Examination of adherence to a community-based chronic illness exercise programme and the development and feasibility evaluation of a multi-component intervention

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PhD

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Submitted for the award of PhD

Dublin City University

School of Health and Human Performance

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Authors Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor of Philosophy is entirely my own work, that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

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And finally, to all the participants I have seen come and unfortunately go, over the previous 6 years; this work is not only for you, it was enabled by you. Seeing some of the benefits the programme has brought to many participants, I now call friends, makes the work worthwhile and has added value to this journey for me.

Peer reviewed material from this thesis

As part of this research journey I have presented the following work at national and international conferences as oral presentations, moderated poster sessions and non-moderated poster sessions.

Oral Presentations

1. **O'Leary, E**., McCaffrey, N., Doyle, F., Furlong, B. and Woods, C. Optimising initiation, attendance and retention to a Community–based Chronic Illness Rehabilitation Programme. 22nd Annual Health Promotion Conference, *7th June 2018, Galway, Ireland.*
2. **O'Leary, E**., McCaffrey, N., Doyle, F., Furlong, B. and Woods, C. Optimising initiation, attendance and retention to a Community–based Chronic Illness Rehabilitation Programme. Faculty of Sport and Exercise Medicine Annual Conference, 15th *September 2017, Dublin Ireland.*
3. **O'Leary, E**., McCaffrey, N., Doyle, F., Furlong, B. and Woods, C. Factors associated with attendance at a Community-based Chronic Illness Rehabilitation Programme. 14th Annual Psychology, Health and Medicine Conference, *3rd March, 2017 Dublin Ireland.*
4. **O'Leary, E.,** McCaffrey, N., Doyle, F., Furlong, B. and Woods, C. Initiation to a Community-based Chronic Illness Rehabilitation Programme in men and women: MedEx Wellness**.** Health Enhancing Physical Activity Annual Conference, 28 *September 2016, Belfast, Northern Ireland, United Kingdom.*
5. **O'Leary, E.,** McCaffrey, N., Doyle, F., Furlong, B. and Woods, C. Factors associated with attendance and retention at a Community-based Chronic Illness Rehabilitation

Programme MedEx Wellness**.** 14th Annual Psychology, Health & Medicine Conference, 3rd March *2017, Dublin, Ireland.*

6. **O'Leary, E.,** McCaffrey, N., Doyle, F., Furlong, B. and Woods, C. Correlates of Uptake to a Community-based Chronic Illness Rehabilitation Programme: MedEx Wellness. Faculty of Sports and Exercise Medicine Spring Study Day, 20 *April 2016, Dublin, Ireland.*
7. **O'Leary, E.,** McCaffrey, N., Doyle, F., Furlong, B. and Woods, C. Patterns of adherence and dropout in a Community-based Chronic Illness Rehabilitation Programme. Age Friendly University Conference, *November 2015, Dublin, Ireland.*
8. **O'Leary, E**., McCaffrey, N., Doyle, F. and Woods, C. Who is most likely to attend a community-based cardiac rehabilitation programme? An observational study of HeartSmart Participants from 2006 to 2013. *All-Ireland Postgraduate Conference in Sport Sciences and Physical Education 24-Jan-2014, Limerick, Ireland.*

Poster Presentations

1. **O'Leary, E.,** McCaffrey, N., Doyle, F., Furlong, B. and Woods, C. Depressive symptoms and perceived wellness as factors associated with attendance in a community-based chronic illness rehabilitation programme: MedEx Wellness**.** International congress on physical activity and health. *16-19 November 2016, Bangkok, Thailand.*
2. **O'Leary, E.,** McCaffrey, N., Doyle, F., Furlong, B. and Woods, C. Proxy versus self-efficacy in a Community-based Chronic Illness Rehabilitation Programme: MedEx Wellness**.** Health Enhancing Physical Activity Annual Conference, 28 *September 2016, Belfast, Northern Ireland, United Kingdom.*

3. **O'Leary, E.,** McCaffrey, N., Doyle, F. and Woods, C. Adherence trends in a community-based phase IV cardiac rehabilitation programme: MedEx Wellness**.** *BACPR October 2015, Manchester UK.*
4. **O'Leary, E.,** McCaffrey, N., Doyle, F. and Woods, C. An examination of factors associated with uptake to a community-based chronic illness rehabilitation programme: Preliminary findings. *ISBNPA June 2015, Edinburgh, UK.*
5. **O'Leary, E.,** McCaffrey, N., Doyle, F., Furlong, B. and Woods, C. An examination of factors associated with adherence to a community-based chronic illness rehabilitation programme: Study methodology, questionnaire design and success to date**.** *5th Conference of HEPA Europe 28-Aug-2014, Zurich, Switzerland.*
6. **O'Leary, E.,** McCaffrey, N., Doyle, F. and Woods, C. An examination in to factors pertinent to long term adherence to a community-based chronic illness programme**.** *BACPR October 2014, Derry, UK.*

Progressive development as a researcher

The late esteemed epidemiologist Professor Geoffrey Rose spoke of the need for "a clean mind and dirty hands" (Coggon, Rose, & Barker, 2003). He made this comment in reference to fellow epidemiologists, however this holds true for behavioural epidemiology and other fields of research. This speaks volumes to me as a researcher about the journey from commencement to completion of my PhD thesis.

I developed a passion and interest in health research in my 4th and final year of my BSc. in Sport Science and Health (Dublin City University). This pursuit of research and the passion for health behaviour inspired me to undertake a MSc. in the University of Ulster, Jordanstown, in Health Promotion and Population Health. Through these pursuits, I developed my capacity and knowledge further as a researcher and health behaviour change specialist. Personally, for me, that was a "clean mind".

Following on from this, I undertook further study in Dublin City University as an applied PhD Candidate. This provided me with the opportunity to get "dirty hands" and further build this "clear mind" in terms of my education and pursuit of this PhD thesis. This "dirty hands" concept could appropriately link with the need for real life applications in which so much of this research was embedded. This applied role has given me a greater appreciation and value for the practical aspects of implementation of evidence-based practice, and behaviour change and a greater insight in the field of translational science and practice.

I am finishing this journey more passionate about bringing about positive change than I ever could have imagined when I started.

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List of Abbreviations

BS	BreatheSmart
BMI	Body Mass Index
CCEP	Community-based chronic-illness exercise-based programme
CIG	Chronic illness group
DCU	Dublin City University
DHS	DiabetesHealthSteps
GP	General Practitioner
HPA	Habitual physical activity
HS	HeartSmart
HSU	Health service usage
ISWT	Incremental shuttle walk test
IPAQ	International Physical Activity Questionnaire
SS	SmartSteps
MET	Metabolic equivalent
MVPA	Moderate to vigorous physical activity
NCD	Non communicable disease
TILDA	The Irish Longitudinal Study on Aging
WHO	World Health Organisation
6MTT	Six minute time trial
LIPA	Light intensity physical activity
VPA	Vigorous intensity physical activity

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Abstract

Background: Community-based multi-chronic illness exercise programmes provide a resource efficient way to assist with the treatment/management of chronic illness. Despite the well-documented benefits of participation in community-based chronic illness exercise programmes (CCEP), adherence remains sub-optimal with positive effects of such programmes relying on optimal adherence. Difficulty remains in interpreting rates of adherence and correlates due to programme heterogeneity. Given the health benefits to be gained from regular attendance, empirically based interventions and strategies to optimise adherence are warranted. The purpose of this thesis was to i) identify rates of initiation, attendance and retention and to identify factors associated with adherence to a CCEP and ii) design, implement and evaluate the feasibility of an intervention aimed at optimising adherence.

Methods: Individuals with chronic illness were referred to a CCEP by health professionals. Study 1 (n=381) was a prospective study encompassing cross-sectional and prospective analysis designs to identify the rates and correlates of adherence. Primary statistical analysis included independent samples t-tests, bivariate correlations, logistic regression and negative binomial regression. An intervention based on Study 1 and the existing evidence base was designed and developed using the behaviour change wheel. Study 2 (n=295) was a feasibility study of a behaviour change intervention aimed at optimising adherence rates (composed of intervention at baseline, week-4 and 12). Study 2 also utilised a quasi-experimental research design to compare trends in rates of adherence over 24 weeks between those receiving the intervention and those not.

Results: *Study 1:* The initiation rate was 73% and the mean number of sessions attended in the 24-weeks was 11. Bivariate analysis identified intentions, self-efficacy and BMI as correlates of initiation. Following adjusted analysis, the associations were no longer statistically significant. Further bivariate analysis indicated chronic illness group, distance to facility, intentions, self-efficacy for exercise and attendance in the first 4 weeks as correlates of 24-week attendance. In an adjusted analysis, age and distance to facility were the only as predictors of attendance. The first 4 weeks' attendance when added to the previous models was the only independent predictor of 24-week attendance.

Study 2: A theoretically informed behaviour change intervention was designed utilising the behaviour change wheel. The intervention was evaluated in terms of its feasibility, and with only 25.6% of participants attending all component of the intervention as planned it is deemed not feasible in its current form. The intervention was also evaluated using intention to treat and per-protocol analysis and using an intention to treat analysis trends indicate that retention was greater in the Intervention than the Standard group. There was no difference in initiation or attendance between the Intervention and Standard group. Per-protocol analysis found trends toward improvements in initiation (96% vs 73.2%,), attendance (mean $\pm$ SD) (22.22 ±12.59 vs 11.13±12.42) and retention (56.3% vs 28.7%) in the Intervention compared to the Standard group.

Conclusion: Bivariate correlates of adherence to a CCEP are diverse, with early stage attendance the strongest predictor of 24-week attendance. The inclusion of a

theoretically informed behaviour change intervention can improve adherence in those who attend all components of the intervention, however, the intervention did not prove feasible. Further research should identify correlates of adherence to CCEP to inform the design and implementation of interventions to optimise physical and mental health in men and women with chronic illness.

Chapter 1

Introduction

1.1 Background

Major chronic illnesses including cardiovascular diseases, diabetes, cancer and chronic respiratory diseases account for 70% of the deaths globally (WHO, 2017) and an estimated 77% of the disease burden in Europe (WHO, 2017). According to the World Health Organisation (WHO), mortality as a result of chronic illnesses remains unacceptably high (WHO, 2014). Dealing with the complex needs of patients with chronic illness has been acknowledged as one of the greatest challenges facing healthcare systems globally (Darker et al., 2015).

Increases in levels of physical inactivity can lead to devastating physiological and clinical consequences as evidenced by the fact that it is the fourth leading risk factor for global mortality (WHO, 2009). Conversely, the impact of physical activity, on human health is profound and unequivocal (WHO, 2009). Studies have consistently found a graded inverse dose response relationship between increased physical activity levels and a reduction in relative risk of all-cause mortality (Kokkinos, 2012; Lee & Paffenbarger, 2000). There are exceptionally few chronic diseases, in which the burden of the disease, comorbidities related to the disease, or the disease-related quality of life are not improved with physical activity (American College of Sports Medicine., 2016).

Hospital and health service exercise rehabilitation programmes are in existence with strong evidence underpinning their benefits (Anderson et al., 2016; McCarthy et al., 2015). In recent times, there has been a push toward the community setting for the delivery of sustainable exercise programmes for stable patients with one or more chronic diseases (Costa Da Silva et al., 2017; Desveaux, Beauchamp, Goldstein, & Brooks,

2014; Weinrich, Stuart, & Benvenuti, 2014). The health benefits associated with chronic illness exercise programmes are largely related to levels of adherence (Murphy et al., 2012). Rates of adherence to community-based exercise programmes for chronic illness vary and are difficult to interpret and compare due programme heterogeneity. However, it appears that both initiation (Keck & Budde, 1999) and subsequent adherence to community-based exercise programmes for chronic illness programmes is suboptimal (Cockram, Cecins, & Jenkins, 2006; Costa Da Silva et al., 2017; Harwood, Smith, Cayton, Broadbent, & Chetter, 2016). Given the benefits that are attainable with optimal adherence and the current rates of sub-optimal adherence, interventions to improve initiation and adherence are warranted. Prior to the development of interventions, factors influencing the adherence needs to be understood. Relatively few published studies have examined interventions with the aim of improving adherence to community-based chronic illness exercise programmes.

1.2 MedEx Wellness-The working model and research setting

MedEx Wellness is a user pay community-based chronic illness exercise programme (CCEP) located in a third level educational institution and represents a community setting. It is novel in its scale and concept and is the working model of exercise-based chronic illness rehabilitation referred to in this thesis. Established in 2006, the primary mission of MedEx Wellness is to transform the lives of people with chronic illness through physical-activity based rehabilitation. The programme works on a partnership approach between members of academic staff and the sports services in the institution. The sports facilities are utilised at non-peak times and the service is

delivered by trained personnel from the sports centre along with academic staff, graduate and undergraduate students.

Starting with an initial intake of cardiac rehabilitation patients, the programme has evolved and grown to approximately 700 patient visits per week and includes patients with pulmonary disease, peripheral arterial disease and type 2 diabetes. Individuals with chronic illness are referred to MedEx by hospital specialists (and their teams) and general practitioners. The CCEP boasts a strong and steady referral base, with approximately 40 new referrals every month. Under the MedEx umbrella there are programmes based on each participant's primary health-related condition. For the purpose of this research the focus is on the following programmes;

- **HeartSmart;** An exercise-based phase IV cardiac rehabilitation programme for those with cardiac related chronic illnesses
- **BreatheSmart**: An exercise-based version of pulmonary rehabilitation for those referred to the community setting
- **SmartSteps**: An exercise-based peripheral vascular disease exercise programme
- **DiabetesHealthSteps:** An exercise-based programme for those with diabetes

The programmes, which will be now referred to as chronic illness groups (CIG) have a rolling commencement date and, unlike other established forms of chronic illness rehabilitation offers structured supervised exercise for as long as participants wish to remain attending. All exercise sessions adhere to the same structure of warm-up, aerobic exercise, resistance exercise and cool-down. Classes are supervised by trained

staff at a ratio of 1:15. While participants can select the exercise sessions to attend based on their chronic illness grouping, they are encouraged to attend the same sessions every week in order to foster social-support and habit formation.

1.3 Thesis aims and objectives

1.3.1 Aims

1. To assess the adherence rates and the factors that influence adherence to a CCEP.
2. To design and develop an intervention with the aim of improving initiation, attendance and retention to a CCEP.
3. To implement and evaluate the feasibility of an intervention to improve initiation, attendance and retention to a CCEP.
4. To identify trends in initiation, attendance and retention to a CCEP between the intervention and the standard (control) group.

1.3.2 Objectives

1. To examine initiation, attendance, retention and dropout rates to a CCEP over a 24-week period.
2. To examine the demographic, behavioural, psychological and physical health-related correlates of initiation, attendance and retention in a CCEP over a 24-week period.
3. To design an evidence-based intervention to optimise initiation, attendance and retention to a CCEP.

4. To map the behaviour change techniques used as part of the newly designed intervention to optimise adherence rates to a CCEP.
5. To investigate the feasibility of an intervention designed to optimise adherence to a CCEP.
5. To observe and monitor trends in initiation, attendance and retention to a CCEP between the intervention and the standard (control) group.
6. To provide usable recommendations to address sub-optimal adherence rates for practice in a CCEP based on research findings.

1.4 Overview and organisation of thesis

1.4.1 Organisation within the MRC Framework

The research is organised within the Medical Research Council's (MRC) guidance for developing and evaluating complex interventions (Craig, Dieppe, et al., 2008; Medical Research Council, 2006) as outlined in **Figure 1.1**. The four phases of the MRC framework with reference to their connection to the research undertaken in this thesis are;

1. *Phase I* is the development phase and is focused on identifying the evidence base, outcomes and predictors.
2. *Phase II* is the feasibility stage and includes elements such as piloting, testing procedures, estimating recruitment sample size etc.
3. *Phase III* represents the evaluation phase and encompasses outcome evaluation, understanding of the change process and assessing cost-effectiveness.

4. *Phase IV* is the implementation phase and includes surveillance, monitoring and longer-term follow up. While this phase is referred to in the discussion chapter it is beyond the scope of this research thesis.

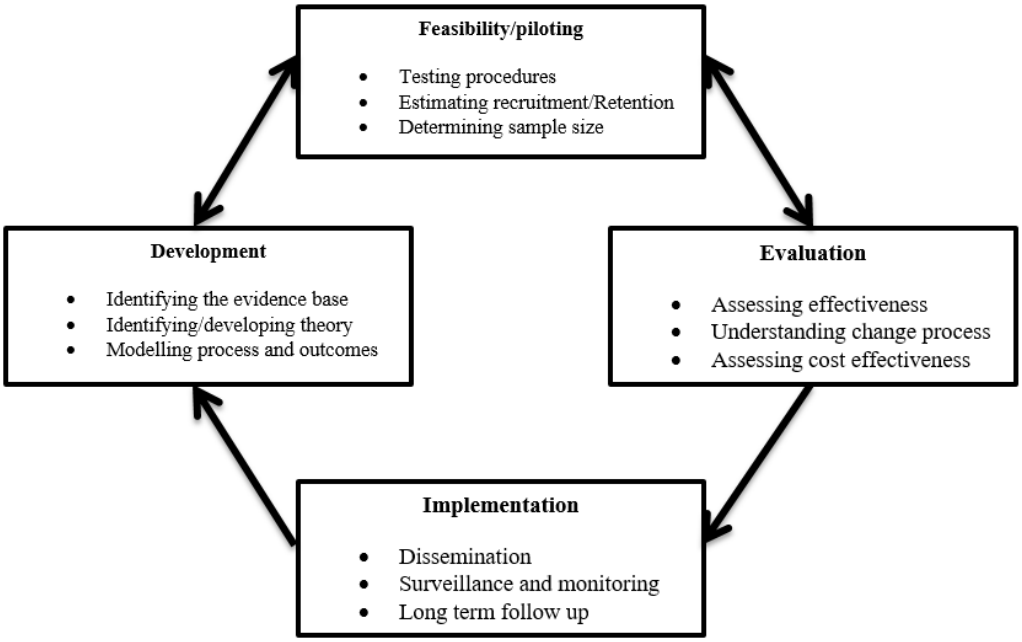

Figure 1.1 Adapted from Medical Research Council guidance

1.4.2 Thesis layout

This thesis encompasses five chapters. This Chapter (Chapter 1) serves to introduce the thesis. In Chapter 2, the current literature in the area of adherence to structured exercise for individuals with chronic illness is critically reviewed. Chapter 3 presents study 1, and includes a background, methodology and results. The intervention design and development is presented in Chapter 4, with Chapter 5 presenting the feasibility study of the intervention implementation. The final chapter, Chapter 6 brings together all parts of research carried out in this thesis and through discussion provides

recommendations and conclusions. Additional supporting material is presented in the Appendices.

The Chapters are presented as follows:

- ***Chapter 1 Introductio****n:* Outlines the rationale and the need for study in the area of adherence to structured exercise for those with chronic illness. This Chapter outlines the aims and objectives of the thesis and an outline of the thesis layout.
- ***Chapter 2 Review of the literature*****:** Presents a critical review of the literature in the areas of adherence to chronic illness structured exercise, theory and determinants of initiation, attendance and retention, and interventions/strategies that have influenced the behaviour of initiation, attendance and retention.
- ***Chapter 3 Study 1*****:** Contains the first study of the thesis. This cross-sectional and longitudinal observational study identifies the rates of initiation, and subsequent attendance, retention or dropout to the CCEP and explores the demographic, psychosocial, health-related fitness and psychological correlates of adherence.
- ***Chapter 4 Intervention design and development:*** Presents the steps leading to and including the intervention design and development using relevant theory and frameworks.
- ***Chapter 5 Study 2***: Study 2 presents the findings relating to intervention feasibility and presents trend in adherence giving an indication of the potential efficacy of the intervention.

- ***Chapter 6 Discussion and conclusion:*** This chapter brings together the findings from the studies of this thesis and is used to outline the impact of the findings and to provide recommendations for services and future research.
- **Appendices**: The appendices include evidence of ethical approval, questionnaire surveys used, forms associated with data collection as well as additional materials in support of the studies.

1.5 Original contributions to knowledge

To the authors knowledge, the original contributions this thesis makes to knowledge includes the following;

- The first examination of the rates and correlates of adherence to a CCEP in Ireland
- The design and development of a bespoke multi component intervention aimed at optimising adherence to a CCEP
- The feasibility examination of a bespoke intervention, with examination of trends in its efficacy on adherence to a CCEP.

Chapter 2

Review of Literature

2.1 Introduction to chapter and methodology

Chapter 2 is a narrative review, and has the purpose of presenting a comprehensive synthesis of information and background on a specific topic or area (Cronin, Ryan, & Coughlan, 2008; Green, Johnson, & Adams, 2006). A narrative review identifies gaps in knowledge and research and as a result, assists in determining and refining research questions (Cronin et al., 2008). While a systematic review may be acknowledged as a stronger, less biased synthesis of evidence than a narrative review (Ferrari Milan, 2015; Grant & Booth, 2009) it was not feasible as part of this thesis and the narrative review enables a broad perspective on the topic of adherence to a CCEP.

This narrative literature review sought to examine adherence to community-based exercise programmes and similar, along with the correlates of such and strategies used to optimise adherence. The area of exercise based chronic illness programmes and rehabilitation, the concept of exercise adherence, correlates and determinants of adherence as well as interventions and strategies to optimise adherence will be presented in this chapter. The review forms the theoretical and evidence base underpinning the thesis and guiding research design and research questions.

