorted into broader themes, so that all the codes across each of the 5 focus groups, belonging to a particular theme were grouped together. This stage was performed in excel whereby the researcher created a sheet for each focus group. From here the potential themes were given separate columns and the corresponding codes were placed underneath the theme, along with participant quotes. In phase 4 the themes were revised and refined. All the coded data extracts were also reviewed to ensure they are appropriately coded to a given theme. The themes were then reviewed to ensure they accurately reflected the dataset and codes. The final phase involved defining and further refinement of the themes and sub-themes [35].

Results

Focus Group Script Development Results

A total number of 119 MedEx participants completed the UTAUT 2 questionnaire. 74.1% of participants had a tablet computer and 75.2% owned a smartphone. A high percentage also revealed that they have used mobile applications on their smartphones (72.3%).

The results revealed that performance expectancy, social influence, hedonic motivation, behavioural intention, effort expectancy and facilitating conditions all rated highly among respondents. More than 50% of respondents scored a total of 15 or more on performance expectancy, social influence, hedonic motivation, behavioural intention (3 item constructs; table 1). Greater than 50% of respondents scored a total 20 or more on the two 4 item constructs, effort expectancy and facilitating conditions (Table 2). A total of 73.5% of respondents from MedEx believed that they had the necessary conditions to facilitate the use of apps in their lives.

Table 1: % respondents scoring ≥15 on the three item constructs

3 Item Constructs		
Construct	**Score ≥15**	**Range (min-max)**
Performance expectancy	58.6%	18 (3-21)
Social Influence	54.7%	18 (3-21)
Hedonic Motivation	56.4%	18 (3-21)
Price Value	40.2%	16 (5-21)
Habit	18.9%	16 (4-20)
Behavioural Intention	56.6%	18 (3-21)

Table 2: % respondents scoring ≥20 on the four item constructs

4 Item Constructs		
Construct	**Score ≥20**	**Range (min-max)**
Effort expectancy	59.8%	24 (4-28)
Facilitating Conditions	73.5%	23 (5-28)

Only 18.9% of respondents scored ≥15 on the Habit construct indicating that end-users did not perceive habit as playing a significant role in the acceptance and use of mobile apps amongst this cohort. 40.2% of respondents scored a total of 15 or more on the price value construct, indicating that perhaps price value does not play as significant a role as some of the other constructs.

The results of the questionnaire were used to inform and develop the usability focus group script (Additional file 2). Questions were developed based on the constructs that rated highly among participants (i.e. performance expectancy, social influence, hedonic motivation, behavioural intention, effort expectancy and facilitating conditions), while habit and price value were not incorporated into questions and these were not deemed as important to the participants based on the criteria set.

Focus Groups Results

Usability of the MedFit App

The first section of the focus groups involved participants providing feedback on the app components. Table 3 provides a list of the feedback from the focus groups based on each app component and the translation of this feedback to app content.

Table 3: Participants usability feedback on the alpha version of the app

	Feedback on the App components	Translation of focus group feedback to app content
Login	➢ Need a password clue ➢ If the wrong password is inputted, have a link to retrieve password ➢ See letters come up on screen as you type your password	➢ Characters appear onscreen as person types in password ➢ Simple retrieve password function
Home screen	➢ Confusion regarding the 'burger' menu – many wouldn't know to click on it ➢ Change burger menu to the word 'menu' ➢ 'My healthy lifestyle' should not have the word my in it as this tab contains generic information ➢ Change 'My healthy lifestyle' icon	➢ Changed the 'burger menu' to the word 'menu' ➢ Removed the word 'My' from the title 'My healthy lifestyle' ➢ Changed the healthy lifestyle icon
Exercise tab/exercise programme	➢ Play video continuously under the timer ➢ Have a pause function in the exercise programme ➢ Play music with a beat. Option to mute the music ➢ Ability to log activity not picked up by FitBit.	➢ Video plays continuously under timer ➢ Ability to log activity not tracked by FitBit in new section called 'Log my activity'
Progress	➢ Need to see results/progress from the 'Test yourself' section ➢ Daily progress statistics should be the default screen ➢ Have range for the group attendance and duration but don't attach any personal identification - this would give people an idea of where they are in relation to the min and max ➢ Remove the group leaderboard	➢ Daily progress results are set as the default screen ➢ Removed identification from the group part of the app ➢ Removed the leaderboard
Healthy Lifestyle	➢ Happy with the information provided ➢ Use visuals to depict information ➢ Different levels of information – basic info, recent research, reference section to publications, links to additional sites for more information.	➢ More pictures used throughout the content ➢ Different levels of information provided to cater for all
My MedFit group	➢ Ability for users to add events to the event list or send them to the researchers via a comment box on the app ➢ Opt in/opt out function regarding the group chat function ➢ Potential to have a chat function/ comment box where users could message for tech support ➢ Small group chats (5-6 people) ➢ Remove the leaderboard	➢ MedFit group to be created in the version after the Beta version of the app. Feedback from the focus groups for this section of the app will then be incorporated into the app
Menu	➢ Video tutorial ➢ FAQ section ➢ Comment box ➢ Contact details for technical support ➢ Leave your details and a message and someone can get back to you (i.e. leave a comment)	➢ Video tutorial, contact details and FAQ all added to the menu function
Feedback notifications	➢ No more than 4 messages per week ➢ Suggestion to turn off notifications	➢ Maximum of 4 message sent per week

Acceptability of the MedFit App

Following in-depth content analysis, four main themes emerged. These were; support, the app as a mentor/guide, translation of activity from gym to home and technology knowledge gap.

Support

Support was split into three sub-themes based on the focus group feedback; learning/familiarisation process, support from family/friends and technical support.

Learning/familiarisation process

Participants placed huge emphasis on an initial familiarisation and set up process. As many participants weren't familiar with using apps on a regular basis participants said that it would be very important to have a familiarisation period where they would be taught how to use the app the either in a one-to-one training session "one-to-one would be great" (FG2) or in "Small groups" (FG2). It was reiterated across the groups that learning how to use the app would occur over time, using a "trial and error" method (FG1). However, at the initial introduction to the app participants would need to be shown how to use the app in a simple, step-by-step manner "it's the lady bird approach. Right from the start, don't assume any knowledge" (FG3). Participants felt that they would also need written instructions/guide to help them learn how to use the app. This would also be helpful if they forgot how to use the app at home as they would something to look at for guidance. "Well a guide is always good… and that's the only reason so if you don't use something often you can come back to it without having to go miles to find out" (FG5).