This narrative review of literature aims to give a comprehensive overview to the topic outlined and incorporates research articles and grey literature. To maximise the quality, it is recommended that a structured approach to the methodology and literature search, similar to a systematic review, be utilised (Ferrari Milan, 2015). The Arskey and O'Malley (2005) scoping review framework and the guidelines by Ferrari Milan (2015) are utilised herein to provide structure to the presentation of the methodology for and the completion of this narrative review of literature. This

framework systematises a process of undertaking a review into 5 phases; these are used as headings below.

1. *Identifying the research question*

   While this narrative review is broad in its area, The PICO(S) framework (Richardson, Wilson, Nishikawa, & Hayward, 1995) was used to assist in the development of the search terms and to assist in ensuring clarity in inclusion of literature. This stands for; population, intervention, comparator, outcome and the more recent addition of; studies. While all components of PICO(S) are not required for every section in the narrative review, the below outline serves as a basic guide:

   - **Population**: Adults with chronic illness (any chronic illness but with a focus on cardiac, pulmonary, diabetes and, 1 or multimorbidity)
   - **Intervention**: Interventions developed to increase/improve/optimise adherence at a community-based (non-hospital) exercise programme
   - **Comparator**: When identifying intervention efficacy, comparators may be control groups
   - **Outcome:** Adherence to include initiation or similar, attendance, and retention or similar
   - **Study:** A range of study designs are included

2. *Identify relevant literature*

   A literature search plan was developed and utilised and include three search strategies; (1) database searches using key terms; (2) browsing targeted websites

of worldwide organisations/agencies, non-governmental organisations and government departments; and (3) reviewing reference lists for additional resources not identified in the first two search strategies.

Grey literature was searched to provide information on the policy context for this thesis and information and the availability of services such as that outlined in this thesis. The organisations included in the website search were the World Health Organization (www.who.int), the International Society for Physical Activity and Health (www.globalpanet.com), the Department of Health (www.health.gov.ie), the Irish Association for Cardiac Rehabilitation (www.iacr.info), the British Association of Cardiac Rehabilitation and Prevention (www.bacpr.com), and Sport Ireland (www.sportireland.ie).

A search of relevant databases including PubMed, EBSCOhost and Science Direct was completed. The following keywords were used to identify and gather articles for use in their respective sections:

- All sections: physical activity, exercise, chronic illness, adherence
- **Section 2.2** (Prevalence and burden of chronic illness):
- **Section 2.3** (Physical activity and exercise): levels, prevalence, trends, temporal trends, benefits, outcomes, physical activity, exercise.
- **Section 2.4** (Structured exercise programmes for the secondary prevention of chronic illness): Chronic illness rehab*, Cardiac rehab* exercise for chronic illnesses (cardiac, pulmonary, diabetes, claudication), out-patient, community-based

- **Section 2.5** (Adherence to health behaviours): Attendance, adherence, initiation, uptake, compliance, retention, completion, percentage, dropout
- **Section 2.6** (Factors associated with adherence exercise programmes for the secondary prevention of chronic illness): correlate, determinant, factor, predictor, association, chronic illness rehabilitation (cardiac, pulmonary, diabetes, claudication).
- **Section 2.7** (Interventions and strategies optimising adherence to CCEPs): Intervention, programme, attendance, adherence, initiation, uptake, compliance, retention, completion, percentage, dropout, chronic illness (cardiac, pulmonary, diabetes, claudication), optimise, increase, enhance or improve.
- **Section 2.8** (Theory of behaviour change to influence adherence to CCEP): theory, model, framework, social cognitive theory, ecological theory, theory of planned behaviour, health belief model, transtheoretical model, COM-B model.
- **Section 2.9** (Intervention Development): theory, model, framework, design, development, complex health intervention, Increase or improve or optimise or influence, community-based or non-hospital based, exercise programme or rehabilitation or physical activity programme.

The titles and abstracts that were returned in the search were screened for suitable literature. The reference lists of research articles and reports were inspected for additional relevant resources that may not have been identified in initial searches. Google and Google Scholar searches were then used to locate these additional resources.

3. *Charting the information and data within the included studies*

   In line with scoping review methodologies a formal assessment of the quality of the included studies was not required but is outlined in this narrative review. Data extraction tables were utilised to capture key pieces of information from the included studies and are presented for some sections (for example **Section 2. 7-**Interventions).

4. *Collating, summarising and reporting results of the review*

   This stage used the chart data and presented further information about the literature identified in this review. Considerations for future research and its implications were considered in this phase.

2.2 Prevalence and burden of chronic illness

Chronic illnesses, also known as chronic diseases or non-communicable diseases (NCD), are those that can be treated and controlled but not cured and are generally long in duration and slow in progression (WHO, 2017). The major chronic illnesses include cardiovascular diseases (CVD), some cancers and chronic respiratory diseases and account for 70% of the deaths globally (WHO, 2017). According to the World Health Organisation, mortality as a result of chronic illnesses remains unacceptably high (WHO, 2014).

The WHO chronic disease profile for Ireland in 2014 (WHO, 2014) attributed 88% of Irish deaths to chronic illnesses including CVD, diabetes, cancer and chronic lung diseases. The most recent WHO report indicated that the attributable deaths due to these chronic illnesses has risen to 90% in Ireland (WHO, 2017). With a growing and

aging population, the burden of chronic illness is expected to rise (Wagner et al., 2001; WHO 2017). Currently, an estimated 50 million people in Europe live with multiple chronic illnesses (Struckmann, Boerma, & Ginneken, 2015). Barnett et al., (2012) identified that 40% of adults had one or more chronic illness and 23% had multiple chronic illnesses. Dealing with the complex needs of patients with chronic illness has been acknowledged as one of the greatest challenges facing healthcare system globally (Darker et al., 2015).

Primordial prevention refers to interventions that are initiated before the development of established chronic disease risk factors (Gordon, 1987). *Secondary prevention* involves interventions taken after the disease is established (Gordon, 1987) and has the aim of preventing progression of the disease. *Tertiary prevention* focuses on preventing complications in order to prevent further deterioration (Gordon, 1987). The present thesis will adopt the term secondary prevention to encompass both secondary and tertiary prevention. The rationale for encompassing these two phases of prevention into one phase of secondary prevention is to adhere to recommendations from The European Society of Cardiology (Piepoli et al., 2016)

2.3 Physical activity and exercise

Physical activity is defined as any level of activity above seated rest that results from skeletal muscle activation and leads to movement and an increase in energy expenditure (Caspersen, Powell, & Christenson, 1985) and can be classified as light intensity PA (LIPA), moderate to vigorous intensity PA (MVPA), and vigorous intensity PA (VPA). LIPA, MVPA and VPA are defined as energy expenditure between 1.6-2.9 METs

(metabolic equivalent). Transport and movement around the home or at work are examples of physical activity. In contrast, *exercise* is defined as physical activity that is planned, structured and repetitive undertaken to improve and/or maintain physical fitness (Caspersen et al., 1985). Examples of exercise include participating in an organised exercise programme or class. Higher levels of physical activity and/or exercise are associated with beneficial health-related outcomes across a wide range of populations (Warburton, Nicol, & Bredin, 2006).

2.3.1 Physical activity and exercise in disease prevention

Higher levels of physical activity and/or exercise influence human development and overall health across the lifespan (Bamman et al., 2014; Bouchard et al., 1995; Colpani et al., 2013; Juonala et al., 2013; Whellan et al., 2007). Evolutionarily, the ability of humans to perform physical activity was essential to survival, and therefore adaptive biological responses to both acute and repeated episodes of physical activity have played a critical role in shaping and defining normal human physiology (Neufer et al., 2015). The physical work associated with hunting, gathering food, building shelter, and evading predators was an absolute requirement of daily life for our ancestors. The advent of steam-based machines in the 18th century, followed by electrical energy-based mass production of the second industrial revolution during the 19th-20th century and more recently the information revolution including cyber physical systems and the internet of things networks has relegated physical activity from a necessity of human existence to a choice of human lifestyle. Increases in levels of physical inactivity can lead to devastating physiological and clinical consequences and physical inactivity has been identified as the fourth leading risk factor for global mortality (WHO, 2009).

Conversely, the impact of physical activity, particularly MVPA on human health is profound and unequivocal (Pedersen & Saltin, 2015). Studies have consistently found a graded inverse dose response relation between increased physical activity levels and a reduction in relative risk of all-cause mortality (Kokkinos, 2012; Lee & Paffenbarger, 2000). There are exceptionally few chronic diseases, in which the burden of the disease, comorbidities related to the disease, or the disease-related quality of life are not improved with physical activity. Regular physical activity helps to build muscle mass during development and preserve musculoskeletal function during aging (Christianson & Shen, 2013), promote cardiometabolic health, improve cognitive performance, and play an important role in the prevention and treatment of a variety of chronic illnesses, including cardiovascular disease, type 2 diabetes, neurological diseases, sarcopenia, osteoporosis, and cancer (Pedersen & Saltin, 2015). Exercise is also effective in restoring physical function and maintaining functional independence in those with chronic illnesses (Pasanen, Tolvanen, Heinonen, & Kujala, 2017).

As little of as 1600 kcal per week in energy expenditure can halt the progression of coronary artery disease and an energy expenditure corresponding to 2200 kcal per week is associated with a reduction in atherosclerotic plaque in medium to large sized muscular arteries that are primarily responsible for myocardial infarction (Hambrecht et al., 1993). The role of physical activity in the prevention and control of chronic illnesses has been recognised internationally by Council of the European Union, (2013), and the United Nations General Assembly, (2011), the World Health Assembly (2008) (WHO, 2008).

2.3.2 Physical activity guidelines and prevalence of insufficient physical activity

The current physical activity guidelines recommend that adults accumulate at least 150 minutes of moderate intensity aerobic physical activity or at least 75 minutes of vigorous intensity activity aerobic activity throughout the week. In addition to aerobic activity, muscle strengthening activities should be performed on ≥2 days per week (WHO, 2010). In addition to this, it is recommended that men and women over 65 years old, with or without chronic illness should perform balance enhancing activity to prevent falls on ≥ 3 d per week. While the current physical activity guidelines are recommended for individuals with and without chronic illnesses, exercising with chronic illness may present as a barrier to many, and for this reason the setting and structure of physical activity may play a crucial role for these individuals.

Despite the acknowledged benefits of physical activity, only 31% of adults globally meet the guidelines for health enhancing physical activity (Hallal et al., 2012), and the proportion of adults insufficiently active (low physical activity category) in the WHO European region is 31% (World Health Organisation, 2015). Currently, only 30 % of Irish adults meet the currently recommended guidelines (Ipsos MRBI, 2016), and 35% of those over the age of 50 (McKee, Kearney, & Kenny, 2015).

2.4 Structured exercise programmes for the secondary prevention of chronic illness

Exercise programs for individuals with chronic illness fall into three broad categories; formal hospital-based rehabilitation, community-based chronic illness exercise programmes (CCEP), and exercise referral programmes (**Figure 2.1**). Due to concerns about patient safety during unsupervised exercise after discharge, hospital

programmes focus on highly structured, physician supervised, and electronically monitored regimes (Ewles & Simmett, 1992). In contrast, community-based models of CCEP appear to be more flexible in their approach. Community-based models have a strong emphasis on education, empowerment and behaviour change approaches (Ewles & Simmett, 1992).

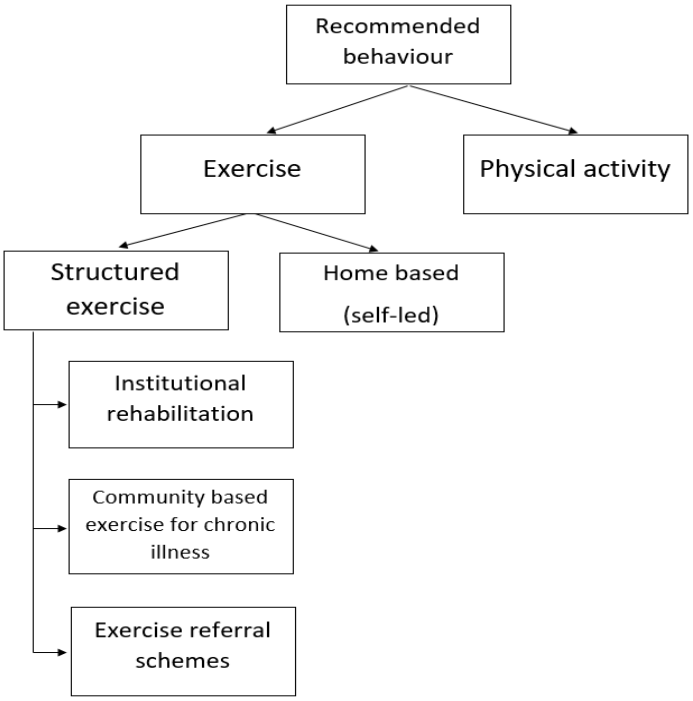

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Figure 2.1 Overview of chronic illness rehabilitation programmes

Cardiac and pulmonary in-patient and outpatient rehabilitation are the longest established chronic illness exercise programmes. More recently, programmes for chronic pain, and cancer have seen enormous growth based on a strong evidence base for their efficacy (Brown et al., 2011; Ferrer, Huedo-Medina, Johnson, Ryan, & Pescatello, 2011; Geneen et al., 2017; Lear et al., 2017).

Cardiac rehabilitation evolved in the 1980s from a solely exercise based intervention to a more comprehensive and multifaceted programme that incorporated

strategies for medical and lifestyle modification (Ades, 2001). The aims of contemporary cardiac rehabilitation programmes are to optimise cardiovascular risk reduction, promote adoption and adherence to healthy behaviours, enhance emotional well-being, reduce disability, and promote an active lifestyle for patients with coronary artery disease (Piepoli et al., 2016; Savage, Sanderson, Brown, Berra, & Ades, 2011; Scottish Intercollegiate Guidelines Network, 2012). Strategies and services required to achieve these goals include exercise training, counselling, education, risk factor modifications and psychological and nutritional interventions (Balady et al., 2007). The core components of cardiac rehabilitation include patient assessment, nutritional counselling, weight management, blood pressure management, lipid management, diabetes management, smoking cessation, psychological management, physical activity counselling, and exercise training (Balady et al., 2007).

A recent Cochrane review (Anderson et al., 2016) reported that exercise-based cardiac rehabilitation reduced cardiovascular mortality compared to usual care with a risk ratio of 0.74 (0.64 to 0.86), however there was no evidence of reduction of total mortality (risk ratio 0.96, 0.88 to 1.04). Overall risk of hospital readmission was also reduced with a risk ratio of 0.82 (0.70 to 0.96). Although meta-analyses were precluded in this review; five of the 20 trials reported that health-related quality of life also showed a significant improvement. Furthermore, four of the included trials reported that exercise based cardiac rehabilitation was cost effective in quality adjusted life years (Anderson et al., 2016). This is important as an earlier Cochrane review (Anderson & Taylor, 2014) identified that psychological and education based interventions alone had

little or no impact on mortality and morbidity highlighting the importance of the exercise component.

The European Society for Cardiology has identified the traditional approach of inpatient, outpatient and community-based services for cardiac rehabilitation (Piepoli et al., 2016). While this is also the structure in Ireland and the UK, the phases are further subdivided into four phases;

- *Phase I:* This phase represents the period immediately after an acute cardiac event in which an individual's diagnosis, risk assessment and stratification and medications are discussed.
- *Phase II:* Commences as soon as possible following discharge and focuses on health education and return to physical activity. This phase varies by institution and may take the form of group sessions, home visits or telephone calls.
- Phase III: Phase three follows on from the education and information provided in phase two and generally includes elements of lifestyle education in combination with exercise training. This phase varies again by centre with attendance required at a cardiac rehabilitation unit a number of times a week for a period of 6-12 weeks.
- Phase IV: This phase represents the longer-term maintenance of the lifestyle changes facilitated in phase three. Phase four can be facilitated by some cardiac-rehabilitation centres, some leisure centres or the independent maintenance of lifestyle changes by the individual.

The most recent National Survey of Cardiac Rehabilitation Service Provision in Ireland (Delaney, Flynn, Kiernan, & Lonergan, 2006) found that only 43% of hospitals provided a formal phase IV programme that does not necessarily include supervised exercise. The Irish Association of Cardiac Rehabilitation has identified only nine phase IV cardiac rehabilitation programmes outside of the hospital setting. While other phase IV services may exist, based on the information available to patients it is not surprising that uptake to such programmes remains low.

Pulmonary rehabilitation is a similarly multi-disciplinary and comprehensive intervention for individuals with chronic obstructive pulmonary disease (COPD) and other pulmonary diseases who are symptomatic and often have reduced functionality in daily life (Hayton et al., 2013). The purpose of pulmonary rehabilitation is to stabilise or reverse the systemic manifestations of the disease, as well as reducing the symptoms and increasing the functional status of the patient (Hayton et al., 2013). The Health Service Executive Pulmonary Rehabilitation programme consists of three phases (Health Service Executive, 2010) with little available information on the provision of these phases;

- *Phase 1:* Represents the inpatient rehabilitation in which a number of pulmonary function tests are administered status in addition to an education component.
- *Phase 2:* Involves an eight-week outpatient rehabilitation phase involving normally three sessions per week that include the individual including breathing training, respiratory muscle training, supervised exercise, relaxation and education regarding the condition, medication, diet and lifestyle.

- *Phase III*: Represents the home-based maintenance phase following the outpatient rehabilitation.

The clinical benefits of exercise-based pulmonary rehabilitation are evident across several different outcome measures including maximal exercise capacity, six-minute walk distance, mean peak power and health-related quality of life (Morris, Kermeen, & Holland, 2017, McCarthy et al., 2015). In response to the clear benefits of pulmonary rehabilitation, it is recommended that all patients with stable COPD and exercise limitations due to breathlessness should be referred to pulmonary rehabilitation within 4 weeks of discharge from a hospital admission due to an exacerbation of COPD (Wise, 2016).

2.4.2 Community-based exercise for the secondary prevention of chronic illness

CCEPs have the potential to improve sustained engagement to a physically active lifestyle in individuals living with chronic illnesses (WHO, 2009). Individuals often present with similar comorbidities (despite differing primary diagnosis) (Desveaux, 2015), highlighting the opportunity to utilise a group-based approach to exercise. Convenience and normality have been identified as key motivators for sustained participation in a community-based group exercise programme (McNamara, McKeough, Mo, Dallimore, & Dennis, 2016).

At present the literature predominantly demonstrates availability of single chronic illness programmes with inconsistency in the duration and scheduling of such. Available evidence is synthesised below based on primary chronic illness they cater for. While models do exist, it has noted that community-based approaches are limited in the

literature (Plotnikoff, Costigan, Karunamuni, & Lubans, 2013). A systematic review on models of CCEP noted similarity in the exercise structures in such programmes (Desveaux, Beauchamp, Goldstein, & Brooks, 2014).

Phase IV cardiac rehabilitation represents the longer-term maintenance of the lifestyle changes facilitated in phase three. Phase four can be facilitated by some cardiac-rehabilitation centres, some leisure centres in the community or the independent maintenance of lifestyle changes by the individual. The Irish Association of Cardiac Rehabilitation signpost to only nine phase IV cardiac rehabilitation programmes outside of the hospital setting including private gym classes and trainers with little research available on these programmes (The Irish Association of Cardiac Rehabilitation, n.d.). Internationally there are a number of CCEP set in community gyms for individuals with heart disease. Across the United States YMCA gyms run 12-week exercise programmes (and many of longer duration) for adults following a heart event or heart disease or those at risk such as the "Healthy Hearts cardiac rehab maintenance programme" in Berkley Heights New Jersey and "Be Heart Healthy" in Fond du Lac in Wisconsin.

Research indicates the positive effects of community-based cardiac rehabilitation programmes on clinical outcomes such as blood pressure, fasting blood glucose and LDL (Ong et al., 2016). In this study, a sample of 94 participants who continued to community-based cardiac rehabilitation following the completion of inpatient cardiac rehabilitation were compared to those who did received usual care (i.e.-did not continue to community-based cardiac rehabilitation). At a 1 year follow up,

those who attended a community-based cardiac rehabilitation programme had significant lowering of low density lipoproteins (LDL) (2.5 to 2.2 mmol/L, p<0.01) with the control /normal care group's LDL increasing over 1 year increased (2.2 to 2.4 mmol/L, p<0.01). The intervention group also had greater improvements in triglycerides (-0.1 vs. +0.1 mmol/L, p=0.01), total cholesterol (-0.3 vs. +0.3 mmol/L, p<0.01), fasting blood glucose (-0.5 vs. +0.3 mmol/L, p<0.01), systolic blood pressure (-3.2 vs. +5 mmHg, p<0.01) and diastolic blood pressure (-2.6 vs. +2.8 mmHg, p<0.01) compared to the usual care group, those who did not attend the community-based cardiac rehabilitation programme (Ong et al., 2016). In another community-based cardiac rehabilitation programme based in Singapore (Kwan, Ong, Tay, & Chang, 2016) in which participants attended three exercise sessions a week, it was observed that at one year follow up there were an overall decrease in body fat percentage by –1.3% (p<0.01, CI –1.9% to –0.9%) and an increase in six-minute walk distance of 9.7 m (p<0.01, CI 2.0 m to 17.5 m). This study also reported an increase in abdominal circumference by 1.0 cm (p<0.01, CI 0.3 cm to 1.6 cm) and visceral fat density of 0.5 mg/dL (p<0.01, CI 0.3 mg/dL to 0.9 mg/dL). A sub-sample of participants (n=43) in this study had complete fasting lipid profiles for both timepoints, and it was identified that there were reductions in total cholesterol of –7.8 mg/dL (p<0.01CI –15.6 mg/dL to –3.9 mg/dL), low-density lipoprotein of –7.8 mg/dL (p<0.01CI –15.6 mg/dL to –3.9 mg/dL), and triglyceride levels by –17.8 mg/dL (p<0.01CI –26.7 to –8.9 mg/dL).

It has further been observed that outpatient and community cardiac rehabilitation programmes can have similar outcomes with Mosleh et al., (2015) suggesting the use of community-based cardiac rehabilitation to deal with the often

cited barrier of transport and travel to hospital setting. Mosleh et al., (2015) found that following either an eight-week cardiac rehabilitation in the community or the hospital that there were no statistical difference in the outcomes of anxiety (12.62±2.20 vs 12.69±2.17, p= 0.81) or depression (8.70 ±1.24 vs 8.62±1.33, p=0.63). When the authors adjusted for other factors, patients who attended community-based cardiac rehabilitation reported higher RAND-36 measured health related quality of life energy scores at six months compared with attenders at the hospital cardiac rehabilitation (p=0.020) but were less likely to undertake frequent exercise (p=0.041).

The efficacy of CCEP for pulmonary disorders has been noted in the short and medium term (up to 6 months) however this is generally not maintained at 12 months with authors noting the importance of adherence to ensure best possible outcomes (Beauchamp, Evans, Janaudis-Ferreira, Goldstein, & Brooks, 2013). In this systematic review and meta-analysis, authors reviewed seven RCTs of supervised exercise programmes post pulmonary rehabilitation in participants with moderate to severe COPD. At a 6 month follow up there were significant improvements in exercise capacity in those who were in the post rehabilitation exercise intervention (standardised mean difference of -0.20, CI, -0.39 to -0.01, p<.05), however this was not sustained at 12 months (standardised mean difference of -0.09, CI, -0.29 to 0.11, p=.37). This meta-analysis did not identify any difference in health-related quality of life between those in the exercise programmes and those not at any time point.

A recently published study exploring the effects of a community-based pulmonary rehabilitation programme found that of the total of 581 patients who

completed the pulmonary rehabilitation, that there were statistically significant and clinically meaningful differences between baseline and end of rehabilitation values (Godtfredsen et al., 2019). There was mean change in 6 minute walk test distance of 45 m ($p<0.01$), and health-related quality of life, as measured by the 15D improved by a score of 0.03 ($P<0.001$) (Godtfredsen et al., 2019). In another study exploring a network of community-based pulmonary rehabilitation programmes authors concluded that an 8 week pulmonary rehabilitation programmes in the community setting is safe and effective (Cecins, Landers, & Jenkins, 2016). In the sample of 251 participants with COPD there were improvements in the 6-minute walk test (mean difference of 44 m, CI 37–52m, p<.0001) and total Chronic Respiratory Questionnaire Score (0.5 points per item, 0.4–0.7, p<.0001). Authors also observed that participants had fewer respiratory-related hospital admission following the program (12% vs. 37%, $p < 0.0001$). Short term efficacy has been found in a CCEP for adults with type 2 Diabetes in Portugal, it identified that in those with impaired lung function there were significant improvements with attendance (Costa Da Silva et al., 2017). In this 8-month programme, significant improvements were observed in participant's lung function PEF (10.7%; $p = 0.005$). At a National level, a number of CCEP for adults with COPD exist such as a programme run by Siel Bleu Ireland for older adults with COPD called "Exercise, COPD and Me" (Siel Bleu, 2018). However, there is no research carried out into the efficacy or adherence of such programmes.

In addition to diet and medication, physical activity is considered a corner stone of type 2 Diabetes care (American Diabetes Association, 2011). A systematic review and meta-analysis of CCEPs for adults with Type 2 Diabetes found that an increase in physical

activity levels had a clinically meaningful reduction in HbA1c levels by 0.32% (CI −0.65, 0.01, p<.06) (Plotnikoff et al., 2013). In a study exploring the effects of a 9-month CCEP for participants with type 2 Diabetes (Diabetes em Moviemento) there were significant positive outcomes observed in the exercise group compared to usual care (Costa Da Silva et al., 2017). The 9 month CCEP was effective in improving in glycaemic control (HbA1c % change of -.88, p<.001, FPG mg/dL change of -21.83, p<.001) , lipid profile (total cholesterol change of -24.10 mmHG, p<.001), blood pressure (systolic blood pressure change of -11.73, p<.001 , Diastolic Blood pressure change of -5.12, p<.001) and anthropometric profile (waist circumference change of -3.07cm, p<.001, BMI change of-.59 $kg.m^2$, p<.001), and an overall reduction of 10-year CAD risk of -.44% (p<.001) (Mendes, Sousa, Reis, & Themudo-Barata, 2017). A study of the same community-based exercise programme for adults with diabetes indicated improvements in in physical fitness measures of participants (Gallé, Di Onofrio, Miele, Belfiore, & Liguori, 2019). There were improvements in BMI by -1.7kg/m2 (p<.05), waist circumference by -8.6cm (p< 0.01), step test by 21.8 reps (p< 0.01), chair stand test by 4.8 reps (p< 0.01), up and go balance test by 1 (p< 0.01) and habitual physical activity by 67 MET-min/week (p< 0.01) following 9 month participation in the programme. Limited examples of structured exercise for those with type 2 Diabetes are available in the literature from Ireland, however there are many resources from the Health Service Executive and Diabetes Ireland in existence, with a self-led course on Diabetes Ireland's website enabling users to learn about the benefits of physical activity and make a plan about their future activity (Diabetes Ireland, 2002). While these self-led home programmes have been found to be beneficial, a gap in the service provision of structured exercise is

evident. It has been noted that regular exercise is warranted to both improve and maintain long term glycaemic control (Van Dijk, Tummers, Stehouwer, Hartgens, & Van Loon, 2012), providing some rationale for the model of structured supervised exercise on a long term basis for those with type 2 Diabetes.

Few programmes offering structured exercise to individuals with claudication are known to be in existence in Ireland however they are more available internationally with noted success. Stewart & Lamont (2001) carried out an audit of the availability of structured exercise settings in the United Kingdom and Ireland for those with claudication and identified that only 27% of consultants noted having somewhere to refer their patients. While there are limited services available, with similarly limited structure, the current research setting offers a popular service with a high level of agreement from referring practitioners. A supervised exercise programme consisting of walking a minimum of three times a week (30-60 minutes) for at least 12 weeks for all suitable patients is recommended (Conte et al., 2015). A community-based programme offering structured exercise for those with claudication (Kruidenier et al., 2009) found significant improvements in absolute claudication distance (from a median of 400m to 1100m, $p<.001$), with improvements noted in the first six months, and little change between 6 months and 12 months. Authors also note that these improvements are similar to hospital based programmes (Kruidenier et al., 2009). Authors of this study note the high dropout rate (Kruidenier et al., 2009), warranting future research on adherence strategies. While home-based unsupervised exercise can have clear benefits, the literature to date suggests that structured supervised exercise programmes generally have superior benefits compared to unsupervised programmes (Fokkenrood

et al., 2013). There is limited available evidence of the efficacy of community-based programmes catering for multiple chronic illnesses, however McNamara et al., (2016) identified that in a community-based setting patients with chronic respiratory and chronic cardiac disease had positive outcomes. Of the 22 participants that completed the 8-week exercise programme there was significant improvement in 6-minute walk test distance of 32 m (p=.005).

2.5 Adherence to health behaviours

Adherence to health and medical recommendations is a complex behavioural process and one which poses many challenges (Miller, Hill, Kottke, & Ockene, 1997). The behavioural processes behind the adherence or non-adherence to medication highlight the complexity of human behaviour. Medication adherence refers to whether a patient takes medication according to the frequency prescribed or continues to take a prescribed medication. Inadequate adherence to medication may cause alterations in risk-benefit ratios, resulting in reduced benefits, increased risks or both, and is significantly associated with adverse clinical outcomes and higher healthcare costs (He et al., 2018). Poor medication adherence has multifactorial causes. This same adage holds true for health behaviours.

The “Healthy Adherence Effect” posits that an individual who adheres to one health behaviour, i.e., medication adherence, is likely to adhere to other healthy behaviours. For example, adherence to placebo medication was found to be correlated with better outcomes in terms of mortality across a number of conditions including coronary artery disease, HIV and diabetes (Simpson, 2006).

The WHO defines adherence as "the extent to which the persons' behaviour (including medication-taking) corresponds with agreed recommendations from a healthcare provider" (WHO, 2003) and includes the initiation of the treatment, implementation of the prescribed regime, and when appropriate, discontinuation of a pharmacological treatment. There are however, scientific challenges involved in evaluating adherence due to the fact that different terms are often used to describe attendance, retention and compliance (Hawley-Hague, Horne, Skelton, & Todd, 2016; Karmali et al., 2014). A review on exercise programmes for older adults concluded that adherence was measured in so many different ways making inter-study comparisons difficult (Picorelli, Pereira, Pereira, Felício, & Sherrington, 2014) and even when studies use the same conceptual approach to adherence (e.g. percentage attendance), the measurements used or the cut off points applied were different across studies.

Many of the terms used to identify adherence are interchangeably, but their interpretation may differ across studies. For example, the complexity of defining adherence is evident from the following search terms used in a recent review of adherence to community-based exercise in older adults; Maint*, Sustain*, Attend*, Compliance, Comply, Complied, Adopt*, Commence*, Instigat*, Begin* (Farrance, Tsofliou, & Clark, 2016). Visek, Olson, & DiPietro (2011) identified the following frequently used terms in studies reporting adherence to exercise classes; completion (or retention), attendance, duration adherence, intensity adherence and lack of uptake. **Table 2.1** summarises the number of different measurements of adherence in the literature in the area of structured exercise for older adults and rehabilitation setting, with commonly used terms including "attendance", "completion" and "compliance".

The definition of adherence outlined by the WHO (2003), although useful, lacks specificity when quantifying the extent of adherence to an exercise programme or prescription. For the purpose of this thesis, adherence will comprise initiation, attendance, retention and point of dropout. This decision was made on the basis of recommendations outlined in Hawley-Hague, Horne, Skelton, & Todd (2016) as well as the nature of the CCEP, the current research setting. Participants are referred to the CCEP by their healthcare professional and are then invited to an induction session at the CCEP prior to starting attendance at the CCEP. The rate of referral in this context is beyond the scope of this reasearch but given the significant level of dropout between induction day and attendance at the CCEP it is warranted to explore this timepoint and serves as the first component of adherence. The components of retention and point of dropout also make up components of adherence in this context given the unending nature of the programme. Retention is a proxy measure for engagement with the programme at a specific timepoint. The identification of the point of dropout adds some useful insight into trends of attendance, however caution is advised and attendance was not monitored beyond 24 weeks, and the point of dropout may not represent a true dropout, it may be a dropout due to period of illness and the participant may re-engage with the CCEP.

Table 2.1 Differing measures of adherence across a number of studies.

Reference	Type of behaviour/exercise/study	Adherence as identified
Hawley-Hague, Horne, Campbell. (2014)	Community-based exercise classes for the elderly	• Attendance in weeks (number of exercise sessions attended within a certain time frame) • Completion of the overall regime
Dorgo, King, Brickey. (2009)	Community exercise sessions for older adults	• Retention rates • Percentage of exercise sessions attended
Flegal , Kishiyama , Zajde , Haas, Oken. (2007)	Exercise intervention (including yoga) for healthy older adults	• Study completion • Percentage of classes attended
Sjosten, Salonoja, Piirtola et al. (2007)	Older adults at falls risk in a community-based exercise intervention	• Percentage of sessions attended • Levels of adherence (>66% of sessions attended =high adherence)
Sullivan-Marx, Mangione, Ackerson, et al. (2011)	Older women participating in an exercise study	• Percentage completion • Percentage attending 3+ sessions a week • Percentage attending 2+ sessions a week
Pack, Johnson, Barr et al. (2013)	Outpatient cardiac rehabilitation	• Number of sessions attended • Completion (identified as >30 sessions attended)
McLachla, Doolan-Noble , Lee, McLean , Kerr (2016)	Outpatient and community cardiac rehabilitation	• Attendance at the programme • Completion= having attended all elements of programme available
Arnold, Bruton, Ellis-Hill (2006)	Outpatient pulmonary rehabilitation	• Attendance at any versus non-attendance at any sessions • Completion of programme
Note: The table does not attempt to exhaust the ways of measuring adherence but aims to highlight the challenge in comparing said adherence across studies.		

2.5.1 Rates of adherence to exercise programmes for the secondary prevention of chronic illness

Despite the noted benefits of CCEP; initiation, attendance and retention is sub-optimal. Most of the existent literature has focused on institutional and formal modalities of rehabilitation exercise programmes, namely cardiac rehabilitation and pulmonary rehabilitation with sparse literature on the rates of initiation, attendance and retention of the multi-chronic illness community-based models.

2.5.1.1 Hospital and outpatient-based exercise for the secondary prevention of chronic illness

Outpatient rehabilitation in Ireland is usually 6-12 weeks in duration. It has been estimated that 60% of eligible patients are referred to phase III cardiac rehabilitation and adherence rates range from 76% to 96% (Delaney et al., 2006). Estimated completion rates for outpatient pulmonary rehabilitation varying between 56% and 77% (Cassidy, Turnbull, Gardani, & Kirkwood, 2014; Fischer et al., 2009; Man et al., 2004; Zakrisson et al., 2011) with a median attendance of between 66% and 88% (Sabit et al., 2008, Man et al., 2004, Hayton et al., 2013). In contrast, a recent clinical audit of pulmonary rehabilitation services in the UK reported that only 42% of patients referred to pulmonary rehabilitation managed to complete the programme (Royal College of Physicians, 2016).

2.5.1.2 Community-based exercise for the secondary prevention of chronic illness

In Germany, only 30% of phase III cardiac rehabilitation post discharge patients initiate a phase IV cardiac rehabilitation programme (Keck & Budde, 1999). Follow-up data at 7 months indicated that 75% of participants remained engaged (Keck & Budde,

1999). The referral rate to community-based phase IV cardiac rehabilitation is only 19% in Ireland (Delaney et al., 2006). This is perhaps not surprising considering that in Ireland there are relatively few phase IV cardiac rehabilitation programmes outside of the hospital setting. There are currently only nine phase IV cardiac rehabilitation programmes outside of the hospital setting including private gym classes and trainers with information for individuals to contact these services (The Irish Association of Cardiac Rehabilitation, 2018.).

In a systematic review of supervised exercise programmes for patients post pulmonary rehabilitation, Beauchamp and colleagues (2013) noted the association between positive outcomes and adherence or compliance. They noted compliance of between 39% (Brooks, Krip, Mangovski-Alzamora, & Goldstein, 2002) and 76% (Ringbaek, Brøndum, Martinez, Thøgersen, & Lange, 2010) one year after completing pulmonary rehabilitation, with a mean compliance of 60% (Beauchamp, Evans, et al., 2013). A community-based pulmonary rehabilitation maintenance programme found that only 46 of the 84 participants who started the exercise programme completed the it (Cockram et al., 2006). Another study on the efficacy of a CCEP for individuals with type 2 Diabetes (Diabetes em Movimento) found that 80% of participants had >65% adherence in 9 months (Costa Da Silva et al., 2017).The completion rate for patients with claudication attending a structured exercise programmes has been reported to be 75% (Harwood et al., 2016), however the author of this systematic review identified that only 1 of the 67 papers included in the review alluded to a minimal attendance required for programme completion. There is currently little published information on the rates of adherence to community-based exercise programmes catering for multiple chronic

illnesses however McNamara et al., (2016) identified that in a community-based setting for patients with chronic respiratory and chronic cardiac disease, of the 76 patients attending for assessment, 31 commenced the 8 week programmes and 22 (71%) completed it. In 2010 Sniehotta, Gorski, & Araújo-Soares, noted that little is known about the rates of attendance at phase IV CR programmes, despite the above the same can be said now in relation to multi chronic illness community-based exercise programmes.

2.6 Factors associated with adherence exercise programmes for the secondary prevention of chronic illness

The social cognitive theory (Bandura, 1998) is a useful guide to understanding the many factors influencing adherence (McAuley, Jerome, Marquez, Elavsky, & Blissmer, 2003; Resnick, Palmer, Jenkins, & Spellbring, 2000; Scholz, Sniehotta, & Schwarzer, 2005). The social cognitive theory explains human behaviour in terms of a reciprocal model in which the environment, personal factors and behaviours interact and result in behaviour. Environment refers to the social context that is external to the individual, personal refers to all factors such as age and gender that are specific to the individual, and finally behaviour refers to the factors that motivate behaviour. Factors relating to initiation, attendance and retention can be classified into the areas of the social cognitive theory; environmental factors, personal factors and behavioural/cognitive factors. The primary correlates of adherence are classified based on the following areas in the

a) Environmental correlates

b) Personal correlates

c) Behavioural/cognitive correlates

A summary of the environmental, personal and behavioural/cognitive correlates of adherence are presented in **Table 2.2** While these factors have been mostly identified in studies of hospital and outpatient rehabilitation, the

2.6.1 Environmental

Distance to a facility, lack of transport and physician referral have been commonly cited as primary reasons for low uptake and attendance to cardiac rehabilitation programmes (Daly et al., 2002a; Ruano-Ravina et al., 2016a). An efficient referral process and structured programme are positively related to adoption and adherence to a community-based phase IV cardiac rehabilitation programme (Martin & Woods, 2012). A systematic review (Cox, Oliveira, Lahham, & Holland, 2017) has mapped the domains most likely to influence referral, initiation or attendance and completion of a pulmonary rehabilitation programme. Environmental factors influencing adherence included waiting time for referral and initiation, travel and transport and physician's knowledge regarding the referral process. Similarly, it has been identified that disruption to established routines, living alone, inconvenient timing of the programme and distance to facility may act as barriers to attendance (Hayton et al., 2013; Keating, Lee, & Holland, 2011). In a community-based exercise programme for individual with either chronic pulmonary or cardiac disease, authors identified through qualitative interviews that the use of community gym as the setting

for the exercise promoted a sense or normality and gave confidence to continue to exercise there post programme completion (McNamara et al., 2016).

2.6.2 Personal

Single status, lower educational attainment (Cooper et al., 2002; Thomas et al., 2007), lower income (Ruano-Ravina et al., 2016), female gender (Cooper, Jackson, Weinman, & Horne, 2002; Ruano-Ravina et al., 2016) living alone (Hayton et al., 2013) and severe exacerbations (Braeken et al., 2017) are associated with lower participation in CCEP. Individuals with co-morbidities are also less likely to participate (Ruano-Ravina et al., 2016) in CCEP. It has been found that individuals ≥ 65 years had higher adherent rates than younger participants (Turk-Adawi, Oldridge, Tarima, Stason, & Shepard, 2013). Similarly, Beckie et al., (2015) found that women who completed cardiac rehabilitation were more likely to be older (Beckie, Fletcher, Groer, Kip, & Ji, 2015).

An explorative study (Pierobon et al., 2017) found that adherence to pulmonary rehabilitation exercise prescription was lower in those with and predicted by higher BMI, higher depression score and lower anxiety (OR =0.79, CI =0.701-0.903; *P*=0.0004; OR =0.356, CI =0.165-0.770 *P*=0.009; and OR =2.361, CI =0.995-5.627 *P*=0.05, respectively). Low fitness, smoking status and level of depressive symptoms also predicted non-completion of pulmonary rehabilitation (Hayton et al., 2013; Keating et al., 2011).

2.6.3 Behavioural/cognitive

There is a significant relation between self-efficacy and adherence to cardiac rehabilitation (Blanchard, Courneya, Rodgers, Daub, & Knapik, 2002; Daly et al., 2002). Attitude, behavioural control and subjective norms have been identified as correlates of

adherence to cardiac rehabilitation (Blanchard, Courneya, Rodgers, Daub, & Knapik, 2002). Disease related knowledge is also associated with greater adherence to cardiac rehabilitation (Ghisi, Britto, Motamedi, & Grace, 2015) as well as self-motivation, social-support, self-esteem and perceived benefits of cardiac rehabilitation (Daly et al., 2002).

Significant factors relating to initiation and adherence to community-based cardiac rehabilitation included social-support and the individual's knowledge of the health benefits (Martin & Woods, 2012). Of particular significance to the current research, structured classes were reported to be important in fostering task, barrier and recovery self-efficacy to ensure longer term adherence (Martin & Woods, 2012). Furthermore, it has also been identified that there was significant predictive utility of behavioural intentions (OR=2.38, CI 1.03–5.48. p<.05) and action-planning (OR=3.37, CI 1.04–10.94, p<.05) in initiation and attendance at a phase IV community-based cardiac rehabilitation in the year following completion of outpatient phase III cardiac rehabilitation (Sniehotta, Gorski, & Araujo-Soares, 2010). The perceived benefit of attendance has also been identified as a factor contributing to attendance in a community-based post cardiac rehabilitation exercise setting (Horwood, Williams, & Mandic, 2015). Authors subdivided adherence levels by non-attenders, low-attenders and high -attenders, with high and low-attenders citing greater levels of perceived benefit compared to the non-attenders (high-attenders=4.6$\pm$.5, low-attenders=4.5$\pm$.5, non-attenders 3.8$\pm$.2, p<.01) (Horwood et al., 2015a). Knowledge and belief about the consequences of pulmonary rehabilitation including beliefs about the purpose and safety of exercises as well as the outcome expectations have also been shown to be associated with referral, uptake and adherence (Cox et al., 2017). In a supervised

walking group, it was identified that a behavioural correlate of perceived behavioural control was associated with walking behaviour in those with claudication, and explained 8% of the variance in walking activity (Galea & Bray, 2006).