Family/friends support

Overall, most participants believed they would get support from family and/or friends to use the app. This support would come in the form of encouragement to use the app. Most people have families who are interested in their loved ones' health and would therefore provide encouragement to use the app if they believed it would benefit their health. "Most families, most people are lucky enough to have people interested in them. When you get sick, the first thing they do, if there's anything they can do to help you get better. If it's just to encourage you to exercise, they'd be all too happy to do it" (FG1).

There were differing views in the groups as to whether friends/family could provide technical support to use the app. Some believed their family, particularly their children would have the knowledge and skills to help them use the app "There's a lot that we don't understand we ask the kids about, you know, and they show us" (FG1). One participant thought their family wouldn't take an interest in the app, that they have their own apps and interests to worry about, however, their friends might because they are of a similar age and interest level.

Technical support

In terms of technical support most participants agreed that they would need a contact for technical support in case they had an issue than neither themselves nor their family/friends could solve. The participants provided numerous suggestions as to what format the technical support should come in. Some suggested the use of a comment box where you could leave a message on the app regarding your query either straight to the technical team or to other users of the app. "Probably the comment box is the best" (FG4).

Participants agreed that the best form of technical support would be the availability of contact number that participants would ring during set hours. "Well if you have your contact details there that if you are stuck, eh you can ring in" (FG2).

App as a mentor/guide

The theme 'app as a mentor/guide' was present in all five focus groups. Participants believed the app would provide instruction and knowledge on how to exercise correctly.

"I think it'll be useful in my life because… I'll go to the gym and I have this to do my warm-up… shows me what weights to do, you know, … Because when you go sometimes you just haven't a clue and you're kind of doing stuff and you could hurt yourself, you could overdo it, it's perfect, you know exactly what you're doing and… keeps you healthy" (FG1).

Feedback and monitoring on their progress while using the app was viewed as important to the participants. "It's important to get feedback" (FG5). Participants liked the idea of "keeping up on things as they're happening" (FG4) and expressed an interest in monitoring their progress on the app. "It would be kinda interesting watching what you're putting in and seeing the progress or the opposite " (FG4).

Participants also believed that the app would heighten awareness to exercise and provide motivation to exercise in the form of prompts/cues (e.g. push notifications). "Because, I mean first of all it would motivate you, and it would also give you correct information and guide you where you're going" (FG5). " I think we sit down a lot more than we realise, we drive a lot more that we realise, you know, I personally speaking and I think it would be sort of a wakeup call to me anyway. To actually see it in black and white " (FG4).

The code 'app as a tool' came under the theme 'app as a mentor/guide' as participants thought the app has a job/function to do and did not necessarily have to be fun. "It's good to have something there to support you but for me, personally it doesn't need to be fun. It just needs to do what it says on the box, as they say" (FG1). "No it's a tool…. It's there to do a job" (FG4).

The app would also motivate their family members to exercise having seen their family member use the app. Participants could see the benefit the app would have to the health of their family not just themselves. "I think it would benefit my own family. I have two teenage daughters that do like to sit down a lot when they're at home, so I think if they saw me using the app at home they'd probably, probably slag the hell out of me but they'd probably eventually come out and join in and do something" (FG2).
"Yeah. I would say the only thing to do would be to try and include the family, in the programme" (FG4).

Translation of activity from gym to home

Overall the majority of participants agreed that the app would create an option for people to exercise who are housebound or for those who for one reason or another can't make it to a structured exercise class.
"Well I bring Mary from Rush but I have my own business so sometimes I can't come and if I can't come well Mary would have her app on her phone and I'd have it myself where you'd get a few minutes in the day where you can exercise, as I said rather than just saying ah I can't go today I'll sit down and have a rest" (FG2).
"I'm living in Skerries, it's not a great job having to get in but if Bridget is gone off in the car well I have to take a bus so eh, well now that makes me think about it again, use that or a bus? I think that would come out first and I would find myself using it" (FG3).

Participants viewed the app as part of building a healthy lifestyle “Like I’d see this as part of building up a healthy lifestyle” (FG5). The app would work in conjunction with structured programmes, allowing for flexibility and planning, providing no excuse not to exercise. "It means I can do it at home and I don't feel like I'm slacking off" (FG1). Participants thought the app could be used in tandem with the gym/structured exercise classes. For the days that they don’t go to the gym, the app could be used instead in order to build up their activity to meet the guidelines.

"Yeah sure you can make the sessions here what happens if you don’t make the sessions here but you but you know you’ve a period in the day where you can exercise… now you know what you can do and even if you go into a gym you’re going to go in and do something without damaging yourself" (FG1).

"I would use it in tandem with the gym. I’d be more inclined to try and keep up with the gym but where I couldn’t do the gym, I would do it so. I might find that I got to the gym twice and use this once" (FG1).

Technology knowledge gap

Participants acknowledged that there is a generation gap when it comes to technology. Participants came from a generation where there were no smartphones and were therefore new to concept of smartphones and their use of them. In comparison it was acknowledged that today’s youth are familiar with technology and have little difficulty using smartphones. "And I mean that stuff is all so easy to the younger generation, even the seven year old granddaughter can use the bloody phone better than I can" (FG1).

"Well I think you see you have a generational problem, here like...You’re talking to people who weren’t brought up with smartphones and apps" (FG3).

One woman also pointed out that they are not part of the “throw away generation” (FG3). She described this as where the older generations are more cautions than young people in trying out new technology in fear that they make break it, whereas younger generations have no fear associated with technology. Older generations came from a time where there was limited use of technology in their working lives and therefore are not up to speed with current smartphone advances.