2.6.4 Correlates of exercise referral schemes

A review of factors that influence referral, attendance and completion of exercise referral schemes was carried out and indicated some important correlates of same to the schemes (Morgan et al., 2013). Although not specifically for secondary prevention of chronic illness, and not necessarily in a group setting, the review provides a valuable synthesis of the correlates that may be relevant in community settings for chronic illness exercise. The following are the key themes identified in the synthesis of 35 studies having an association with referral, attendance and completion of exercise referral schemes;

- Referral process
    - Lack of engagement by health care professionals
    - Low priority for GPs
    - Lack of awareness
    - Lack of feedback of schemes
- Motivation
    - Although inconclusive a number of studies reported that participants lacked self-motivation
- Existing health concerns
- Personal commitments (lack of time)

- External support from family or friends
- Religion and culture (Barriers to Muslim women, language problems cited)
- Cost
- Location and travel
- Negative perception of gym environment
- Confident and knowledge in operating equipment
- Personalised nature of programmes
- Support and supervision from providers
- Peer and group interaction and support
- Routines

Table 2.2 Summary table of correlates to chronic illness exercise programmes

Modality of exercise	Environmental correlates	Personal correlates	Behavioural/cognitive correlates
Cardiac rehabilitation	Distance to facility (-) Lack of access to transport (-) Do not drive (-)	Women (-) Presence of co-morbidities (-) Single (-) Lower education (-) Lower income (-)	Self-efficacy (+) Attitude (+) Behavioural control (+) Subjective norm (+) Disease related knowledge (+)
Community-based cardiac rehabilitation	Referral process (+) Structured exercise session (+)		Social-support (+) Knowledge of health benefits (+) Self-efficacy (+) Behavioural intentions (+) Action-planning (+)
Pulmonary rehabilitation	Waiting time for referral and start (-) Travel and transport (-) Physicians knowledge about referral process (+) Disruption to routines (-) Inconvenient timing of the programme (-) Distance to facility (-)	Women (-) Living alone (-) Extremes in age (-) Higher BMI (-) Lower anxiety (+) Higher BMI (-) Smoking status (-) Low fitness (shuttle walk)(-)	Knowledge and belief about consequences of rehabilitation (+) Beliefs about the purpose and safety of exercises (+) Outcome expectations. (+)
Claudication rehabilitation			Perceived behavioural control (+)
Exercise referral programmes	Referral process (+/-) Religion and culture (-) Cost (-) Location and travel (-)	Existing health concerns (-) Personal commitments (lack of time) (-) Routines (+/-)	Motivation (*) External support from family or friends (+)

	Negative perception of gym environment (-) Personalised nature of programmes (+)	Confident and knowledge in operating equipment (+)	Support and supervision from providers (+) Peer and group interaction and support (+)

(+) refers to a positive correlation, (-) refers to a negative correlation, (*) refers to an inconclusive correlation.

2.7 Interventions optimising adherence to physical activity and exercise for the secondary prevention of chronic illness

The National Institute for Health and Care Excellence define a behaviour change intervention as sets of techniques that are used together with the aim of changing the health behaviours of individuals, communities or populations (National Institute for Health and Care Excellence., 2014). With sub-optimal levels of adherence to established forms of rehabilitation, it is unsurprising that interventions have been carried out to improve these rates of adherence. It is evident that to date, the majority of this work has been in the area of structured hospital and outpatient forms of rehabilitation with little research into interventions and strategies to improve adherence in community-based forms of exercise-based rehabilitation.

2.7.1 Strategies and intervention in the hospital and outpatient rehabilitation setting

In a systematic review of interventions to improve uptake and completion to pulmonary rehabilitation, Jones et al., (2017) discussed the one study that was finally included in the analysis (Ringbaek et al., 2010). In this intervention, a tablet computer that was enabled with support for exercise training improved attendance rates and completion rates when compared with a control. The support included an activity diary to be completed by the participant as well as a bank of video exercises the participant could choose to carry out. In the intervention group, 42 out of 46 participants (91%) completed the programme compared with 57 out of 69 controls (82%). The intervention group attended 631 out of 784 sessions and the control group attended 509 out of 724 sessions. (Ringbaek et al., 2010).

A recently updated Cochrane review of interventions to promote utilisation (uptake and adherence) to cardiac rehabilitation concluded that while interventions

may increase cardiac rehabilitation enrolment, adherence and completion, the quality of evidence was low to moderate due to heterogeneity of the interventions used (Santiago de Araújo Pio, Chaves, Davies, Taylor, & Grace, 2019). When compared with control groups, the effects of interventions (in 16 trials) to increase enrolment were significant (risk ratio 1.27, CI 1.13 to 1.42), however this finding does not add value to the current study as intervention prior to enrolment was beyond the scope of the research. Results from interventions, aimed at improving to adherence to cardiac rehabilitation (8 trials) identified a standardised mean difference of 0.38 (CI 0.20 to 0.55) compared to controls. When compared with controls (7 trials), interventions to improve cardiac rehabilitation completion were positive (risk ratio 1.13, CI 1.02 to 1.25). Interventions that were included in the Cochrane review that have relevance to the current research are summarised in **Table 2.3**.

Table 2.3 Summary of relevant interventions from recent Cochrane publication on interventions to promote utilisation of cardiac rehabilitation

Study	**Intervention outline**
Beckie & Beckstead, (2010)	Gender tailored CR programmes. Transtheoretical model of behaviour change based motivational interviewing session at week 1 and 6.
Carroll, Rankin, & Cooper, (2007)	Peer advisor/support started within 48 hours of hospital discharge
Focht, Brawley, Rejeski, & Ambrosius, (2004)	A group-delivered cognitive-behavioural physical activity programme that had he aim of gradually weaning participants from dependency on the CR staff and group programme towards independent self-regulation of physical activity.
Kraal, Peek, Van den Akker-Van Marle, & Kemps, (2014)	Combined motivational interviewing in the initial CR phase with ongoing objective feedback on training progression
Lynggaard, Nielsen, Zwisler, Taylor, & May, (2017)	Interview to assist with learning and coping strategies
McGrady, Burkes, Badenhop, & McGinnis, (2014)	Four 30-minute small group sessions consisting of motivational interviewing (focusing on goal setting, strengthening perceived benefits of CR) and relaxation.
Mosleh, Bond, Lee, Kiger, & Campbell, (2014)	Theoretically informed invitation letter and supportive leaflet.
Oldridge & Jones, (1985)	Self-management techniques, including an agreement to participate in the programme for 6 months to be signed by the participant and the co-ordinator, and self-report diaries to be completed and discussed with the co-ordinator at regular intervals
Parry et al., (2009)	Peer telephone calls focusing on pain management, exercise and encouragement to adopt CR.
Price, (2012)	Individualise personal coaching programme (via phone calls) encouraging uptake to CR and emphasising problem solving, decision making and confidence building.
Suskin et al., (2007)	A letter from the consulting cardiologist endorsing CR.
Wyer et al., (2001)	Theory of planned behaviour informed letter aimed at uptake of CR and subsequent adherence.
This table highlights some relevant studies aimed at improving uptake or adherence to cardiac rehabilitation programmes from the recent Cochrane publication (Santiago de Araújo Pio, Chaves, Davies, Taylor, & Grace, 2019.)	

2.7.2 Strategies and intervention in the community setting

While information relating to interventions and strategies optimising adherence to exercise and to structured hospital based programmes of rehabilitation aids in understanding potential strategies to optimise adherence in the current setting, the behaviour of adherence to a community-based multi chronic illness rehabilitation is a stand-alone behaviour and with that, may have specific strategies that may influence this behaviour. There exists a gap in the literature in the area of interventions and strategies aimed at improving adherence to community-based exercise programmes for those with chronic illness.

While not a paper outlining an intervention to improve adherence, Sniehotta, Gorski, & Araújo-Soares, (2010) explored the predictive utility of the common-sense self-regulation model (CS-SRM) and the extended theory of planned behaviour (TPB) on the behaviour of attendance at phase IV cardiac rehabilitation. Uptake to phase IV cardiac-rehabilitation was found to be significantly higher (66%) in patients completing phase III cardiac rehabilitation who completed an action plan than those who did not complete an action plan (34%) (Sniehotta, Gorski, & Araújo-Soares, 2010). This study adds insight into action planning as a strategy to improve uptake and attendance at phase IV cardiac rehabilitation. The construct of behavioural intentions, and action planning, the component known to "bridge" or mediate the intention behaviour gap has previously been highlighted as a key component in order to improve adherence to exercise and physical activity post cardiac rehabilitation attendance (Sniehotta, Scholz, & Schwarzer, 2005). Qualitative work by Martin & Woods (2012) that explored the correlates of adherence to phase IV community-based cardiac rehabilitation also adds value to potential strategies to influence adherence. While this was exploring the

factors affecting adherence, given the relevance to the current study it needs to be considered. In the qualitative study (Martin & Woods, 2012), self-efficacy for exercise and social-support for exercise were identified as important constructs in long-term adherence to community-based rehabilitation.

Exercise consultations have been found to support the adherence of physical activity and exercise related behaviour change. While originally this intervention was aimed at sedentary health individuals, it has been adapted for improving adherence to activity and exercise attendance in rehabilitation settings including phase IV community-based rehabilitation (Hughes, Adrienne and Mutrie, Nanette, 2006). Exercise consultations, also known as exercise counselling in the United States of America, include the following key components; assessing stages of change, decisional balance (pros and cons), barriers to activity, goal setting and preventing relapse, and social-support (Hughes, Adrienne and Mutrie, Nanette, 2006). Lowther, Mutrie, & Scott, (2002) compared the effect of a fitness assessment, exercise consultation and standard exercise information on the physical activity levels in a group of sedentary healthy individuals and identified that those who received the exercise consultation were significantly more active at 12 months. A similar outcome was observed in a group of sedentary individuals with type 2 Diabetes from a diabetic outpatient clinic (Kirk, Mutrie, MacIntyre, & Fisher, 2004). The intervention made up of exercise consultations delivered at baseline and 6 months, with phone calls at 1- and 3-months post-consultation resulted in greater time spent in physical activity over the 12 months of observation. Those who received the intervention significantly increased total activity with a median difference of 115 minutes (CI 73-150 minutes) compared to controls. Exercise consultations have also been proven to be effective in improving adherence to

exercise following phase III cardiac rehabilitation (Hughes, Mutrie, & Macintyre, 2007). In this study, phase I3 patients were randomised to either an exercise consultation and exercise information group or control group with information only. While both groups were regularly active at baseline, total activity was maintained in the intervention group compared to a significant decrease in activity in the control group. Despite the efficacy of the intervention in maintaining total physical activity, peak oxygen uptake decreases comparably in both groups. These findings suggest that the exercise consultation successfully maintained physical activity for 12 months post phase III cardiac rehabilitation.

The literature pertaining to interventions to optimise adherence to community-based exercise programmes for chronic illness is limited, so further exploration was carried out into literature outlining interventions and strategies improving adherence to physical activity related behaviours in those with chronic illness (and older adults).

A systematic review (van der Wardt et al., 2017) exploring adherence support strategies for exercise interventions in adults with mild cognitive impairment identified some strategies utilised to optimise adherence, however few studies reported included adherence related outcomes to be able to quantify their effectiveness. The strategies included in the review were; the use of behaviour change theories to underpin exercise programmes, individual tailoring, worksheets or exercise booklets, goal setting, phone calls and reminder, newsletter, support to overcome exercise barriers, information adaptation period, individual supervision, support for clinicians, group setting, music accelerometer/pedometer, and emphasis on enjoyable activities. One study that was included in the review (Cox et al., 2013) had the aim of optimising adherence to long term physical activity adherence in adults with memory complaints. This study utilised

a home-based telephone monitored programmes to encourage adherence to self-led physical activity with an individual counselling session, a manual and 6 scheduled phone calls however there was no difference between the groups in levels of adherence.

Another systematic review of interventions used to improve exercise adherence in older adults was carried out by Room, Hannink, Dawes, & Barker, (2017) identified that interventions including feedback and monitoring strategies showed positive outcomes despite currently insufficient evidence to recommend their use. While the authors of this study looked at exercise adherence, this was not necessarily structured exercise in the community setting or caters for those with chronic illnesses. One study that was included in this review, and has particular relevance to this thesis, sought to optimise exercise adherence in adults with claudication (Cheetham et al., 2004). Participants were randomised from a vascular centre to either exercise advise alone or exercise advice and a 45-minute structured exercise and motivation class. At 6-month follow-up the supervised exercise group had improved their treadmill walking by 129% compared to 69% in the advice alone group (p=0.001), with improvements maintained at the 9 and 12 months follow up. This highlights the importance of the structured exercise in the current research setting (MedEx Wellness), however it does not add insight to any potential strategies to optimise adherence to the supervised structured exercise.

Duncan & Pozehl (2003) implemented a 12-week supervised exercise programme followed by 12 weeks of unsupervised home exercise for individuals with heart failure. Sixteen participants were randomised to either exercise only group or exercise and adherence optimising intervention group. The intervention was based on social learning theory and included individualised graphic feedback (in the form of bar

charts) on exercise goals and participation and problem-solving support. After 12 weeks of supervised exercise, both groups had the same adherence to exercise prescription, however following phase 2, the home-based exercise intervention group continued to improve and maintained their adherence compared to the non-intervention group ($t(df= 10) = 3.57$, $p<.01$). The intervention group completed a mean of 5.0 sessions/week, and the exercise-only group completed a mean of 3.4 sessions weeks. This study indicated the positive potential feedback, monitoring, goal setting and support are in adherence to home based structured exercise.

Yates, et al (2005) compared an over the phone or face to face structured educational counselling booster session (brief intervention post completion of cardiac rehabilitation) with usual care. During the booster sessions, participant's individualised goals were used as a basis for intervening and encouragement and praise was provided where appropriate, and there was also discussion around barriers to achievement of goals. Those who received the booster intervention had a greater mean adherence to exercise, however this was not significant at 3 or 6 months indicating the short-term efficacy of the above strategies in short term supervised exercise adherence.

Steele et al., (2008) identified the short-term efficacy of an intervention aimed to optimising exercise adherence following the completion of outpatient pulmonary rehabilitation. Individuals were randomised to the intervention group including counselling on monitoring, and problem-solving in maintaining a home exercise programme or usual care. Results indicate less decline in adherence in the intervention group compared with the control (intervention mean, +3min; control mean, −13min; P=.015), however there was no difference at 1 year follow up.

A Cochrane review of interventions to improve adherence to exercise for adults with chronic musculoskeletal pain(Jordan, Holden, Mason, & Foster, 2010) concluded that self-management techniques, supervised exercise and individualised exercise may enhance exercise adherence. However, they also note the need RCTs with long term follow up as well as a validated measure of exercise adherence. In this review, there were four trials that included an exercise component and an additional adherence optimising component. The first study (Basler et al. 2007) utilised physiotherapy with counselling based on the transtheoretical model of behaviour change in the intervention group, and physiotherapy alone in the control group. While both groups had improvements in their functional capacity, there were no differences in the time spent in physical activity upon follow up between the groups. Friedrich et al., (1998) explored the effect a combined exercise and motivation programme on exercise compliance of patients with lower back pain. Patients were randomised to a standard exercise programme (10 sessions of physical therapy) or a combined exercise and motivation programmes. The motivation programme consisted of 5 additional sessions 1) counselling with focus on locus of control, assisting with barriers and programme tailoring, 2) reinforcement techniques, including positive feedback, 3) oral agreement between client and physiotherapist was reinforced with a written behavioural contract, 4) clients put the behavioural contract in a visible spot in their homes, and 5) an exercise diary. Those in the intervention group were more likely to attend all their physical therapy appointments (p=.0005), however there was no difference in self-reported compliance with long term exercise between the groups. Hughes et al., (2006) assessed the efficacy of an exercise and behaviour change programme followed by home programme with a waitlist control. While the intervention saw greater adherence

outcomes than the control, the study did not explore the potential of the effect of the additional element of the behaviour change intervention on the exercise behaviours so adds limited value to this review of literature. Luszczynska, Gregajtys, & Abraham, (2007) compared the adherence related outcomes of an intervention versus controls. The intervention included an education session on exercise and a discussion with consultant and reinforcing intervention (performing the exercise in front of the consultant and getting reinforcement on the completion) and an exercise diary. The control group received education alone. The intervention group had a significantly higher frequency of exercise at 3 weeks later however there was no longer term follow up.

Room et al., (2017) said that in relation to interventions to improve exercise adherence in older adults, there is need for better reporting, use and the development of theoretically derived interventions, the same holds true in the area of structured exercise adherence for those with chronic illness. Given the importance and need for sustained behaviour maintenance in relation to physical activity and chronic illness there are very few studies available in the literature of interventions/strategies to improve and sustain adherence to CCEPs.

It is evident from the literature outlined that the use of terms such as “attendance” and adherence” are used interchangeably. It is also essential to acknowledge that while it is important to examine interventions to improve adherence to physical activity and exercise related health behaviours, that the behaviours of home exercise, community exercise and outpatient exercise are integrally different and may require different strategies. The availability of relevant literature identifies a gap in the existing knowledge base.

2.8 Theory of behaviour change to influence adherence to CCEP

A number of theories and theoretical models have been developed to understand health behaviours, and in particular the health behaviour of exercise participation. A behavioural theory is a set of inter-related concepts that present a systematic view of behaviour by outlining relations among variables in order to explain the behaviour (Kerlinger, 1986). Early approaches to health promotion and health behaviour change were largely a-theoretical (Buchan, Ollis, Thomas, & Baker, 2012) with theory and practice being viewed seen as the opposite ends of the spectrum (Glanz, Rimer, Viswanath, & Orleans, 2008).

It is generally accepted that physical activity related behaviour change programmes that are theoretically grounded are more effective than a-theoretical strategies (Biddle, Hagger, Chatzisarantis, & Lippke, 2000). Theory provides a lens to better understand behaviour as well as providing a directional approach to understand the behaviour. Theories and models are now acknowledged as important at all stages of behaviour change intervention from planning, to implementation and evaluation. Models draw on a number of theories to understand behaviour and may be particular to a behaviour or setting. While theories may be similar to models in their goal of understanding and outlining behaviour, they differ to models in their mechanism for action. This thesis is underpinned primarily by the Social Cognitive Theory (Bandura, 1998) and the COM-B model of behaviour change (Michie, van Stralen, & West, 2011). However, other relevant theories and models are also examined and explored.

2.8.1 Ecological Models of Health Behaviour

Ecological models of health behaviour refer to the interaction between an individual and his/her environment and are underpinned by the core principal that human behaviour occurs in response to a number of influences. These include intrapersonal, interpersonal, organisational, community, physical environmental and policy influences (**Figure 2.2**). A major limitation of ecological models of health behaviour is that they do not provide guidance in terms of directional mechanisms for a required behaviour change. These multi levels of influence have been acknowledged throughout this research.

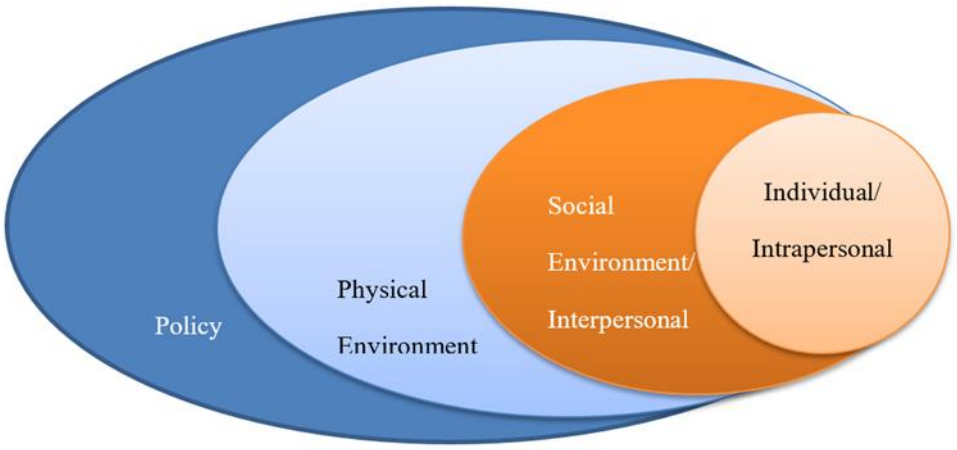


Figure 2.2 Social Ecological Model

2.8.2 Transtheoretical Model

The Transtheoretical model (Prochaska & Diclemente, 1986) is an integrative health behaviour change theoretical model that describes the process of how people change their behaviour. Stages of change, processes of change, decisional balance and self-efficacy are core concepts that underpin the Transtheoretical model. The model proposes that change does not normally happen as one discrete event, but rather occur

over time with progress through six stages which may or may happen in a cyclical manner. The stages are pre-contemplation, contemplation, preparation, action, and maintenance (**Figure 2.3**). In relation to physical activity the stage of pre-contemplation refers to when an individual is inactive with no intention to change; contemplation to an individual who is inactive, but intending to change in the next six months; preparation to an individual who is engaging in some activity, but not regularly; Action to an individual who is regularly physically active, but only began in the past six months); and Maintenance to an individual who is regularly active for more than six months. The model acknowledges that individuals can move in and out of the cycle by relapsing. While the Transtheoretical model may be helpful in understanding how to influence behaviour, it may not be useful in initiating an exercise rehabilitation programme in men and women with chronic disease. Exercise consultations however, as discussed earlier in the chapter, are based on the Transtheoretical model of behaviour change. In recent times, caution is advised in over reliance on the transtheoretical model of behaviour change, as it has been said that problems with the model are so serious that in fact they have held back advances in the field (West, 2005). This is largely due to research indicating the lack of evidence around movement through the discreet stages (Littell & Girvin, 2002). It has also been noted that there is a place for this common sense like approach, in which the want and ability to change is influences by a range of personal and situational factors (West, 2005). The strengths of this model are as such, and in the context of this thesis, have particular importance due to the link with the exercise consultations.