It was also said that there may be a ‘fear of the unknown’ associated with the use of apps on smartphones, as smartphones weren’t available as they grew up. "I'm totally illiterate with this stuff, I just… no matter how

many times I'm shown I can't do it" (FG1). "No no, well I'm just saying that like, I'm just anxious about it" (FG2).

However it was also acknowledged by a participant that smartphones are part of life and have multiple purposes. "The smartphone is part of my life. I look at football and everything on it" (FG5).

Summary

In summary participants responded well to the MedFit app and were positive towards its potential use by people to continue their cardiac rehabilitation following hospital based rehabilitation. However, four main themes were identified from the focus groups which would potentially impact participants' acceptance and ultimate use of the app. Figure 2 provides a summary of the key themes and subthemes found following the content analysis of the focus group transcriptions. In the following section a description of how the app content was modified based on these themes and the participants' usability feedback, as well as how the themes relate to the underpinning theory is detailed.

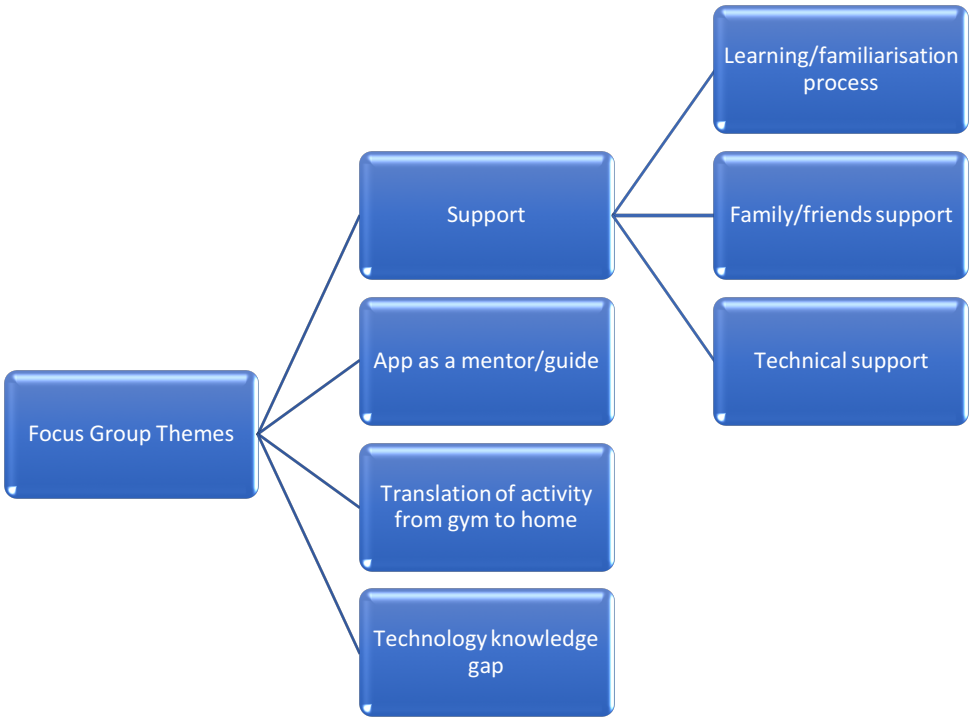

Figure 2: Summary of focus group themes and subthemes

Synthesis of app development procedure

Table 4 depicts the phases of intervention development and how the underpinning theory is related to the behaviour change techniques used, the focus group feedback, ultimately leading to the app content. The first column represents the constructs from the social cognitive theory, which have been mapped to the behaviour change wheel and behaviour change techniques. Feedback from the focus groups is then linked to the underpinning theory, culminating in the app components and content. Additional file 3 provides visual representations (i.e. screenshots) of the beta version of the app based on this development work.

Table 4: Development process of the MedFit App

Social Cognitive Theory	Behaviour change wheel- intervention Functions)	BCTs (code number and title of BCT)	Co-design feedback (focus group themes)	App content developed as a result of feedback and theory
Knowledge	Education, Training, enablement	4. Shaping Knowledge 4.1 Instruction on how to perform a behaviour 9. Comparison of outcomes 9.1 Credible source	Support: Technical Support, Technology knowledge gap App as a mentor/guide	○ **Healthy lifestyle** – Tips and recommendation on healthy lifestyle components. ○ **Exercise** – Video and teaching points are used to guide participants through each exercise. These have been developed with guidance from literature and instructors working in community based CR. ○ **Progress** – Feedback on activity level.
Perceived self-efficacy	Education, Training, Modelling	6. Comparison of behaviour 6.1 Demonstration of the behaviour 6.2 Social comparison 15. Self-belief 15.1 Verbal persuasion about capability 15.3 Focus on past success	App as a mentor/guide Support: Technical, family and friends, and the learning and familiarisation process	○ **Exercise -** Demos of exercises, tests and feedback on tests and activity performed. ○ **Social Interaction** – Provide support to participants by encouraging social interaction through the 'MedFit group'.
Outcome expectations	Education, training, persuasion, modelling.	5. Natural Consequences 5.1 Information about health consequences 5.6 Information about emotional consequences	App as a mentor/guide	○ **Healthy lifestyle** – Tips and recommendation on healthy lifestyle components. ○ **Notifications** – To help initiate and maintain the behaviour change.
Perceived facilitators/ impediments	Education, Training, Enablement, Environmental restructuring, persuasion	3. Social support 3.1 Social support (un-specified) 3.2 Social support (practical)	Translation of activity from gym to home	○ **Social interaction** - Provide support to participants by encouraging social interaction through the 'MedFit group'.

		3.3 Social support (emotional) 12. Antecedents 12.1 Restructuring the physical environment 12.2 Restructuring the social environment	Support: Technical, family and friends, and the learning and familiarisation process	○ **Contact us** – Technical support number and information. ○ **Exercise** – Ability to exercise anywhere and at any time.
Goals	Education, persuasion, training.	1. Goal setting and Planning, 1.1 Goal setting (behaviour), 1.2 Problem solving 1.3 Goal setting (outcome), 1.4 Action planning, 1.5 Review behaviour goal (s), 1.7 Review outcome goal (s), 2. Feedback and Monitoring, 2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour, 2.4 Self-monitoring of outcome (s) of behaviour , 2.6 Biofeedback, 2.7 Feedback on outcome (s) of behaviour, 7. Associations, 7.1 Prompts/ cues , 8.3 Habit formation, 8.7 Graded task	App as a mentor/guide	○ **Progress** – Individual, personalised goal given to get participant. Results and feedback provided on activity. ○ **Notifications** – to provide encouragement and support to users to reach their PA goal. ○ **Exercise** – Classes adapted based on person's ability and needs .

Discussion

This study describes the development of a mobile application for exercise rehabilitation, for adults with CVD in line with the mHealth Development and Evaluation Framework. The early stages of the formative research process, development and feasibility/piloting in line with the Medical Research Council's framework, were used to design this complex mHealth intervention. To develop the alpha version of the app the most appropriate theories we chosen to underpin the app, a systematic review was conducted to identify what BCTs to include in the app and the technical design team gave their feedback on the content and design of the app. This study predominantly focused on the gaining feedback on the alpha version of the app through focus group testing. This co-design process was crucial to the user validation of the app.

The creation of eHealth technologies is often led by a technology-driven approach as opposed to the user-centred approach. To date a large proportion of mHealth technologies are designed on the basis of health system constructs which may potentially not be as effective as development which involves end users in the design process [36]. Furthermore, technical design teams often base their ideas on assumptions that are not validated by end user needs and wants [37]. Studies have shown that the full potential of eHealth and mHealth technologies can only be exploited when developed by a multi-disciplinary team who apply a human-centred co-design approach with the specific context of the technology's use in mind [38][39]. This user-centred design approach plays a key role achieving user engagement which in turn can improve the likelihood that the intervention will be effective [37].

With this in mind, the research team aimed to develop a theoretically informed app with potential cardiac patients at the heart of the design. This design process was undertaken by a multi-disciplinary team of health psychologists, physical activity specialists and technology specialists. The team used a novel approach to application development whereby health behaviour change theory and the unified theory of acceptance and use of technology (UTAUT2) was used to guide app development, with the patient voice at the heart of the mobile applications development.

Some interesting themes emerged from the focus groups. Support appeared to be a critical theme to participant's acceptance and use of the app. Support was split into three subthemes, learning/familiarisation process, family/friends support and technical support. Participants explained how came from a generation that did not use technology and would therefore need technical support and training on how to use the app. This tied into the theme of 'technology knowledge gap' as the participants were not overly familiar with smartphones and particularly mobile apps. However, participants expressed a willingness to learn how to use the app as long as they had the availability of technical support. A user guide as well as a contact number for support were suggested methods of technical support by the groups. This need for technical support for older adults using new technologies is in line with findings from previous research [40][41]. Older adults may need face-to face training as well as a written manual when learning how to use new technology [42]. It may also be helpful to provide use cases and scenario analysis when teaching older adults to use technology [43].

Overall participants believed they would receive support/encouragement to use the app from family/friends. A lack of support may increase feelings of complication and anxiety and decrease the likelihood of using the technology [44]. Social support is therefore an important factor to consider when developing mobile applications. The fact that participants believed that they would receive support to use the MedFit app is a positive finding.

The app was viewed as a mentor/guide providing instruction and on the exercise. The availability of personalised feedback and monitoring was viewed as a major positive to participants. This finding is in line with a review of smartphone applications for promoting physical activity conducted by Coughlin and colleagues (2016) which found that participants preferred apps that coach and motivate them and provide tailored feedback toward personalised goals [45]. Additionally, the MedFit app allowed for the 'translation activity from gym to home' because it can be used anytime and anywhere. Participants viewed this flexibility as another benefit to the app.

This feedback was translated into feasible technical improvements through close collaboration with the technical team, who adapted and made modifications to the app based on this co-design process. The feedback was then linked to the underlying behaviour change theory and techniques to create theory driven, user

centered content.

In relation to the mechanisms of behaviour change, it is important to use theory to inform intervention design and to specify the BCTs are used [46]. It has been well documented that behaviour change interventions are poorly described in accurate and sufficient detail for readers to truly understand, evaluate and/or replicate the intervention reported [47] Many mHealth cardiac rehabilitation studies to not specifically address the behaviour change strategies in their design [48]. This was reiterated in our systematic review whereby only two studies specifically mentioned the BCTs included in their interventions. However, neither study gave a full account of the BCTs used in their studies and how these were linked to the intervention components. It is also apparent that interventions based on behaviour change theory are more effective than those lacking a theoretical basis [49][50]. Armed with this knowledge, we aimed to describe in detail the active ingredients of our intervention, so that the applications development was easy to understand, evaluate and replicate for future research.

Strengths and Limitations

A key strength of this study was the development of the app in line with the mHealth development and evaluation process and the MRC's formative research process. These provided a best practice and systematic process to developing an mHealth intervention. Furthermore the inclusion of potential end-users in the development and design process was a huge strength to this study. Incorporating the needs and wants of users ensured that app was designed specifically for adults with cardiovascular disease, increasing the likelihood of adherence to the app.

A potential limitation to this study was the fact that the findings from the focus group are not generalizable to the wider public, as these were the thoughts and responses of a small sub-sample of community based cardiac rehabilitations participants. The findings do however provide potential strategies and guidance to enhance the likelihood that cardiac rehabilitation mHealth interventions will be engaging to end-users. Another limitation of the study was the difficulty we had recruiting women to take part in the focus groups (65% male). However it must be noted that this does reflect the fact that women are significantly less likely to participate in and complete CR [51]. This is reflective of the population we had to recruit from the cardiac rehabilitation programme in DCU, hence why we had a larger number of men than women involved in the study.

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Conflicts of Interest

None declared.

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ACCEPTABILITY OF MOBILE PHONE APPLICATIONS AMONG ADULTS WITH CHRONIC ILLNESS

Questionnaire

Instructions:

1) Please answer ALL questions in ALL sections.
2) Completion of this form will take 5-10 minutes.
3) The contents of this questionnaire will be kept strictly confidential.