Figure 2.3 Transtheoretical model of behaviour change

2.8.3 Theory of Reasoned Action and Theory of Planned Behaviour

The Theory of Reasoned Action (Ajzen & Fishbein, 1980) posits that behavioural intention is the most proximal determinant of behaviour with attitude and subjective norms contributing to the behavioural intention and subsequent behaviour. Variables external to the model impact intention by their influence on attitude and subjective norms (Ajzen & Fishbein, 1980). The Theory of Planned Behaviour (Ajzen, 1985) extends upon the Theory of Reasoned Action by inclusion of the construct of behavioural control. Perceived behavioural control contributes to intentions and behaviour both directly and indirectly (**Figure 2.4**). Sniehotta, Gorski, & Araújo-Soares, (2010) explored the predictive utility of the Common-sense Self-Regulation Model and the extended Theory of Planned Behaviour on the behaviour of attendance at phase IV cardiac rehabilitation. In the study authors found that uptake to phase IV cardiac-rehabilitation was

significantly higher (66%) in patients completing phase III cardiac rehabilitation in those who completed an action plan than those who did not complete an action plan (34%) (Sniehotta, Gorski, & Araújo-Soares, 2010). The construct of behavioural intentions, and action planning, the component known to "bridge" or mediate the intention behaviour gap has previously been highlighted as a key component in order to improve adherence to exercise and physical activity post cardiac rehabilitation attendance (Sniehotta, Scholz, & Schwarzer, 2005) and so must form an integral component of the Theory of planned behaviour if it is utilised as a part of the thesis.

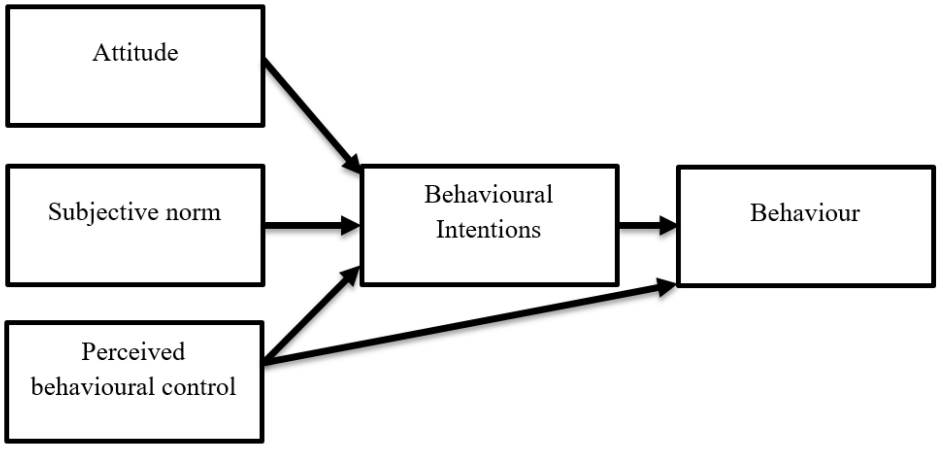


Figure 2.4 Theory of Planned Behaviour

2.8.4 Health Belief Model

The Health Belief Model was developed in the 1950's in order to help understand the failure of individuals to adopt disease detection and prevention strategies (Rosenstock, 1974). It was later extended to understand an individual's response to symptoms (Kirscht, 1974) as well as their behaviour in response to diagnosis (Becker, 1974). The model originally proposed that an individual's perceived threat of a disease

along with their belief in the effectiveness of the health behaviour would lead them to adopt healthy behaviours. The current health belief model proposes that healthy behaviours occurs as a result of perceived susceptibility, perceived severity, perceived benefits, perceived barriers, a cue to action and self-efficacy. While the specificity of this model in relation to illness is clear in that it is associated clearly with illness, it does not allude to other factors that lead to adoption and maintenance of health behaviours. The model however has been effective in its role in Horwood, Williams, & Mandic, (2015) examination of motivations ad barriers or attending community-based cardiac rehabilitation, as well as in Oldridge & Streiner (1990) in which it aided in providing predictive utility in compliance and dropout to cardiac rehabilitation.

2.8.5 COM-B Model

The COM-B model (Michie, van Stralen, et al., 2011) was proposed as a means to understand health behaviour. It is however, also useful in guiding intervention design and planning (Michie, van Stralen, & West, 2011). The model recognises that behaviour is part of an interacting system involving capability, opportunity, motivation and behaviour, and identifies that the individual, group or environment have equal status in controlling behaviour (**Figure 2.5**). Capability is an individual's psychological and physical capacity to carry out the specific behaviour. It included components such as having the skills and or knowledge to carry out the behaviour. Opportunity can be defined as all of the factors that are outside the individual that may influence the behaviour. Motivation is all the brain processes that energise and direct behaviour in a certain way. This can include habits as well as conscious decisions around goals. Figure

2.5 utilises double headed arrows identifying the reciprocal interactions between the components of the COM-B model

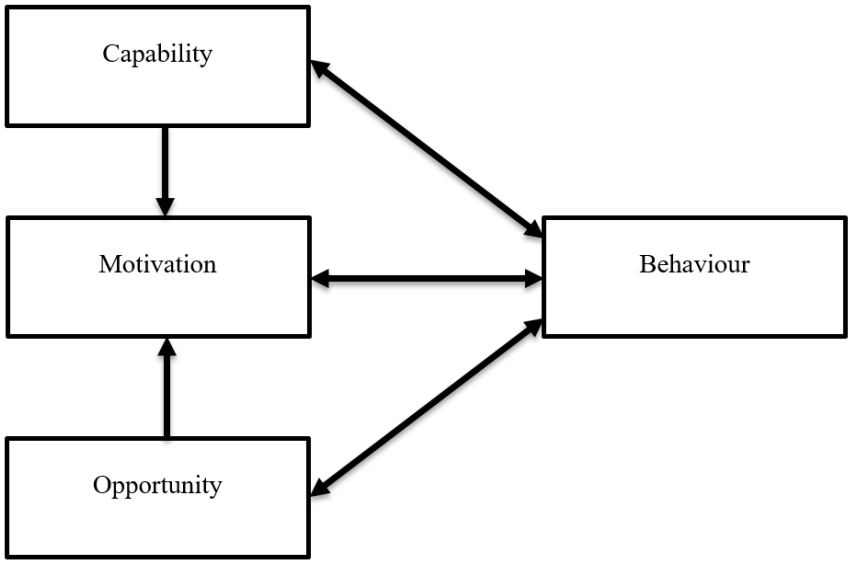


Figure 2.5 COM-B model

2.8.6 Social Cognitive Theory

The Social Cognitive Theory (Bandura, 1998) posits that learning occurs in a social context with a dynamic interaction of the person, environment, and behaviour. The theory emphasises the influence of personal and environment factors on health behaviour and cognitions. Reciprocal determinism is a central concept of Social Cognitive Theory and refers to the dynamic and reciprocal interaction of the individual, the environment and behaviour (**Figure 2.6**). This theory differs from ecological models of health behaviour in that it proposes that individuals can help shape the environment in which their behaviours occur.

Self-efficacy, the confidence in one's abilities is a key construct within the Social Cognitive Theory and had been identified as a major factor in predicting behaviour

(McAuley et al., 2003). Self-efficacy is of particular importance in chronic disease management as low self-efficacy has been consistently associated with lower adherence to exercise based rehabilitation programmes and more positive outcomes (Millen & Bray, 2008; Selzler, Rodgers, Berry, & Stickland, 2016).

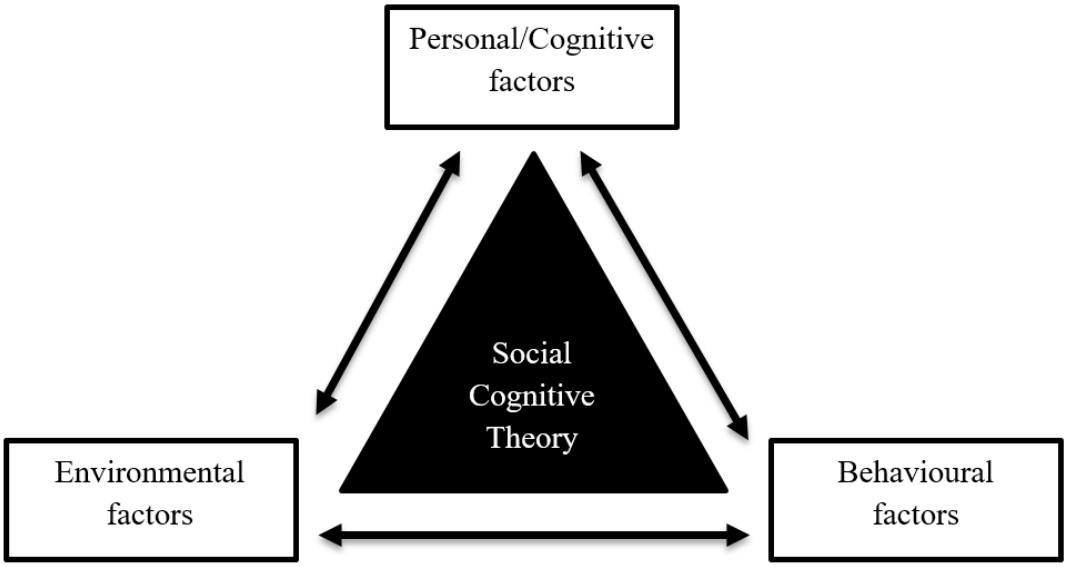


Figure 2.6 Social cognitive theory

Social cognitive theory is a theory that is commonly used in understanding adherence and chronic illness related behaviour and in interventions to promote cardiac rehabilitation utilisation. For example in a recently published Cochrane review on interventions promoting the utilisation of cardiac rehabilitation(Santiago de Araújo Pio et al., 2019), half of all interventions (n=15) had a theoretical grounding and three (Focht et al., 2004; Pfaeffli Dale et al., 2015; Price, 2012) of these had a grounding in social cognitive theory.

2.9 Intervention Development

The theories and models previously reviewed were used primarily in the early stages to understand the health behaviours leading to initiation and subsequent adherence to CCEP. Additional models and frameworks that are used in intervention design and development warrant exploration. The development of the thesis was guided by the MRC framework (Craig, Dieppe, et al., 2008), and it also serves to provide guidance to intervention design and development. It is a framework that provides guidance on the development, evaluation and implementation of complex health interventions to improve health (**Figure 2.7**). Complex interventions have several interacting components (Moore et al., 2015). However, the complexity can also be related to the interaction of the intervention within its context, in this setting those with chronic illnesses in a CCEP. A number of dimensions of complexity have been identified by the MRC framework (Craig *et al.*, 2008) and include:

- The number and difficulty (e. g. skill requirements) of behaviours required by those delivering the intervention;
- The number of groups or organisational levels targeted by the intervention;
- The number and variability of outcomes;
- The degree of flexibility or tailoring of the intervention permitted

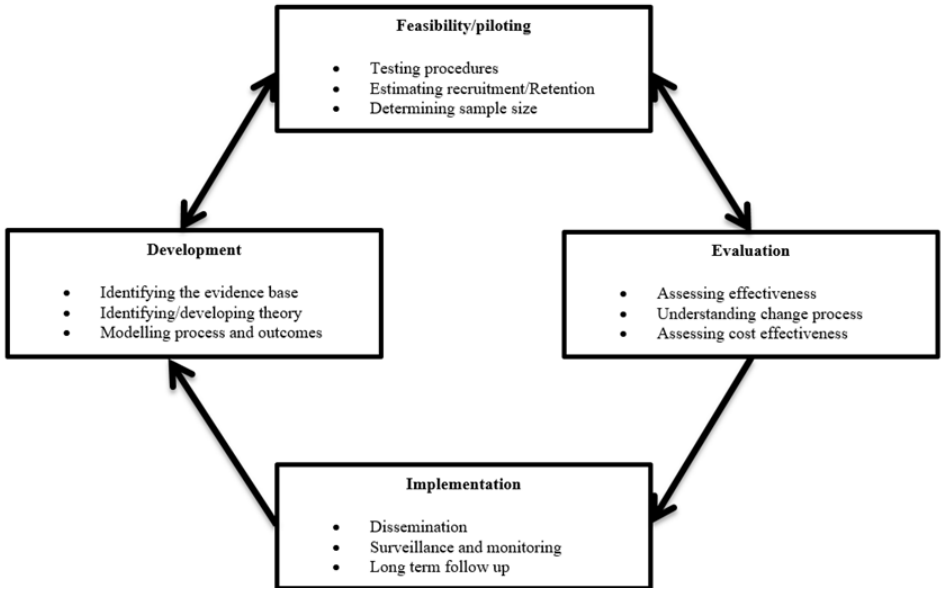
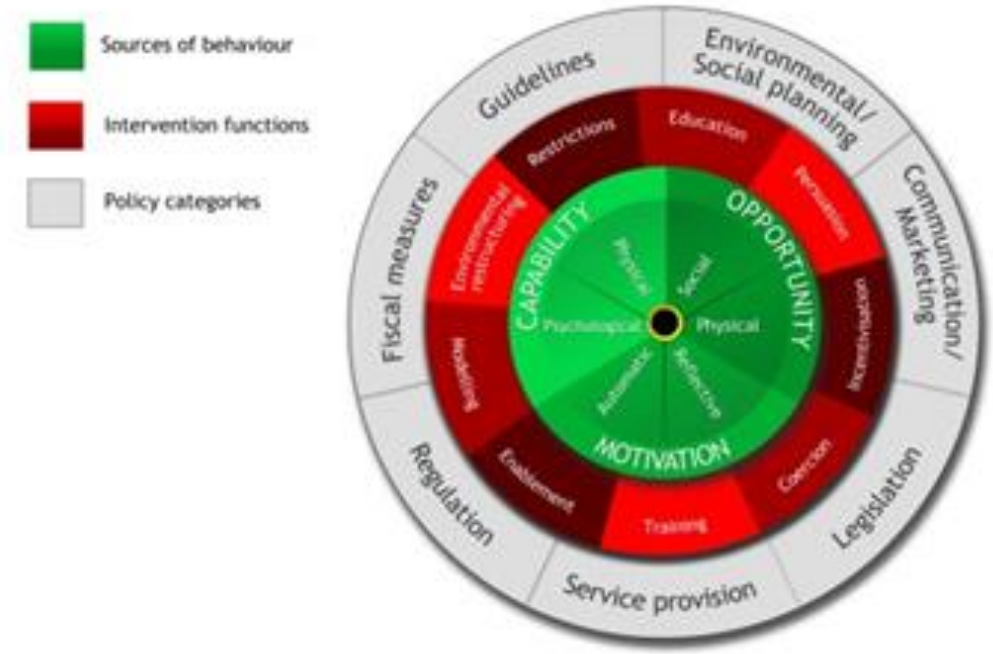


Figure 2.7. MRC Framework

The Behaviour Change Wheel is an additional component of the COM-B model (Michie, van Stralen, & West, 2011) outlined previously that highlights the inter-relatedness of the components of "capability", "opportunity" and "motivation" to an individual's behaviour. The Behaviour Change Wheel (**Figure 2.8**). developed from 19 existing frameworks, aims to guide intervention development and identifies intervention options for each component that can be adopted to change behaviour. It provides a structured approach to designing the behaviour change intervention. The wheel consists of three layers. The central layer refers to the COM-B model, with the next layer identifying the nine intervention functions which are chosen based on the preliminary analysis using the COM-B model. The outer layer consists of seven policy categories that have the potential to support the intervention. There are three stages encompassing eight steps in the intervention design process using the Behaviour Change Wheel.

The behaviour change wheal has been used in the design and development of interventions aimed at health behaviour change or maintenance. For example, Tully et al., (2018) in a recent protocol paper for the pilot RCT of a peer-led walking programme to increase physical activity in inactive older adults, utilised the behaviour change wheal to map promising BCTs on to components of behaviour.

Figure 2.8 Behaviour change wheel



In an effort to improve the reporting of behavioural strategies and interventions Michie et al., (2013) developed an extensive, agreed by consensus, hierarchically structured taxonomy of 93 techniques. A behaviour change technique (BCT) is the smallest observable, replicable component of an intervention, or the smallest "active-ingredient" of an intervention. BCTs form an integral part of the behaviour change wheel in that they guide the choice of most effective BCTs for the specific outcome behaviour. Effective BCTs have been identified for interventions to increase healthy eating and physical activity (Michie, Abraham, Whittington, McAteer, & Gupta, 2009),

smoking cessation (Michie, Hyder, Walia, & West, 2011; West, Walia, Hyder, Shahab, & Michie, 2010) and safe drinking (Michie et al., 2012), but a gap remains for the identification of BCTs for interventions to optimise adherence to CCEP.

2.10 Summary of evidence base

This literature review summarised the benefits of physical activity and exercise for the secondary prevention of chronic illness and the benefits of chronic illness exercise programmes. Community-based exercise programmes have been put forward in recent times for their sustainable potential. Chronic illness groups can be combined in exercise programmes due to similarities in the recommended exercise guidelines and similarity in presence of comorbidities. Despite the benefits associated with exercise it appears that these benefits are not being achieved to the full potential due primarily to sub-optimal adherence and so it is evident that intervention is warranted. Theory has helped guide and enable researchers to identify correlates of adherence to existing CCEPs. A knowledge gap exists with regard to interventions and strategies that are effective in improving adherence to CCEPs. Theoretical models of behaviour change and those that can aid in intervention development and design have been discussed.

Chapter 3

Study 1

Rates and correlates of adherence to a community-based chronic illness exercise programme

3.1 Introduction

Hospital and community-based chronic illness rehabilitation programmes improve health-related quality of life, exercise capacity and functional status and reduce hospital readmissions and mortality (Abbassian, Khan, Poulter, Ransome, & Thomas, 2006; Beauchamp, Francella, Romano, Goldstein, & Brooks, 2013; Clark, Hartling, Vandermeer, & McAlister, 2005; Desveaux, Beauchamp, Goldstein, et al., 2014b; A. R. Jenkins et al., 2018; Mendes, Sousa, Themudo-Barata, & Reis, 2016; Taylor et al., 2004). Despite the acknowledged benefits of exercise for patients with chronic illness, the rates of initiation and ongoing attendance vary substantially between forms of formal institutional rehabilitation, exercise referral schemes and CCEP, and are generally sub-optimal. For example, in Ireland it has been estimated that adherence rates to phase III cardiac rehabilitation in Ireland range from 76% to 96% (Delaney et al., 2006) and estimated completion rates for outpatient pulmonary rehabilitation internationally varies between 56% and 77% (Cassidy, Turnbull, Gardani, & Kirkwood, 2014; Fischer et al., 2009; Man et al., 2004; Zakrisson et al., 2011). The referral rate to community-based phase IV cardiac rehabilitation is only 19% in Ireland (Delaney et al., 2006) with no evidence of the adherence once a participant initiates the programme. The international literature pertaining to community-based programmes for other chronic illnesses is equally as varied. A community-based pulmonary rehabilitation maintenance programme found that only 46 of the 84 participants (55%) who started the exercise programme completed the it (Cockram et al., 2006). The completion rate for patients with claudication attending a structured exercise programmes has been reported to be 75% (Harwood et al., 2016). McNamara et al., (2016) identified that in a

community-based setting for patients with chronic respiratory and chronic cardiac disease, of the 76 patients attending for assessment, 31 commenced the 8-week programmes and 22 completed it. In addition to representing a significant waste in resources, poor adherence rates contribute to the low levels of individual improvement in health-related outcomes, with poor patient outcomes acknowledge by Beauchamp and colleagues (2013) to be associated with low levels of adherence.