Demographic Profile:

- Name: _____
- Date of Birth: _____
- Gender (Please circle appropriately): Male/Female
- How long have you been attending MedEx? (Please tick one box only)

☐ 0-1 month ☐ 2-5 months ☐ 6months - 1 year ☐ 1-3 years ☐ 3+ years

Tablet Computer and Smartphone:

Q1. Do you have a tablet computer e.g. Apple iPad, Kindle etc.? (A tablet is a wireless, portable personal computer with a touch screen interface. A tablet is typically smaller than a notebook computer but larger than a smartphone.)

Please circle ONE answer only

Yes No

Q2. Do you have a smartphone e.g., Samsung galaxy, iPhone etc.? (Smartphones allow you access the internet, apps, etc.)

Please circle ONE answer only

Yes No

Q3. If yes, is it an:

O Android phone
O iPhone (i.e. Apple iPhone)
O Other Smartphone: Please list _____

Q4. Do you use mobile applications (apps) on your smartphone e.g. Gmail, YouTube, Facebook? (A mobile app is a software application developed specifically for use on smartphones and tablets. To access an app you download it from an app store and click on the icon e.g. Gmail)

Please circle ONE answer only

Yes No

Section A: UTAUT 2

This section is seeking your opinion regarding the importance of mobile applications (apps) e.g. Skype, WhatsApp, Twitter. Respondents are asked to indicate the extent to which they agreed or disagreed to the following statements using the 7 Likert scale [(1) = strongly disagree; (2) =disagree; (3) = somewhat disagree; (4) = neutral; (5) = somewhat agree; (6) agree; (7) = strongly agree] response framework.

Please circle one number per line to indicate the extent to which you agree or disagree with the following statements.

No	Questions	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
PE	**Performance Expectancy**							
PE1	I would find mobile apps useful in my daily life.	1	2	3	4	5	6	7
PE2	Using mobile apps would help me to accomplish things more quickly.	1	2	3	4	5	6	7
PE3	Using mobile apps would increase my productivity.	1	2	3	4	5	6	7

No	Questions	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
EE	**Effort Expectancy**							
EE1	Learning how to use mobile apps would be easy for me.	1	2	3	4	5	6	7
EE2	My interaction with mobile apps would be clear & understandable.	1	2	3	4	5	6	7
EE3	I would find mobile apps easy to use.	1	2	3	4	5	6	7
EE4	It would be easy for me to become skillful at using mobile apps.	1	2	3	4	5	6	7

No	Questions	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
SI	**Social Influence**							
SI1	People who are important to me think that I should use mobile apps.	1	2	3	4	5	6	7
SI2	People who influence my behaviour think I should use mobile apps.	1	2	3	4	5	6	7
SI3	People whose opinions that I value prefer that I use mobile apps.	1	2	3	4	5	6	7

No	Questions	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
FC	**Facilitating Conditions**							
FC1	I would have the resources necessary to use mobile apps.	1	2	3	4	5	6	7
FC2	I would have the knowledge necessary to use mobile apps.	1	2	3	4	5	6	7
FC3	Mobile apps would be compatible with other technologies I use.	1	2	3	4	5	6	7
FC4	I would get help from others when I have difficulties using mobile apps.	1	2	3	4	5	6	7

No	Questions	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
HM	**Hedonic Motivation**							
HM1	Using mobile apps would be fun.	1	2	3	4	5	6	7
HM2	Using mobile apps would be enjoyable.	1	2	3	4	5	6	7
HM3	Using mobile apps would be very entertaining.	1	2	3	4	5	6	7

No	Questions	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
PV	**Price Value**							
PV1	Mobile apps are reasonably priced.	1	2	3	4	5	6	7
PV2	Mobile apps are good value for money.	1	2	3	4	5	6	7
PV3	At the current price, mobile apps provide a good value.	1	2	3	4	5	6	7

No	Questions	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
HT	**Habit**							
HT1	The use of mobile apps would become a habit for me.	1	2	3	4	5	6	7
HT2	I would become addicted to using mobile apps.	1	2	3	4	5	6	7
HT3	I must use mobile apps.	1	2	3	4	5	6	7

Section B: Behavioural Intention

This section is seeking your opinion regarding the importance of mobile applications (apps). Respondents are asked to indicate the extent to which they agree or disagree to the following statements using the 7 Likert scale [(1) = strongly disagree; (2) =disagree; (3) = somewhat disagree; (4) = neutral; (5) = somewhat agree; (6) agree; (7) = strongly agree] response framework.

Please circle one number per line to indicate the extent to which you agree or disagree with the following statements.

No	Questions	Strongly disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
BI	**Behavioural Intention**							
BI1	I intend to continue using mobile apps in the future.	1	2	3	4	5	6	7
BI2	I will always try to use mobile apps in my daily life.	1	2	3	4	5	6	7
BI3	I plan to continue to use mobile apps frequently.	1	2	3	4	5	6	7

- Would you be interested in participating in follow up focus groups? If yes, please provide a contact number.

  O Yes Contact Number: _____
  O No

Thank you very much for taking part.

Should you have any further questions or if you would like to withdraw from the study, please do not hesitate to contact the researcher.
Orlaith Duff: 01-7007653

Focus Group Script

- Run with 5-6 people of mix gender and ages
- No more than 2 hours long with 10 minute a tea/coffee break in between
- Introductions (Hello and welcome, as you are aware this is a session to provide feedback on MedFit, a mobile app for cardiovascular rehabilitation)
- Explain how the focus group will work

Usability Section

FitBit

- Show participants the FitBit and its charger. Have the FitBit charged in advance so that they can see the different features of the FitBit.
- Ask participants to try the FitBit on to see what they think of it.
- Feedback screen – What would be the top three pieces of information shown on the screen e.g. heart rate, step count, flights of stairs climbed?

App name: Does anyone have any suggestions for the name of the app? MedFit is currently the demo name.

App components

Log in screen

- Show the participants the app login in screen.
- Are the visuals appealing and easy to interpret?
- Explain to participants that the initial setup will be on a laptop for security purposes and that they will then be given a login and password to access the app.
- Ask participants do they would find the process of typing in their login and password. Would it be easy? If not, what would be difficult about setting up an account?

Home page

- The home page includes the sections, exercise, progress and my healthy lifestyle. What do participants think of the home screen? Does it look too busy or is it laid out clearly?
- Can the participants decipher what is in each section before clicking into them? i.e. is the name of each section self-explanatory?

Exercise

- Explain the format of the exercise programme i.e. warm up, main phase, cool down and stretching and show the participants videos of how to do the exercises.
- Explain how each exercise is counted down i.e. 30 seconds
- Ask the participants - What do you think about this? What do you like? What do you not like? What would you change? Any other comments?
- Test yourself – explain the 6 minute walk test and sit to stand test. (Don't clink into each – just explain that the test are similar to those completed in MedEx)*What do you think about this? What do you like? What do you not like? What would you change? Any other comments?*
- How do you think you would follow the exercises? Where would you place the phone? (Deirdre demo the exercises)

Progress

- Facilitator to show the participants feedback visualisation on the big screen to get feedback and goes through each piece of feedback on the dashboard systematically.

My Exercise Statistics

- My Activity bar chart (active mins per day): do you understand the information? Is there anything else you would like to see here? Any other comments? Anything you would change?
- Daily step count (progress bar indicates how many steps you have taken from 0 to 10,000): do you understand the information? Is there anything else you would like to see here? Any other comments? Anything you would change?
- Daily Heart Rate Information (average HR): do you understand the information? Is there anything else you would like to see here? Any other comments? Anything you would change?
- Weekly exercise goal: This is a prescribed goal which you can alter, which could potentially be based on step count and/or exercise sessions on the app. What do you think of this idea?
- Weekly exercise goal: In terms of the visuals on the screen, do you understand the information? Is there anything else you would like to see here? Any other comments? Anything you would change?
- Weekly workout time (hours and minutes): do you understand the information? Is there anything else you would like to see here? Any other comments? Anything you would change?
- Total exercise sessions: do you understand the information? Is there anything else you would like to see here? Any other comments? Anything you would change?

My Group's Exercise -> Found by clicking on the burger menu on the top right hand corner

- Group exercise duration: do you understand the information? Is there anything else you would like to see here? Any other comments? Anything you would change?
- Group attendance (sessions): do you understand the information? Is there anything else you would like to see here? Any other comments? Anything you would change?

Feedback Notifications: Go through handout

- Go through the examples of the rules
- What do you think of the idea of getting messages based on your progress/feedback and/or messages providing tips and recommendations during the week? Which would you be in favour of (i.e. progress or tips) and why? Would you like a combination on both types of messages? Any other comments?

My Healthy Lifestyle

- Show the screens for the health behaviours. Each section (e.g. physical activity) has recommendations and tips, as well as peer mentor videos and ask the expert videos. It could potentially have links to other relevant sources e.g. websites. What do you these ideas? Would you use this function? What do you like about it? What do you not like about it? What would you change about it?
- In terms of the peer mentor/ ask the expert videos: Would you watch them? What do you like about them? What do you not like about them? Would you use them as well as the text content? Instead of? Do they have any advantages/disadvantage above the text content?

Questionnaires

- Show the participants the example questionnaire on the iPad and how it will be filled in. What do you this of this? Do you think it would be easy/ difficult to answer the questions on a phone? Why or why not?

My MedFit Group

- Show the participants what is envisaged as part of this section i.e. events, message board, leader board.
- How would you expect to interact with other participants using mPATHway, if at all? What would you like about it? What would you not like about it?
- There will be an *events page* which will list local and national physical activity events. What do you think of this idea? Would you use this function? What do you like about it? What do you not like about it? What would you change about it?
- *Message board/chat function*? Explain briefly what we imagine the available social interaction features to be. Show an example of 'boards.ie'. What do you think of this

concept? Would you use this function? What do you like about it? What do you not like about it? What would you change about it?

- *Sample of Leader board* – Explain the concept of a leader board. Participants would be able to see the physical activity minutes/ step count of other users. Are there any other suggestions about what could be shown on a leader board?
- Would users be willing to have their name on a leader board or would you prefer to have an anonymous leader board with nicknames or I.D.'s for example?
- What do you think of the leader board? Would you use it? *What do you like? What do you not like? What would you change? Any other comments?*

Contact us

- Explain what is envisaged in this section e.g. video tutorials on how to navigate through the app and a section of frequently asked questions
- What do you think of this idea? Is there anything else you would like to see in this section? What do you like? What do you not like? What would you change? Any other comments?

Acceptance and use questions based on the UTAUT2

Performance Expectancy
1. Do you think you would find this app useful in your daily life? Why do you think that? If not, what do you think would make the app more useful?
2. Do you think this app would help you achieve the goals you set out in cardiac rehabilitation more efficiently? In what way do you think it will/will not help?
3. Do you think you would be more productive if you had this app to help you with your cardiac rehabilitation? Why do you think that?

Effort Expectancy
1. Do you think you would find learning to use this app easy? Why/ what parts of the application do you think make the app easy to use? If not, what could we do to make the app easier to use?
2. Do you think your interaction with this app would be clear and understandable? If not, what could we do to ensure that you could clearly understand and use the app?
3. In its current form do you think this app would be easy to use? If yes, what in particular makes it easy to use? If no, what suggestions/ feedback could you provide us with to make the app easier to use?
4. Do you think you could become skillful at using this app? Do you think it would take long to be able to understand and work the app properly yourself? Is there anything we could do that would help you to become skillful at using the app?

Social Influence
1. Do you think your family and friends would encourage you to use this app?
2. Why do you think they would encourage you to use the app? / Why would they not encourage you to use the app?
3. How could we make the app more appealing to your family and friends?
4. Is it important to you that your family/friends encourage you to use the app?