Although much can be learned in relation to the correlates of initiation and ongoing adherence to CCEP from the existing evidence, effective comparison is limited due to differences in programme length, modality, structure and chronic illness groups. In relation to adherence, current evidence of the correlates focus on programmes for specific chronic illnesses such as cardiac rehabilitation or pulmonary rehabilitation and are often of fixed duration. The correlates of adherence to CCEP of continuous duration is lesser known. The literature points to numerous correlates of attendance to formal and community models of rehabilitation including; health-related fitness, gender, age, marital status, education, and socioeconomic status, referring professional, transport and existence of a referral pathway (Jackson, Leclerc, Erskine, & Linden, 2004; Keating, Lee, & Holland, 2011; Sun, Jadotte, & Halperin, 2017). Modifiable psychosocial correlates of attendance to CCEP similar to that in the current study, include; social-support, belief in health benefits, self-efficacy, intentions, action-planning and perceived benefit (Martin & Woods, 2012; Sniehotta, Gorski, & Araújo-Soares, 2010). It is generally accepted that physical activity related behaviour change interventions that are theoretically grounded are more effective than a-theoretical strategies (Biddle et al., 2000), and so theory has played an integral role in the intervention design.

Chronic illnesses represent a substantial burden in terms of disease burden (WHO, 2017). With this growing epidemic, the current healthcare model is unsustainable. Evidence suggests overlap in the management of chronic illness (Desveaux, 2015) and thus overlap in the delivery of CCEP as a promising opportunity.

3.2 Research questions

Study 1 addresses the following research questions:

- **Question 1**: What are the rates of adherence to a CCEP?
- **Question 2:** What are the correlates of initiation, attendance and retention to a CCEP?

3.3 Aims and Hypotheses

3.3.1 Aims

- To identify the rates of initiation, attendance, retention and time to dropout to a CCEP.
- To determine the demographic, behavioural, psychological and physical health-related correlates of initiation, attendance and retention.

3.3.2 Hypotheses

1. Rates of initiation, attendance and retention will be low.
2. Those who initiate the CCEP will have better health-related fitness and more positive scores on the behaviour change measures (self-efficacy, social-support, intentions) than non-initiators.

3. Higher attendance at the CCEP will be positively correlated with health-related fitness, behaviour change outcomes, health-related wellness, health service usage and early stage attendance.

3.4 Methodology

3.4.1 Overview of study design

Study 1 is a prospective study encompassing cross-sectional and prospective analysis designs. **Figure 3.1** presents an overview of Study 1, including the timeline, procedures and outcomes.

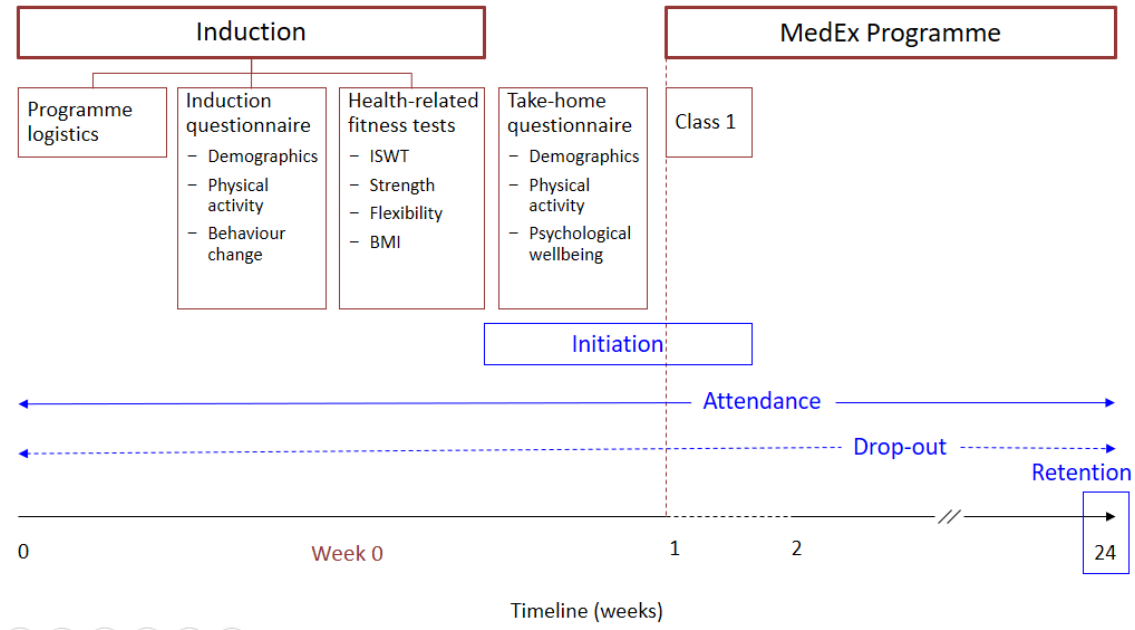


Figure 3.1 Overview of Study 1

3.4.2 Research setting

This research study was undertaken in a university-based, user pay CCEP called MedEx Wellness (MedEx), which represents a community setting. Individuals with chronic illness are referred to CCEP by hospital specialists and primary care physicians.

Participants are assigned to one of four class programmes based on their primary chronic condition; cardiac rehabilitation (HeartSmart), pulmonary rehabilitation (BreatheSmart), claudication rehabilitation (SmartSteps) and a Diabetes care programme (DiabetesHealthSteps). Each programme has a rolling commencement date and a continuous duration. Unlike other established forms of chronic illness rehabilitation, the structured supervised exercise sessions are offered participants for as long as they want to remain attending.

Sessions are scheduled in the morning, afternoon and evening from Monday to Saturday. Participants are recommended to attend two exercise sessions a week and each session has approximately 15-70 participants. All exercise sessions adhere to the same structure of 60 min duration including a warm-up, aerobic exercise, resistance exercise and cool-down followed by a social tea/coffee. Trained staff in a ratio of 1:15 led exercise sessions. Participants could choose which exercise sessions to attend but were encouraged to attend the same sessions every week to foster social-support and habit formation.

3.4.3 Participant recruitment

Potential participants with established chronic illness referred to the CCEP were invited to an induction session prior to starting the programme. Participants were recruited at the induction to the programme (rolling recruitment) over one year commencing in September, 2014. A plain language statement was provided, and participants had the opportunity to ask questions. Participants were required to provide written informed consent. All programme participants opted in to the research study,

with one participant withdrawing consent at a later date. This participant's data was removed in line with research ethics. The study was approved by Dublin City University Research Ethics Committee (DCUREC3014227).

3.4.4 Inclusion criteria

Inclusion criteria included the following;

- ≥18 years of age
- Presence of an established chronic illness
- A referral from a medical professional outlining patient safety to participate in the CCEP.

3.4.5 Overview of procedures

Participants attended a 2 hour induction session staffed at a ratio of one tutor to six participants. The programme timetable, car parking arrangement, facility access, and costs (€8 per session or €45 a month) were explained to participants. Participants completed a questionnaire and undertook a series of health-related fitness assessments. Prior to leaving the facility, the participants received a second questionnaire which they were asked to complete at home and return to the researchers on the first day of attendance at the programme. Programme initiation was recorded, and attendance was monitored over 24 weeks.

3.4.6 Questionnaire design and development

A multi-section, self-report survey was developed to assess physical activity behaviour and the correlates of initiation and attendance. The theoretical constructs to be assessed were identified based on the existing evidence followed by a search of the evidence for the most appropriate measure to assess this construct. Social Cognitive Theory (Bandura, 1998) (personal, behavioural and environmental factors) and the COM-B model of behaviour change (Michie, van Stralen, et al., 2011) underpinned the questionnaires. All elements included in the questionnaires were psychometrically valid where appropriate.

3.4.6.1 Questionnaire pilot work

Prior to the beginning of the study, a pilot questionnaire and a plain language statement were mailed to potential participants along with the invitation to the induction day. Potential participants who did not attend the induction session were contacted by phone by a member of the administrative staff. Following informal conversations with participants and feedback from administrative staff, it was highlighted that the long questionnaire was a barrier to attendance. As a result, the questionnaire was divided into two components and administered at induction day and as a take home questionnaire.

3.4.7 Descriptive and correlational measures

The full range of descriptive and predictive variables were not collected for the entire sample. This was due to the fact that the "Take-home questionnaire" was not returned by participants who did not initiate the CCEP after induction. **Table 3.1** outlines

the correlates that were measured and are available for analysis corresponding to the outcome measure.

Table 3.1 Correlates available by mode of measurement for initiation and attendance

Correlate		Initiation	Attendance
Health-related fitness physical measures			
• ISWT	Singh, Morgan, Scott, Walters, & Hardman, (1992)	Yes[a]	Yes
• Strength	Csuka & McCarty, (1985)	Yes	Yes
• Flexibility	Baumgartner & Jackson, (1998)	Yes	Yes
• BMI		Yes	Yes
Demographic information			
• Age		Yes	Yes
• Gender		Yes	Yes
• Distance to facility		Yes	Yes
• Chronic disease group (CDG)		Yes	Yes
• Marital status		No[b]	Yes
• Educational attainment		No	Yes
• Employment status		No	Yes
• Presence of co-morbidity		No	Yes
Self-report physical activity			
• Habitual PA	Prochaska et al., 2001	Yes	Yes
• IPAQ	Craig et al., 2003	No	Yes
Behaviour Change			
• Self-efficacy	Luszczynska & Sutton, 2006; Shields & Brawley, 2006	Yes	Yes
• Intentions	Sniehotta, Schwarzer, Scholz, & Schüz, 2005	Yes	Yes
• Social-support from family	Sallis, Grossman, Pinski, Patterson, & Nader, 1987	Yes	Yes
• Social-support from friends	Sallis, Grossman, Pinski, Patterson, & Nader, 1987	Yes	Yes
Health-related wellness			
• Wellness (SF12)	Ware, Kosinski, & Keller, 1996	No	Yes
• Depressive symptoms	Kroenke et al., 2009	No	Yes
• Health service usage	Kenny et al., 2010	No	Yes

Abbreviation list: PA= physical activity, ISWT= Incremental Shuttle Walk Test, BMI=Body Mass Index, IPAQ = International Physical Activity Questionnaire.

[a] Yes refers to availability of variable for the outcome of Initiation or Attendance.

[b] No refers to availability of variable for the outcome of Initiation or Attendance.

3.4.7.1 Health-related fitness assessment

The health-related fitness measures were assessed via a battery of physical fitness measures and questionnaire components.

Body Mass Index (BMI) was measured by assessing a participant's height (cm) and weight (kg) to the nearest 0.1 cm and 0.1 kg, respectively, using a stadiometer and scale (SECA Leicester Height Measure). BMI was calculated as body mass (kg) divided by squared body height in metres.

Aerobic fitness was assessed using an Incremental Shuttle Walk Test (Singh et al., 1992) (ISWT). Participants walked between two lines 10-m apart at progressively faster speeds signalled by an audio signal (beep). The number of completed laps was recorded. If a participant failed to reach the line by the time the "beep" sounded, they were given one more opportunity to catch-up and if they failed to do the test was completed.

Lower body strength was assessed using a sit to stand test (Csuka & McCarty, 1985). From a seated position with their arms crossed and their right and left hand placed on left and right shoulder respectively, participants were instructed to stand and sit 10 times as fast as possible (**Figure 3.2**). The test commenced following a "3,2,1, Go" countdown by the examiner. The test was monitored to ensure that participants stood up fully and placed their buttocks completely on chair during each repetition. The time taken to complete the task was recorded to the nearest 0.1 of a second with a stop watch.

Figure 3.2. Sit to stand to measure lower body strength

Flexibility was assessed using a modified sit and reach test (Baumgartner & Jackson, 1998). Participants sat on a flat bench with their legs fully extended and feet against a sit and reach box (Eveque Leisure Equipment Ltd, Cheshire, UK) (**Figure 3.3**). Participants reached forward as far as possible while sliding their fingers along the measurement scale on top of the sit and reach box and exhaling. Measurements were recorded to the nearest cm. Each participant performed three trials with the best score recorded for analysis. When the maximal reach distance was short of the sit and reach box, the distance between the fingers and the box was measured with a tape measure and a negative distance was recorded.

Figure 3.3. Sit and reach test to measure flexibility

Habitual physical activity (HPA) was assessed using a modified two-item measure (Prochaska et al., 2001). Participants were provided with definitions of moderate and vigorous physical activity and instructed to only include activities of this intensity when completing the questions. The first item asked participants the number of days (0–7) they were physically active for a total of at least 30 minutes per day in the past seven days. The second item asked the same question with respect to a usual week. HPA was defined as the mean number of days that a participant had accumulated 30 minutes of moderate-to-vigorous physical activity and was calculating by averaging the scores from the two items (Cronbach Alpha, α =.941).

Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ) short form (Craig et al., 2003). This seven item measure included the following example *"During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?".* Responses were converted to Metabolic Equivalent Task (MET) minutes and are presented as total MET minutes, walking MET minutes, vigorous MET minutes and moderate MET minutes.

3.4.7.2 Induction questionnaire

The induction questionnaire was completed onsite during the induction session. **Appendix C** outlines the questionnaire.

Demographics including age and gender were obtained along with referral information and the participant's address. Distance to facility was calculated using Google Maps and recorded in km. The individual's primary chronic illness determined which chronic illness exercise group (CIG) they were allocated to.

Social-support for exercise from family and friends was assessed using a validated tool (Sallis et al., 1987) with 10 items assessing support from family and 10 items reflecting support from friends. Participants were asked, for example, how frequently over the past three months "*a family member offered to exercise with you*". Responses were recorded on a Likert scale of 1-5, with higher scores representing greater social-support (Cronbach alphas α = .913 (friends), α = .913 (family)).

Intentions for exercise were assessed using a modified 6-item measure (Sniehotta, Schwarzer, et al., 2005) to assess intentions to exercise as well as intentions to attend the CCEP. Questions included the stem "*I intend to*" and item examples were "*exercise several times a week*", and "*attend MedEx at least once a week*". Likert scale responses ranged from 1 (completely disagree) to 4 (totally agree) with a higher score indicating greater intentions for exercise (Cronbach alpha, α =.908).

Self-regulatory self-efficacy for exercise was assessed using a modified 11-item scale (Luszczynska & Sutton, 2006; Shields & Brawley, 2006). Items within this scale also provided specific information on task, scheduling, and recovery self-efficacy. Participants were asked the stem "*How confident are you that you can…"* and included items such as "*plan exercise sessions that will be at least moderately difficult (e.g. have you breathing a little hard, your heart rate increases)?*". Participants rated their confidence on a Likert scale from 0 (not confident at all) to 10 (very confident), with a higher score indicating greater self-efficacy for exercise (Cronbach alpha, α = .953).

3.4.7.3 Take-home questionnaire

At the end of the induction session, a take-home questionnaire was given to participants to complete at home and return on their first attendance to the programme. Participants who returned to the programme without the questionnaire received verbal reminders from programme staff and those who required assistance in completing the questionnaire were asked to contact a member of the staff or research team. The take-home questionnaire is presented in **Appendix D.**

Demographics including marital status, employment status, educational attainment, referral source and presence of self-report chronic illness were collected.

Depressive symptoms were measured using the 8-item patient health questionnaire (PHQ8) (Kroenke et al., 2009), a validated diagnostic and severity measure of depression. The questions include the stem "*how often during the past two weeks were you bothered by*…" with examples including "*little interest in doing things*" and were answered on a Likert scale form 0-3 with 0 being "not at all" and 3 being "nearly every day" (α =.788).

Health-related wellness was assessed using the physical and emotional health subscales of the SF-12 Health Survey (Ware et al., 1996). The SF-12 Health Survey consists of 12 questions producing both a physical and a mental component summary score. All questions have a 2-6 response level with a higher score indicating better physical or mental health. For example, the first question asked "*In general would you say your health is…*" With responses on a 5 item Likert scale from 1 to 5 with 1=excellent and 5 = poor.

Health service usage for the previous six months was obtained using a questionnaire modelled on The Irish Longitudinal Study on Aging (Kenny et al., 2010). Questions ask about the frequency of use of general practitioner services, hospital outpatient services and nights spent in hospital. For example, "*In the last 12 months, about how often did you visit you GP?*". A space was available to write a number with a guide above this space indicating the range from 0-200.

3.4.8 Outcome variables

3.4.8.1 Initiation

Initiation as a binary variable represents whether the participant attended a supervised exercise session following induction. On arrival at the reception area of the Sports Centre at Dublin City University, participants scanned a wristband fob (which they received at induction) to access the facility and register for their session. Initiation rates were monitored between June 2014 and July 2015.

3.4.8.2 Attendance

Attendance was defined as a physical presence at an exercise session and was reported as the total attendance in the 24-week period. Preliminary scoping of attendance data indicated patterns of attendance. This preliminary analysis highlighted high levels of attendance during the initial four weeks followed by a gradual decrease in attendance between weeks 4 and 12 and a levelling off period that was associated with more gradual decline in attendance during the final 12 weeks. Therefore, attendance in first 4 weeks, weeks 5 to 12 and weeks 13 to 24. Attendance rates were monitored using the data provided by the wristband fob that was used by each participant to access the facility at each visit.

3.4.8.3 Time to dropout

Time to dropout was defined as the time period from the induction day to the last week that an attendance was recorded. Caution is required in interpreting this construct as it may not reflect a true "dropout". A participant may in fact be absent for a period and return to the programme following the period of research observation.

3.4.8.4 Retention

Retention was defined as attending a CCEP session during week 24. Again, caution is required in interpreting this construct as it may not reflect a true retention. The participant may be engaged with the programme but be absent at week 24. The construct of retention as an outcome variable, albeit crude, serves the purpose of identifying engagement with the programme at a specific time point.

3.4.9 Data treatment

3.4.9.1 Data storage

Hard copies of data including questionnaires and physical measurement record sheets were stored in a locked area in the School of Health and Human Performance at Dublin City University. An electronic copy of data were saved in Statistical Package for Social Sciences (SPSS) and included unique participant ID numbers to ensure participant confidentiality.

3.4.9.2 Data entry

Data input was undertaken by the author and designated undergraduate and graduate level students. All researchers were trained in the use of SPSS for the purpose of data input. The author prepared a blank SPSS template file with pre-entered variable

names, values, labels. This blank template was provided to the input team. An additional SPSS template file was given to the research team to record ID numbers and sensitive personal data (names and date of birth), independent of the main survey data. Responses to open-ended questions were typed in full into the dataset. Approximately 5% of each questionnaire input batch was selected at random by the author and checked for quality and accuracy by comparing to the hard copy data. Each "batch" of questionnaires were compiled based on the recruitment week. If there were any errors in the questionnaire input, the full batch was examined for further errors. The author failed to record the percentage of agreement.

3.4.9.3 Data cleaning and scoring

Data were screened for outliers, irregular data and missing data using descriptive statistics including means, frequencies, standard deviations, minimum values, maximum values, skewness and kurtosis. Expectation maximisation was used to impute minimal missing data using SPSS, on the tools of social-support from family, social-support from friends, self-efficacy and intentions only when a minimum of 70% of responses were made on each scale for each participant. A number of measures within the questionnaires required scoring and were done so using recommended scoring protocols.

3.4.9.4 Data analysis

The data were identified as not normally distributed but given the outcome of attendance and population at hand this was hypothesised. Data were analysed using SPSS v.21 (IBM Corp, Armonk, NY). Descriptive statistics including mean, median, standard deviations, proportions and bivariate correlations were carried out and

reported as appropriate (Field, 2013). Independent samples t-tests were used to explore and identify difference in measured variables between genders. Chi-square analysis was used to explore the difference in proportions such as CIG and gender. ANOVAs were used to analyse the relation between attendance and the demographic and CIG related variables. Bonferroni post hoc analysis was carried out to identify where the significant differences lay as identified in ANOVA analysis.

The internal consistency of self-report measurement scales was tested using Cronbach Alpha (α) where applicable. Binary logistic regression was used for multivariate analysis on the dichotomous outcome of initiation, with Lemeshow and Homer's test statistic used to assess the goodness of fit. Negative binomial regression was used for multivariable analyses, modelling count outcomes as appropriate (Tabachnick & Fidell, 2013). Models were built using the strategy of demographic variables in the first block, health-related fitness in further blocks, behaviour change variables in subsequent blocks and finally health service usage and health and wellbeing variables were then included. Variables were included in modelling based on knowledge of association, the literature and/or when the variable showed at least a $p<0.15$ association with the outcome measure.

3.5 Results: Participant characteristics

A total of 381 participants (mean age=64.07± 11.59, 56%=male) were recruited. The sample was recruited in one year in line with time feasibility as part of the PhD timeline. Participant characteristics are presented **Tables 3.2-3.4,** illustrating the mean, median and standard deviation and proportion where appropriate. Independent samples t-tests and chi-square analyses were performed, and p-values reported in the tables to indicate gender difference in participant characteristics.

3.5.1 Demographic variables

Table 3.2 presents participant descriptive demographic characteristics of the sample recruited.