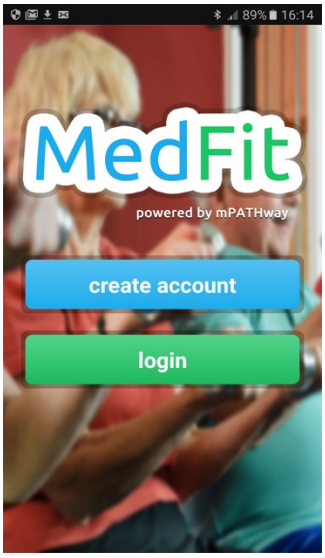
Facilitating Conditions
1. Do you think you have the resources necessary to use the app? E.g. money, time skill etc. If not, is there anything that could be done to facilitate easy use of the app?
2. Would you have the necessary knowledge to use the app? If not would you need detailed instructions on how to use the app e.g. instruction manual/ video tutorial?
3. Would the app be compatible with other technologies you use?

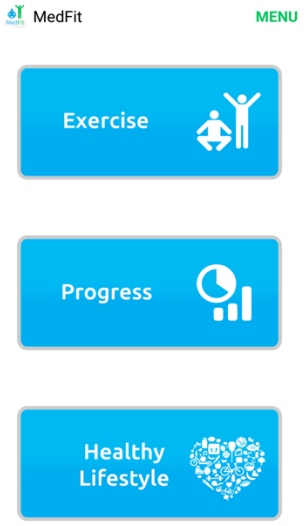
4. If you had difficulty using the app would you get help from family or friends? Do you think you would need IT support from our team in case you have a problem using the app? What form do you think this IT support should come in? (e.g. phone number for support) When should the IT support be available? (e.g. 9am-5pm Mon-Fri)

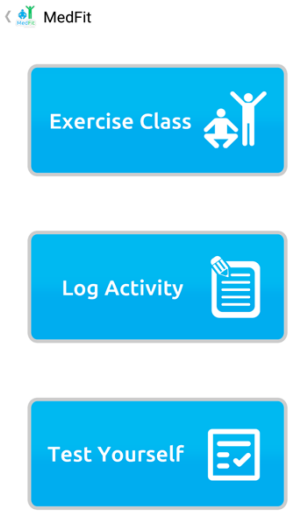
Hedonic Motivation
1. Do you think it would be fun/enjoyable/entertaining to use the app? Why/Why not? Is there anything that would make the app more enjoyable to use?

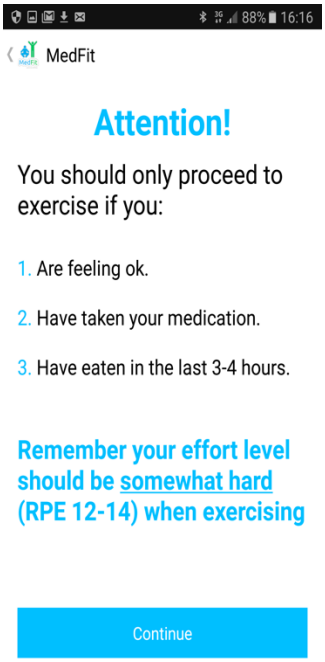
Behavioural Intention
1. Could you see yourself using the app regularly? Why/Why not?
2. Do you think you would try to use the app in your daily life? Is there anything that could be added/changed to make the app more appealing to use regularly?

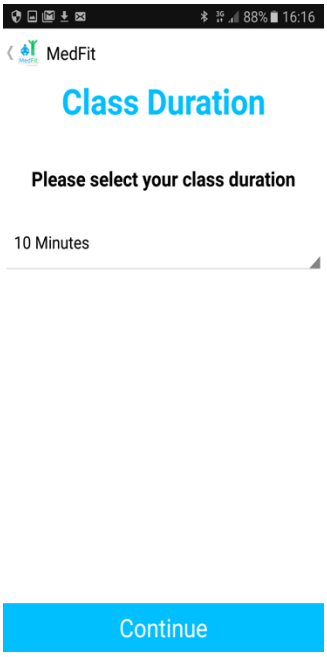
Additional file 3: MedFit App Screenshots