Table 3.2 Participant characteristics (demographic variables)

	Full sample		**Men**		**Women**		
Variable	**N=381**	**Mean ± SD, or percentage (%)**	**N=218 (57.2**	**Mean ± SD, median or percentage (%)**	**N=163 (42.8)**	**Mean ± SD, median or percentage (%)**	**P value**
Age (years)	381	64.07± 11.59, 65	218	63.30±11.70, 65	163	65.09± 11.40, 66	.136[a]
Distance from facility (km)	381	10.03± 15.77, 5.5	218	10.28± 14.14, 6	163	9.69± 17.75, 4.7	.721[a]
Marital status	262		142		120		.01* [b]
Married/living with partner	183	69.8%	111	78.2%	72	60%	
Single	22	8.4%	9	6.3%	13	10.8%	
Separated/divorced	22	8.4%	10	7%	12	10%	
Widowed	35	13.4%	12	8.5	23	19.2%	
Education	256		139		117		.03*[b]
None/primary school	46	18%	16	11.6%	30	24%	
Junior cert or equivalent	66	25.8%	38	27.3%	28	23.9%	
Leaving cert or diploma	99	38.7%	57	41%	42	35.9%	
Degree	45	17.6%	28	20.2%	17	14.6%	
Employment status	264		143		121		.00**[b]
Unemployed	10	3.6%	7	4.9%	3	2.5%	
Student	1	0.4%	1	.7%	0	0%	
Homemaker	22	8.3%	1	.7%	21	17.4%	
Unable to work due to illness	53	20.1%	26	18.2%	27	22.3%	

Employed	41	15.5%	33	23.1%	8	6.6%	
Retired	121	45.8%	67	46.9%	54	44.6%	
Other	16	6.1%	8	5.6%	8	6.6%	
Chronic illness group	381		218		163		.000** [b]
HeartSmart	150	39.4%	93	42.7%	57	35%	
BreatheSmart	145	38.1%	62	28.4%	83	50.9%	
SmartSteps	55	14.4%	40	18.3%	15	9.2%	
DiabetesHS	31	8.1%	23	10.6%	8	4.9%	
Referral source	263		144		119		.241
Phase III cardiac rehabilitation	53	20.2%	36	25%	17	14.3%	
Hospital consultant	123	46.8%	62	43.1%	61	51.3%	
GP	76	28.9%	39	27.1%	37	31.1%	
Other	11	4.2%	7	4.9%	4	3.4%	

Abbreviation list: SD=standard deviation

[a] p-value following undertaking independent samples t-tests between gender

[b] p-value following undertaking Chi-square test between gender and variables

* $P < 0.05$; ** $P < 0.01$

3.5.2 Behaviour change, health-related wellness and health service usage information

Table 3.3 presents behaviour change, health-related wellness and health service usage information of research participants.

Table 3.3 Participant characteristics (behaviour change, health-related wellness and health service usage information)

	Full sample		**Men**		**Women**		
Variable	**N=381**	**Mean ± SD, median or percentage (%)**	**N=218 (57.2**	**Mean ± SD, median or percentage (%)**	**N=163 (42.8)**	**Mean ± SD, median or percentage (%)**	**P value**
No. of chronic illnesses	279	1.63±.91, 1	144	1.54± .83, 1	127	1.76±.98	.05[a]
Self-rated health	215		115		100		.275[b]
Excellent/very good	34	15.9%	22	29.3%	12	12%	
Good	102	47.4%	55	47.8%	547	47%	
Fair	66	30.7%	31	27%	35	45%	
Poor	13	6%	7	6.1%	6	6%	
Behaviour change							
Social-support from family	361	2.10±1.02, 1.82	208	2.12±1.02, 1.90	153	2.08±1.01, 1.8	.673 [a]
Social-support from friends	270	1.63±.85, 1.3	162	1.6 2±.89, 1.2	108	1.63±.79, 1.3	.850 [a]
Intentions for exercise	363	3.26±.64, 3.33	208	3.34±.60, 3.50	155	3.15±.67, 3.06	.004** [a]
Self-efficacy for exercise	357	7.14± 2.35, 7.54	208	7.50±2.33, 8	149	6.66±2.29, 6.86	.001** [a]
Health-related wellbeing							
PHQ8	184	5.55±5.14, 4	100	5.15±5.13, 4	84	6.02±5.14,5	.25 [a]
SF12-physical functioning	219	44.12±7.03, 44.07	116	45.48± 7.25, 46.4	103	42.59± 6.48, 42.59	
SF12-mental role functioning	219	45.28±9.69, 48.18	116	45.87± 9.80 , 49.12	103	44.61± 9.57, 46.93	.002**[a]
Health-service usage			114		101		
Full medical card	121	56.3%	57	50%	64	63.4%	
GP visit card	14	6.5%	10	8.8%	4	4%	
Number of GP visits	184	6.57±5.62, 5	104	6.12± 4.62 , 5	80	7.16± 6.68, 5.5	.211[a]

Number of hospital outpatient visits	199	6.24±7.01, 4	110	6.35± 7.14, 4	89	6.10± 6.89, 4	.144[a]
Nights in hospital	206	6.40±12.08, 1	108	7.16± 12.88 , 1.5	98	5.57± 11.13, .5	.808[a]

Abbreviation list: SD=standard deviation, PHQ8 = Patient health questionnaire, SF12=Short form 12 questionnaire [a] p-value following undertaking independent samples t-tests between gender

[b] p-value following undertaking Chi-square test between gender and variables

* $P < 0.05$; ** $P < 0.01$

3.5.3 Health-related fitness and physical activity measures

Table 3.4 presents health-related fitness and physical activity levels of research participants..

Table 3.4 Participant characteristics (health-related fitness and physical activity)

	Full sample		**Men**		**Women**		
Variable	**N=381**	**Mean ± SD, or percentage (%)**	**N=218 (57.2)**	**Mean ± SD, median or percentage (%)**	**N=163 (42.8)**	**Mean ± SD, median or percentage (%)**	**P value**
Health-related fitness							
ISWT (laps)	281	41.19±23.51, 36	156	48.66±24.56,45	125	31.86±18.32, 29	.00** [a]
Strength (seconds)	321	20.10± 6.36, 19.10	186	19.46±6.75, 18.72	135	20.98±5.69, 20	.03* [a]
Flexibility (cm)	337	7.97±8.74,8	186	6.47±9.11, 6.75	151	9.81±7.92, 10	.000** [a]
BMI ($kg/m^{2)}$	345	29.89±6.48,29	192	29.38±6.09, 28.8	153	30.53±6.91, 30	.103 [a]
Habitual PA screening (days in MVPA)	348	3.48±2.31,3.5	201	3.73±2.33, 4	147	3.14±2.25, 3	.02* [a]
Total MET minutes	176	2218.57±2675.04	96	2886.91± 3157.5, 1791	80	1416.57± 1633.53, 823.5	.001** [a]
Moderate MET minutes	193	488.91±962.76	102	670.39± 1152.99, 50	91	285±637.49, 0	.004* [a]
Vigorous MET minutes	202	638.42±1510.57	108	995.18± 1911.57, 0	94	228.51±640.18, 0	.000** [a]
Walking MET minutes	193	996.07±1051.79	104	1094.39± 1047, 792	89	881.17± 1051.22, 495	.161 [a]

Abbreviation list: ISWT=Incremental shuttle walk test, BMI=Body Mass Index, IPAQ= International physical activity questionnaire, MET=Metabolic equivalent of task.

[a] p-value following undertaking independent samples t-tests between gender

[b] p-value following undertaking Chi-square test between gender and variables

* $P < 0.05$; ** $P < 0.01$

3.6 Results: Rates of adherence

Primary outcomes measures for rates of initiation, attendance, time to dropout and retention are presented in **Table 3.5**. Rates of adherence are further presented by gender, and CIG. This section is responding to and in line with the first aim of Study 1;

- To identify the rates of initiation, attendance, retention and time to dropout to a CCEP.

Table 3.5 Rates of adherence

	Rate of Initiation (%)	**Attendances in 24 weeks** (mean ± SD, median)	**Attendance in first 4 weeks** (mean ± SD, median)	**Attendance weeks 5 to 12** (mean ± SD, median)	**Attendance in weeks 13 to 24** (mean ± SD, median)	**Time to dropout[a] (weeks)** (mean ± SD, median)	**Retention (%)**
Full sample	73.2%	11.13±12.42, 6	3.08±2.54, 2	3.85±4.85 2	4.20±6.5, 0	11±9.88, 7	21.3%
Gender							
Men	69.7%	11.23± 13.31, 5	2.98±2.59, 3	3.88±5.36, 1	4.36±6.83, 0	10±10.11, 6	20.2%
Women	77.9%	10.98± 11.15, 7	3.21±2.47, 3	3.81±4.08, 2	3.97±6.05, 0	11±9.81, 9	22.7%
Chronic illness group							
HeartSmart	74%	12.4 ±13.15, 7.5	3.27±2.58, 3	4.10±4.97, 2	5.06±7.11, 0*[b]	11±10.06,9	18.7%
BreatheSmart	74.5%	8.67±9.94, 5	2.79±2.31, 2	3.18±4.04, 1	2.70±5.09, 0	10±10, 6	22.8%
SmartSteps	74.5%	14.09±14.09, 8*[a]	3.62±2.85, 4	4.98±5.34, 4	5.49±7.01, 0*[b]	10.5±10.06, 7	27.3%
DiabetesHealth Steps	61.3%	11.06±14.54, 6	2.55±2.59, 2	3.81±6.40, 1	4.71±7.29, 0	8.48±9.5, 5	16.1%

This table indicates the percentage rates of attendance and retention and the number of attendances in each time point.

Abbreviation list: SD= standard deviation

[a]=Week of last recorded attendance

*[a]=SmartSteps have greater attendance than Breathesmart as identified in Post-Hoc Analysis.

*[b]=HeartSmart and SmartSteps have greater attendance than BreatheSmart as identified in Post-Hoc Analysis.

3.6.1 Rates of initiation

The overall initiation rate was 73.2%.

3.6.2 Rates of attendance

Attendance – Full 24-week period

The mean (± SD) number of CCEP sessions attended during the entire 24-week period was 11.13 ± 12.42 (median=6; min=0, max=57 sessions). **Figure 3.5** presents the pattern of attendance over the 24-weeks for the full sample.

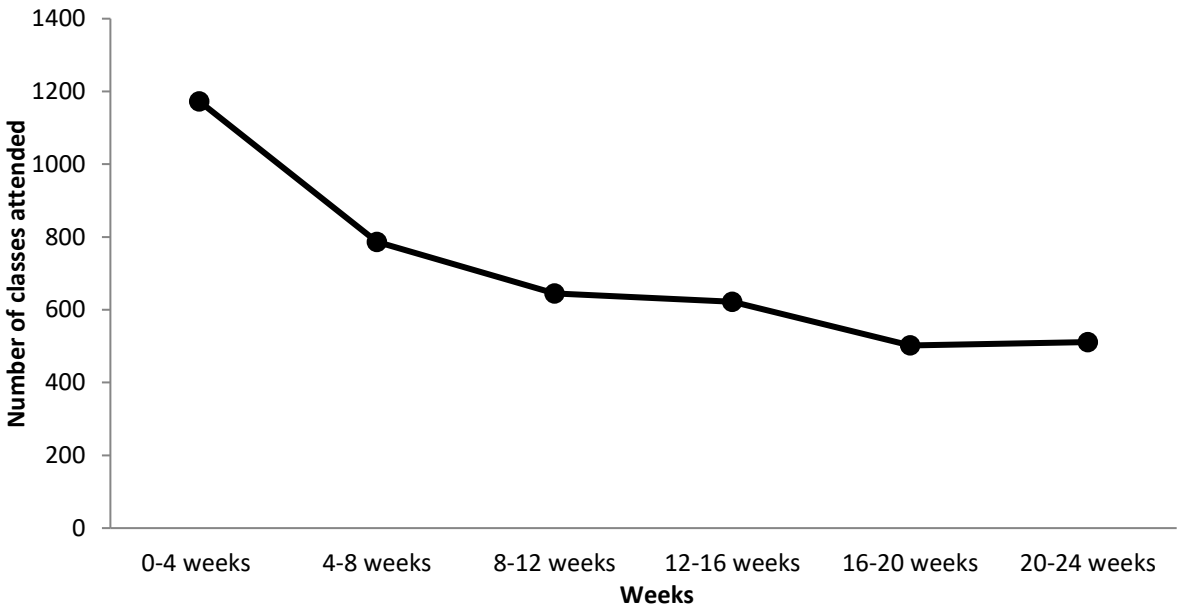


Figure 3.5 Attendance pattern over 24-weeks (n=389)

Attendance – Week 1-4

The mean (± SD) number of sessions attended during the first 4 weeks was 3.08 ± 2.54 (median=3).

Attendance - Weeks 5-12

The mean (± SD) number of sessions attended between weeks 5 and 12 was 3.85 ± 4.85 (median=3).

Attendance - Weeks 13-24

The mean (± SD) number of sessions attended between week 13 and 24 was 4.20 ± 6.50 (median=0).

3.6.3 Time to dropout

The mean time to dropout was 10.70 ± 9.98 weeks (median =7).

3.6.4 Rates of retention

The overall retention rate was 29%.

3.7 Results: Factors associated with adherence

The components of adherence are herein presented as; initiation, attendance and retention. This section is responding to and in line with the second aim of Study 1;

- To determine the demographic, behavioural, psychological and physical health-related correlates of initiation, attendance and retention.

3.7.1 Initiation

Difference in participant characteristics including health-related fitness scores and behaviour change measures between initiators and non-initiators are presented in **Table 3.6**. Independent samples t-tests were performed and P-values are reported to indicate difference between initiators and non-initiators.

Table 3.6 Characteristics of initiators and non-initiators

	Initiators (n=279) (mean± SD, median)	**Non-initiators** (n=102) (mean± SD, median)	**P value**[a]
Age (years)	64.42±11.25, 65	63.10±12.49, 63.5	.32
Distance to facility (km)	8.98±10.55, 5.8	12.91±24.85, 5	.125
Health-related fitness			
ISWT (laps)	40.95±23.49, 36	42.10±23.77, 43	.74
Strength (seconds)	20.29±6.63, 19.16	19.35±5.10, 19	.29
Flexibility (cm)	7.99±8.81, 8	8.14±8.53, 8	.85
BMI	29.48±6.27, 29	31.42±7.04, 29.7	.02*
Behaviour change			
Social-support family	2.16±1.02, 2	1.93±.99, 1.6	.05
Social-support friends	1.68±.89, 1.3	1.49±.71, 1.2	.17
Intentions for exercise	3.30±.63, 3.33	3.15±.65, 3.17	.046*
Self-efficacy for exercise	7.31±2.27, 7.73	6.66±2.5, 7.73	.02*

Abbreviation list: ISWT=Incremental shuttle walk test, BMI=Body mass index
[a] p-value from independent samples t-tests between initiators and non-initiators
* $P < 0.05$; ** $P < 0.01$

Demographic factors associated with initiation

More women than men initiated the programme post induction. However, this difference did not reach statistical significance (69.7% men vs. 77.9% women; (X^2(2) =3.19, p=0.08). There was no significant difference in age (mean ± SD; 64.42±11.25 years, median=65) and non-initiators (63.10±12.49 years, median =63.5.) (t (379) = -.988, p=.324), distance to facility (t (114.56) =-.1.546, p=.125) or programme (74% HS, 74.5% BS, 74.5% SS, 61.3% DHS, X^2(3) =2.464, p=.48) between initiators and dropouts.

Health-related fitness factors associated with initiation

BMI was the only health-related fitness measure that was significantly different between initiators and non-initiators (t (343) = 2.281, p=.023). Initiators had a significantly lower BMI than non-initiators. Performance in the Incremental Shuttle Walk (t (279) = .331, p=.741), flexibility (t (335) =0.192, p=0.848), or strength (t (319) =-1.068, p=.287) was similar in initiators and non-initiators.

Behaviour change factors associated with initiation

Initiators had significantly higher scores than non-initiators for intentions to exercise (t (361) =-1.99, p=.046), and self-efficacy for exercise (t (355) =-2.299, p=.022). There was no statistically significant difference in social-support from friends (t (168.74) =-1.866, p=.064) or family (t (168.68) =-1.966, p=.051) between initiators and non-initiators.

Predictors of Initiation

Model 1: Demographic variables

A logistic regression model was performed to explore the contributions of age, gender and programme to the likelihood of initiation. The logistic regression model was not statistically significant (p=.87) indicating that a combination of these three variables did not predict initiation.

Model 2: Health-related fitness variables

A logistic regression model was performed and while adjusting for age, gender and programme, the inclusion of the variable BMI did not reach statistical significance (p=.15), with the overall significance of p=.69 and did not predict initiation.

Model 3: Behaviour change variables

A logistic regression model was performed to explore the likelihood of initiation. While controlling for age, gender, programme and BMI, the behaviour change variable of intentions for exercise, self-efficacy for exercise, and social-support from family and friends were included in the model however the model did not reach statistical significance (p=.45). The overall model had a p-value of p=.69. The model is presented in **Table 3.7.**

Table 3.7 Logistic regression predicting likelihood of initiation (behaviour change variables)

Variable	Odds ratio	95% CI for odds ratio		P-Value
		Lower	Upper	
Age	1.009	.977	1.042	.577
Gender	1.201	.575	2.509	.626
Programme:				
HeartSmart				.819
BreatheSmart	1.312	.586	2.936	.509
SmartSteps	1.231	.390	3.881	.723
Diabetes	.763	.232	2.507	.656
BMI	.961	.911	1.013	.136
Intentions for exercise	1.218	.662	2.241	.526
Self-efficacy for exercise	1.094	.929	1.289	.281
Social-support from family	1.176	.735	1.882	.500
Social-support from friends	1.002	.612	1.641	.994
Constant	1.386			.896

3.7.2 Attendance

Correlates of attendance are presented in two parts. Part 1 explores the demographic, health-related fitness and behaviour change correlates of attendance from induction to 24 weeks attendance. This represents the data collected from 381 participants at induction. The take-home questionnaire was returned by 279 participants. Additional analysis in part two explored further demographic, health-related wellbeing, and health service usage correlates of attendance. Data on the health-related fitness and behaviour change variables was also included in this analysis.

Attendance: Part 1

Bivariate analysis was performed using independent samples t-tests, chi-square analysis, and ANOVA's and associations are presented first followed by multivariate analysis of correlates. Multivariate analysis includes logistic regression analysis and negative binomial regression analysis.

Demographic correlates of attendance in the full 24 weeks

An independent samples t-test identified that attendance over the 24 weeks period was similar in men and women (male=11.23 ± 13.32 vs. female=10.99 ± 11.15; (t (374.08) =.196, p=.845) and was unrelated to age (r=.092, p=.074). There was a significant difference in attendance between programme groups (F (3,377) = 3.560, p=.014) as identified by an ANOVA, with bonferroni post hoc testing indicated that the SmartSteps programme had a significantly greater attendance than BreatheSmart. Bivariate correlation analysis indicated that there was a weak inverse association between the number of sessions attended and distance to the facility (r=-0.101, p=.048) with those living further away having lower attendance.

Behaviour change correlates of attendance in the full 24 weeks

Bivariate correlation analysis indicated that there was an association between number of sessions attended and intentions for exercise (r=.107, p=.043) and self-efficacy for exercise (r=.125, p=0.18). Higher scores are associated with higher attendance.

Health-related fitness correlates of attendance in the full 24 weeks

There was no association between any of the health-related fitness measures and the number of sessions attended over the 24-week period.

Predictors of 24-week attendance

Model 1: Demographics

Negative binomial regression was performed to model the number of sessions attended. Age, gender, distance to facility and programme of enrolment were initially entered into the model. The model (p=.00) was statistically significant. The travel distance to the facility independently contributed to the model. Attendance decreased by 0.99% for every 1 km increase in distance to the facility. The negative binomial regression model along with confidence intervals is presented in **Table 3.8.**

Table 3.8 Negative binomial regression predicting count attendance (demographic)

		95% Confidence Interval		
Variable	**Odds Ratio**	**Lower**	**Upper**	**P value**
Intercept	8.496	4.144	17.415	.000
Age	1.007	.997	1.017	.156
Distance to DCU	.985	.976	.994	.002
Gender (male)	.940	.752	1.175	.585
HeartSmart	1.077	.713	1.627	.723
BreatheSmart	.756	.494	1.157	.198
SmartSteps	1.224	.757	1.979	.410
DiabetesHealth Steps	0			

Model 2: Health-related fitness

A second negative binomial regression was performed to model the number of sessions attended with the addition of BMI to the variables in the first model (age,

gender, programme and distance to facility). The overall model was again statistically significant (p=.000). The distance to facility contributed independently to the model as seen (**Table 3.9**).