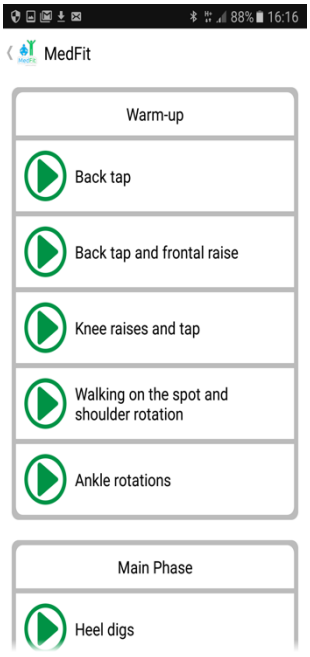


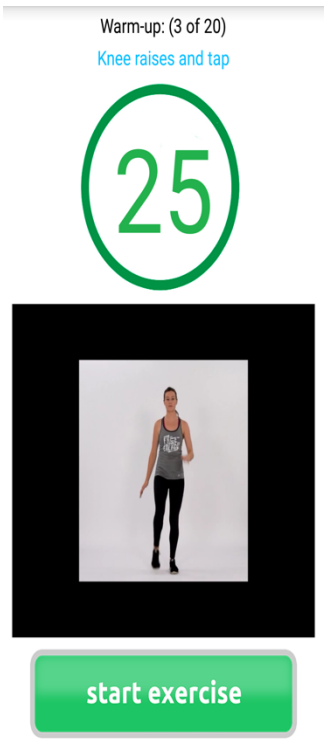


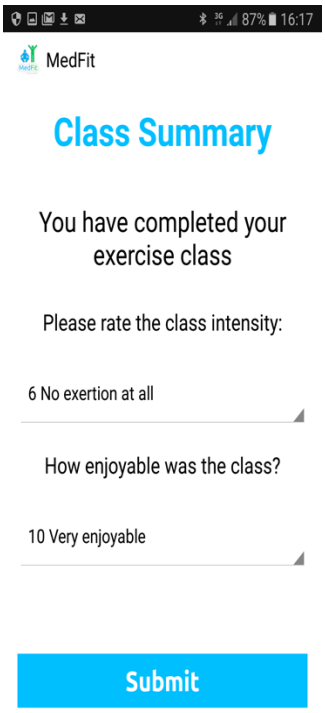


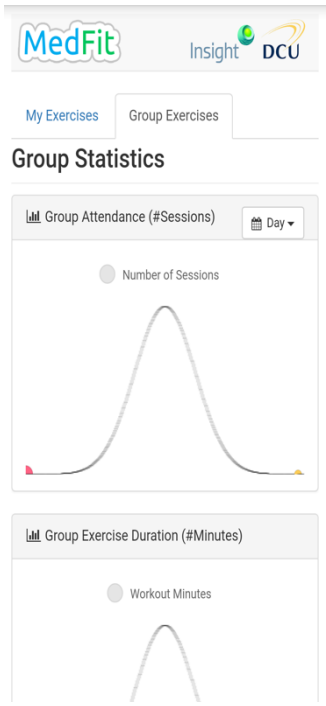


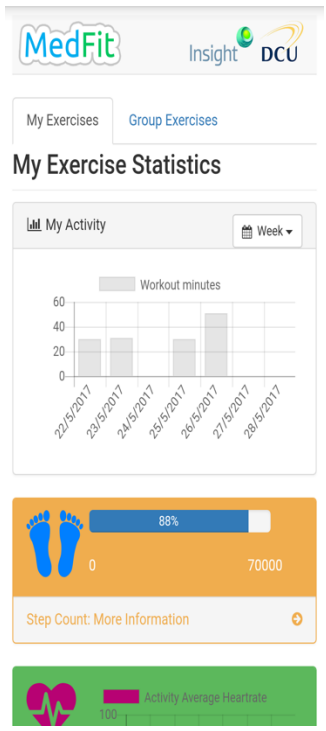


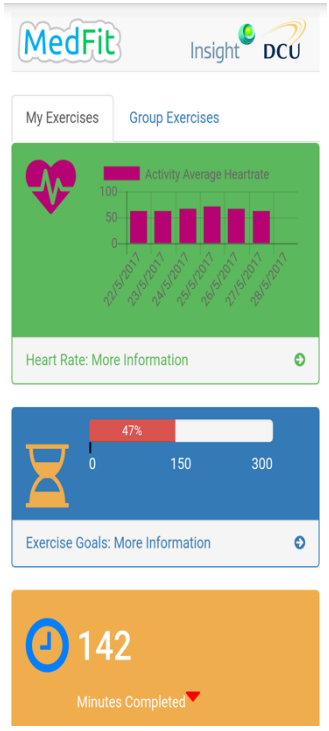


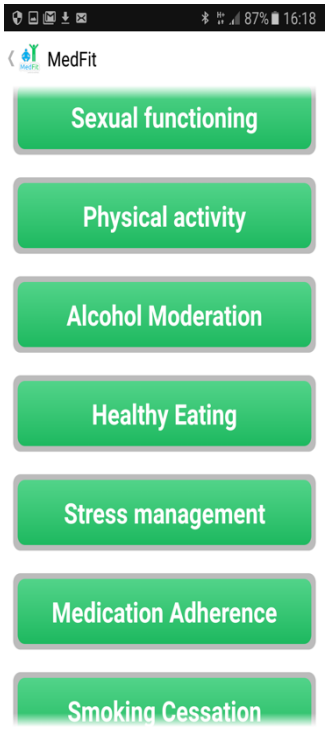

Warm-up: (3 of 20)
Knee raises and tap
25
start exercise


MedFit
Class Summary
You have completed your exercise class
Please rate the class intensity:
6 No exertion at all
How enjoyable was the class?
10 Very enjoyable
Submit


MedFit
Insight DCU
My Exercises
Group Exercises
Group Statistics
Group Attendance (#Sessions)
Day
Number of Sessions
Group Exercise Duration (#Minutes)
Workout Minutes


MedFit
Insight DCU
My Exercises
Group Exercises
My Exercise Statistics
My Activity
Week
Workout minutes
60
40
20
0
22/5/2017
23/5/2017
24/5/2017
25/5/2017
26/5/2017
27/5/2017
28/5/2017
88%
0
70000
Step Count: More Information
Activity Average Heartrate
100


MedFit
Insight DCU
My Exercises
Group Exercises
Activity Average Heartrate
100
50
0
22/5/2017
23/5/2017
24/5/2017
25/5/2017
26/5/2017
27/5/2017
28/5/2017
Heart Rate: More Information
47%
0
150
300
Exercise Goals: More Information
142
Minutes Completed


MedFit
Sexual functioning
Physical activity
Alcohol Moderation
Healthy Eating
Stress management
Medication Adherence
Smoking Cessation

Physical Activity

Being active helps keep your heart healthy.

You're in control – by taking ten minutes a few times a day to get active, you could change your life.

Being active helps lower your risk of a secondary cardiac event because it:

- Exercises your heart, helping to keep it strong.
- Helps lower your cholesterol: a fatty substance in your blood which can cause your arteries to clog up.
- Helps lower your blood pressure, which means your arteries are less likely to clog up.

Medication Adherence

Medicines are taken to help keep your symptoms under control or to prevent or treat a heart condition.

Understanding your medication:

It's important to know what you're taking, why you are taking it, and how it will affect you.

When you're given a new prescription, speak to your doctor about:

- the medication prescribed for you and its potential benefits and risks
- how to take it safely
- possible side effects and what to do if you

Sexual Functioning

Sexual activity is a major quality of life issue for men and women with cardiovascular disease and their partners.

Men and women with stable cardiovascular disease who have no or minimal symptoms during routine activities can engage in sexual activity.

People with unstable cardiovascular disease or whose symptoms are severe, should be treated and stabilized before having sex.

What you need to know according to the American Heart Association:

- Ask your doctor to evaluate you before resuming sexual activity.

Healthy Eating

Even if you already have a heart condition, a healthy diet can benefit your heart. You should aim for a well-balanced diet. The best way to understand a well-balanced diet is to think of foods in food groups.

Try to eat:

- plenty of fruit and vegtables.
- Plenty of starchy foods such as bread, rice, potatoes and pasta. Choose wholegrain varieties wherever possible.
- some milk and dairy products.
- some meat, fish, eggs, beans and other non-dairy sources of protein.