Table 3.9 Negative binomial regression predicting count attendance (health-related fitness)

Variable	Odds ratio	95% CI for odds ratio		P value
		Lower	Upper	
Intercept	13.892	4.898	39.469	.000
Age	1.007	.996	1.018	.217
Distance to DCU	.985	.975	.996	.006
Gender	.990	.783	1.251	.933
HeartSmart	1.107	.715	1.714	.648
BreatheSmart	.751	.480	1.174	.209
SmartSteps	1.210	.726	2.016	.465
Diabetes HealthSteps	0			
BMI	.986	.956	1.004	.134

Model 3: Behaviour change

A third negative binomial regression was performed to model the number of sessions attended. The behaviour change variables of intentions for exercise, self-efficacy for exercise and social-support from family were added to the Negative binomial regression model that already included age, gender, CIG and BMI. The overall model (p=.002) was statistically significant. Age and travel distance to the facility independently contributed to the model. Attendance decreased by 0.99% for every 1 km increase in distance to the facility and increased by 13% for every year older a participant is in age. The negative binomial regression model along with confidence intervals is presented in **Table 3.10.**

Table 3.10 Negative binomial regression predicting count attendance (behaviour change)

Variable	Exp (B)	95% CI for odds ratio		P value
		Lower	Upper	
Intercept	7.448	1.972	28.127	.003
Age	1.013	1.001	1.025	.040
Distance to DCU	.986	.975	.997	.012
Gender	.965	.742	1.254	.789
HeartSmart	.902	.561	1.452	.673
BreatheSmart	.674	.413	1.097	.113
SmartSteps	1.093	.632	.632	.892
DiabetesHealth Steps	0			
BMI	.986	.967	1.006	.162
Intentions	1.107	.896	1.368	.347
Self-efficacy	.998	.940	1.059	.940
Social-support from family	1.056	.928	1.201	.412

Attendance: Part 2

Bivariate analysis was performed using independent samples t-tests, chi-square analysis, and ANOVA's and associations are presented first followed by multivariate analysis of correlates. Multivariate analysis includes logistic regression analysis and negative binomial regression analysis. A correlations matrix is presented in **Table 3.11.**

Demographic correlates of attendance in the full 24 weeks

Bivariate analysis was performed using chi-square analysis and it was indicated there was no association between employment status (F (5,258) =2.726, p=.020) and attendance, or between programme of enrolment (F (3,275) =5.570, p=.001) and

attendance. Bonferroni post hoc analysis identified that participants who were unable to work had a significantly lower attendance than those who were retired and BreatheSmart participants have a significantly lower attendance than participants in HeartSmart and SmartSteps. Bivariate correlation analysis indicated that there was no significant relation between the number of sessions attended in the 24 weeks and age (r=.092, p=.125), distance to facility (r-.086, p=.152). Independent samples t-tests identified no significant relationship between number of sessions attended and gender (t (276.779) =1.398, p=.163). ANOVA analysis indicated no difference in number of sessions attended and education (F (3,251) =.682 p=.564) or marital status (F (3,258) =.294, p=.83).

Psychological wellness and illness related correlates of attendance in the full 24 weeks

Bivariate correlation analysis was performed and identified a weak, significant association between the number of sessions attended in the 24-week period and both the mental summary score (SF-12) (r=.150, p=.027) and the PHQ8 score (r=-.206, p=.005) from the SF 12. Participants with higher wellness scores had a greater attendance. There was no relation between the number of sessions attended and number of chronic illnesses (co-morbidities) reported (r=.042, 0=.49), or the physical summary score (r .072, p=.287). Furthermore, health service utilisation was not associated with the number of sessions attended in the 24-week period and the number of GP visits (r=-.099, p=.181), outpatient visits (r-.076, p=.283), or nights in hospital (r=-.131, p=.061).

Table 3.11 Correlation matrix of factors associated with attendance

Variable	# sessions in 24 weeks	# sessions in first 4 weeks	Age	Distance (km)	PHQ8	SF12 physical	SF12 mental	# chronic illnesses	# GP visits	# outpatient visits
Number of sessions in 24 weeks	1	.								
Number of sessions in first 4 weeks	638**	1								
Age (years)	.092	.113	1							
Distance to DCU (km)	-.086	-.129*	-.179**	1						
PHQ8	-.206**	-.140	-.158*	.111	1					
SF12 physical	.072	.011	-.007	.049	-.219**	1				
SF12 mental	.150*	.149*	.134*	-.045	-.687**	.354**	1			
Number of chronic illnesses	.042	-.009	.029	.014	.214**	-.145*	-.126	1		
Number of GP visits	-.099	-.053	-.070	-.094	.290**	-.127	-.224**	.148*	1	
Number of outpatient visits	-.076	-.016	-.011	-.005	.152*	.016	-.025	.066	.163*	1
Number of nights spent in hospital	-.131	-.101	-.107	-.034	.111	.019	-.105	.214**	.220**	.304**

Table 3.11 presents a correlation matrix of Pearson Correlation analysis
* $P < 0.05$; ** $P < 0.01$
# = “number of”

Predictors of 24-week attendance

Model 1: Demographic

A negative binomial regression was performed to model the number of sessions attended in the 24 weeks. Age, gender and CIG were initially entered into the model. While the model overall showed predictive utility (p=.042) none of the entered variables individually contributed significantly to the model. Model 1 is presented in **Table 3.12.**

Table 3.12 Negative binomial regression predicting count attendance (demographics)

		95% CI for odds ratio		
Variable	**Exp (B)**	**Lower**	**Upper**	**P value**
Intercept	12.124	5.174	28.409	.000
Age	1.007	.996	1.019	.224
Gender (male)	1.047	.811	1.351	.724
Programme				
HeartSmart	.894	.537	1.488	.666
BreatheSmart	.627	.372	1.058	.080
SmartSteps	.974	.544	1.742	.928
DiabetesHealth Steps	0			

Model 2: Health-related wellness and health service usage

A second negative binomial regression was performed to model the number of sessions attended by adding the number of nights spent in hospital in previous 12 months, PHQ8 depressive symptoms score and SF12 mental component score to the variables in the first model (age, gender, programme of enrolment). The additional variables did not improve the predictive utility of the model (p=.667). Model 2 is presented in **Table 3.13.**

Table 3.13 Negative binomial regression predicting count attendance (health-related wellness and health service usage)

		95% CI for odds ratio		
Variable	**Exp (B)**	**Lower**	**Upper**	**P value**
Intercept	17.760	3.086	102.210	.001
Age	1.002	.986	1.018	.831
Gender (male)	1.011	.724	1.412	.949
HeartSmart	.929	.481	1.795	.827
BreatheSmart	.733	.365	1.472	.733
SmartSteps	.926	.449	1.906	.834
DiabetesHealth Steps	0			
Nights in hospital	.995	.980	1.009	.475
PHQ 8	.981	.937	1.026	.401
SF12 (mental)	1.001	.977	1.025	.996

Model 3: Behaviour change and health-related fitness

A third negative binomial regression that also included behaviour change and health-related fitness variables was performed to model the number of sessions attended and it identified that the addition of the variable BMI did not add value to the model (p=.610). Model 3 is presented in **Table 3.14.**

Table 3.14 Negative binomial regression predicting count attendance (behaviour change and health-related fitness

Variable	Exp (B)	95% CI for odds ratio		P value
		Lower	Upper	
Intercept	10.799	1.088	107.217	.042
Age	1.003	.986	1.021	.701
Gender	.999	.674	1.481	.996
HeartSmart	.925	.451	1.894	.830
BreatheSmart	.687	.323	1.460	.329
SmartSteps	.799	.904	.415	.968
DiabetesHealthSteps	0			
Nights in hospital	.993	.978	1.009	.392
PHQ 8	.981	.936	1.029	.436
SF12 (mental)	.999	.974	1.025	.944
Distance to DCU	1.006	.986	1.026	.572
BMI	.997	.965	1.030	.875
Intentions	1.157	.834	1.606	.383
Self-efficacy	.968	.885	1.059	.484
Social-support from family	1.166	.972	1.400	.875

Model 4: Early attendance as predictor of 24-week attendance

A final negative binomial regression was performed to model the number of sessions attended. Early stage behaviour (ie. attendance in the first 4 weeks) was added to the model, while including all previously explored variables. The addition of early stage attendance contributed greatly to the model, and also contributed independently. The model was significant (p=.000), with the strongest significant odds ratio for attendance in the first four weeks (OR=1.384). For each additional attendance in the first 4 weeks there was a 38% increase in the likelihood of additional attendance in the 24 weeks. (**Table 3. 15**).

Table 3.15 Negative binomial regression predicting count attendance (early attendance)

		95% CI for odds ratio		
Variable	**Exp (B)**	**Lower**	**Upper**	**P value**
Intercept	1.848	.153	22.250	.629
Age	1.008	.990	1.027	.363
Gender	.934	.624	1.397	.740
HeartSmart	1/028	.494	2.139	.941
BreatheSmart	.815	.380	1.750	.600
SmartSteps	.796	.358	1.768	.574
DiabetesHealth Steps	1			
Nights in hospital	.991	.976	1.006	.237
PHQ 8	.987	.940	1.035	.584
SF12 (mental)	1.002	.975	1.029	.904
4-week attendance	1.385	1.258	1.523	.000

3.7.3 Retention

The overall retention rate (i.e. engagement at week 24) was 29% (278/381). Independent samples t-tests and chi-square analysis were carried out exploring correlates of retention (demographics, health-related fitness, behaviour change, health-related wellness, and health service usage), however there were no associations found. Further multivariate explorative analysis was carried out using logistic regression analysis and again indicated no predictive ability of the variables collected and the outcome of retention.

3.8 Study 1- Conclusion

The present study provided information on the demographic, health-related fitness, health service usage, health-related wellbeing and behaviour change characteristics of men and women attending induction to a CCEP. Initiation, attendance and retention rates along with point of dropout were also examined.

Programme of enrolment, distance to facility, behavioural intentions for exercise, self-efficacy for exercise, PHQ 8 score, mental health component score of the SF12 and 4-week attendance were identified as correlates of attendance in an unadjusted analysis. Adjusted analysis indicated age and distance to the facility as the only correlates of attendance highlighting the limited added value of health-related fitness and behaviour change variables in predicting initiation and attendance in this sample. Attendance during the first 4 weeks was also found to predict attendance over the 24-week monitoring period while adjusting for all other variables. The correlates of retention in this sample could not be identified. Strategies to optimise attendance and adherence are warranted to ensure the benefits associated with attendance at a CCEP can be achieved.

Chapter 4

Intervention design and development

4.1 Introduction

Despite the well-documented benefits of participation in CCEPs, adherence remains sub-optimal as identified in study 1 of this thesis. Given the associated health benefits to be gained from regular attendance to CCEP, empirically based interventions to optimise adherence are warranted.

The review of literature (Chapter 3) outlined strategies utilised to improve adherence to structured exercise, rehabilitation settings and community-based programmes for chronic illness. While there were limited examples directly relevant to the novel programme that is the setting for this research, the social cognitive theory (Bandura, 1998) guided the choice of a number of strategies utilised in the literature. Support building and action planning are strong strategies emerging from the evidence (Martin & Woods, 2012; Sniehotta, Gorski, & Araújo-Soares, 2010). Exercise consultations are routinely used in the area of chronic illness and physical activity and have proven successful in facilitating behaviour change (Hughes, Mutrie, & Thow, 2006; Hughes, Mutrie, & Macintyre, 2007) and so are warranted to be a component and modality to be included in the proposed intervention to optimise adherence to the CCEP. Early attendance (number of sessions attended in the first 4 weeks) was a significant predictor of 24-week attendance. This, along with the albeit small associations of the behaviour change variables of intentions, self-efficacy and social-support, provide rationale and evidence for intervention design to optimise the proportion of people initiating, attending and remaining engaged with the CCEP.

It is generally accepted that physical activity related behaviour change interventions that are theoretically grounded are more effective than a-theoretical strategies (Biddle et al., 2000), and so theory has played an integral role in the intervention design. This chapter outlines the stages of intervention design and development which has an underpinning in Social Cognitive Theory (Bandura, 1998) and utilises the COM-B model and the Behaviour change wheal for intervention design (Michie, van Stralen, et al., 2011). The MRC guidance for developing and evaluating complex interventions (Craig, Dieppe, et al., 2008; Medical Research Council, 2006) was adhered. Chapter 4 is represented in Phase 1 of the MRC framework as outlined in **Figure 4.1**. The intervention design and delivery carried out in Phase 1 leads to Phase 2. Phase 2 according to the MRC (2006) is the feasibility stage and includes elements such as piloting, testing procedures, estimating recruitment sample size etc. and is presented in **Chapter 5.**

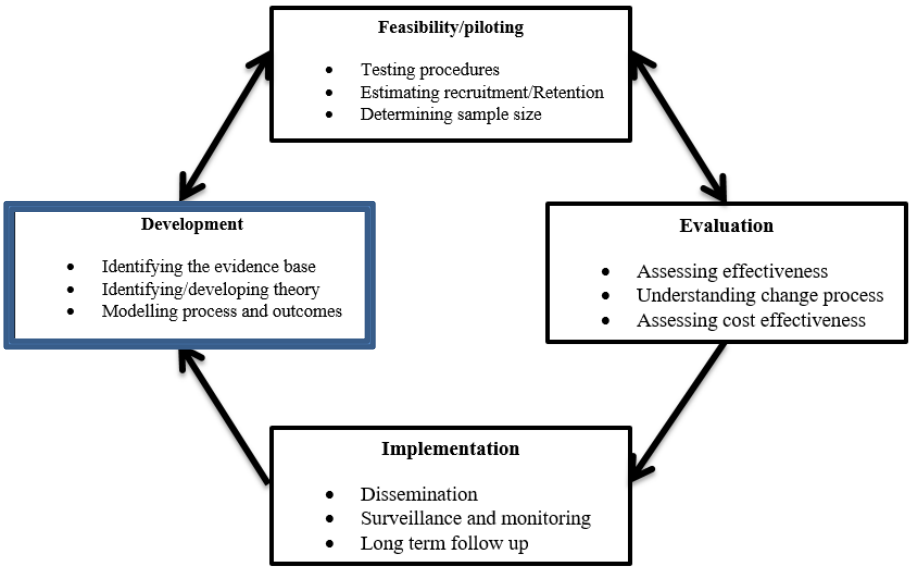


Figure 4.1 Adapted from Medical Research Council guidance

4.2 Chapter aims

1. To design an intervention aimed at optimising adherence underpinned by behaviour change and maintenance theory
2. To outline the stages of intervention design and development
3. To present the intervention as it was designed and delivered using TIDieR guidelines

4.3. Intervention need and rationale

The underpinning rationale for this study stemmed from the sub-optimal levels of adherence to the CCEP identified in Study 1, and existing evidence regarding poor adherence rates in other formal and CCEPs such as those identified by (Keck & Budde, 1999)), Delaney et al., (2006) and Cockram et al., (2006). There was low uptake rates to phase IV cardiac rehabilitation in Germany, where only 30% of phase III cardiac rehabilitation post discharge patients initiated a phase IV cardiac rehabilitation programme (Keck & Budde, 1999). While there is no evidence for phase IV cardiac rehabilitation uptake rates in Ireland, there is a low rate of referral (19%) (Delaney et al., 2006). Rates of adherence are similarly sub-optimal in pulmonary rehabilitation programmes in the community where it was observed that only 46 of the 84 participants who started the exercise programme completed the it (Cockram et al., 2006). As outlined in the review of literature, there is currently little published information on the rates of adherence to community-based exercise programmes, catering for multiple chronic illnesses that are similar to the current CCEP, however McNamara et al., (2016) identified that in a community-based setting for patients with chronic respiratory and chronic cardiac disease, of the 76 patients attending for assessment, 31 commenced the

8 week programmes and 22 (71%) completed it indicating that overall low levels of adherence.

The initiation rate of 73% in study 1 of this thesis, although encouraging, has potential for improvement and represents a waste in resources in hosting an induction for referred patients when 27% do not initiate the programme. More alarming was the finding that the mean and median attendance over the 24 weeks was 11.13±12.42, (median 6) sessions. The retention rate of 23% falls short of the recommended prescription of attendance at two exercise sessions per week and is a cause of concern.

Given the sub-optimal levels of adherence outlined in the current thesis., strategies are warranted to intervene and improve these rates. There are limited examples in the literature of interventions that have the aim of optimising adherence in similar settings, however the evidence available is synthesised in the review of literature. One example of a promising behaviour change intervention in phase IV setting utilised action-planning as the strategy to bring about change. This action planning intervention resulted in significantly higher rates of uptake to phase IV cardiac rehabilitation following the completion of a phase III programme (Sniehotta, Gorski, & Araújo-Soares, 2010). Action planning was highlighted in a Cochrane review as a component of interventions associated with greater adherence outcomes (Karmali et al., 2014) and as a result is warranted to be a component of the proposed intervention.

A number of modifiable correlates that are associated with increased attendance to chronic illness intervention programmes have been identified though the literature

search and help inform intervention design and development. These correlates include self-efficacy, social-support, self-esteem and health behaviour knowledge (Daly et al., 2002; Jasmine, Wai-Chi, & Hegney, 2012). The evidence base underpinning the current research includes qualitative work by Martin & Woods (2012) that explored the correlates of adherence to phase IV community-based cardiac rehabilitation. In the qualitative study (Martin & Woods, 2012), self-efficacy for exercise and social-support for exercise were identified as important constructs in long-term adherence to community-based rehabilitation.

In addition to identifying the rates of initiation, attendance and retention, Study 1 of this thesis also examined the strategies highlighted in the qualitative work undertaken by Martin and Woods (2012) and the action-planning work carried out by Sniehotta, Gorski, & Araújo-Soares (2010) that than can be used to optimise levels of initiation and adherence. The number of attendances in the first 4 weeks was identified as a significant predictor of 24-week attendance as part of Study 1 and so the timing of the intervention in line with this period is important.

Strategies to improve adherence to community-based chronic illness rehabilitation are needed and will have implications for practitioners and policy makers and most importantly the programme participants.

4.4 Theoretical underpinning of the intervention

The current research is underpinned by the social cognitive theory (Bandura, 1998). The social cognitive theory (Bandura, 1998) acknowledges a range of personal,

environmental and behavioural factors that influence behaviour. The COM-B model of behaviour change (Michie, van Stralen, West, et al., 2011) was also utilised to understand the behaviour and potential mechanisms for action. Behavioural intention as a proximal antedate to behaviour as outlined in the theory of planned behaviour (Ajzen, 1991) also forms a component in the theoretical construct underpinning the intervention as well proposing "action-planning" as a strategy to bring about behaviour change. While social cognitive theory (Bandura, 1998) was used primarily in the early stages of this research and in understanding adherence, the intervention design and development adopted in the present study was undertaken using Michie's (Michie, van Stralen, & West, 2011) COM-B model of behaviour change. This model asserts that behaviour occurs as a result of an individual's capabilities, opportunities and motivations. In line with the COM-B model, the behaviour change wheel (Michie, van Stralen, et al., 2011) outlined in the review of literature and in greater detail in the next section, formed an integral part of the intervention design process and provided a structured framework that was adhered to. The taxonomy of behaviour change techniques (Michie et al., 2013) was utilised in the design phase to ensure transparency within the intervention. Finally, the APEASE (an acronym for affordability, practicability, effectiveness (and cost effectiveness), acceptability, side effects/safety and equity) criteria (Michie, van Stralen, & West, 2011) for designing and evaluating interventions was also used in the design of this study.

4.5 Intervention planning and design

The first stage in intervention planning was concluded based on Study 1 that initiation and subsequent attendance was sub-optimal and warranted intervention. The intervention planning and design evolved ecologically and in line with the behaviour

change wheel (Michie, van Stralen, et al., 2011). While the author took the lead on the intervention development and design, each stage utilised the skills and knowledge of the MedEx research team, with roles presented throughout the following phases. This aspect of intervention development is identified as "partnership approach" by O'Cathain et al., (2019). O'Cathain et al., (2019) outlined a taxonomy of approaches to intervention development and the current intervention was designed also using the following approaches; Theory and evidence based, implementation based, and target population centred.

4.5.1 Stages of intervention design

The behaviour change wheel (**Figure 4.2**) developed from existing frameworks, provided a structured approach to designing and developing the behaviour change intervention. The wheel consists of three layers. The central layer refers to the COM-B model, with the next layer identifying the nine intervention functions which are chosen based on the preliminary analysis using the COM-B model. The outer layer consists of seven policy categories that have the potential to support the intervention. There are three stages encompassing eight steps in the intervention design process using the Behaviour Change Wheel. The intervention design is presented herein using the three stages and eight steps of intervention design. The APEASE criteria were acknowledged throughout.

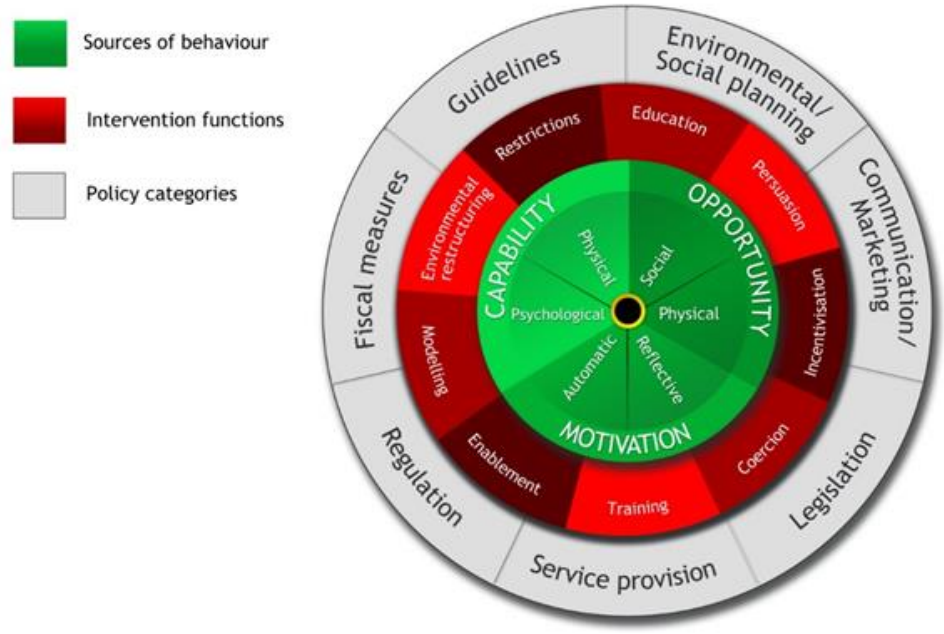


Figure 4.2. Overview of the behaviour change wheel

Stage 1: Understanding the behaviour

Stage one encompasses four steps with the purpose of understanding the behaviour. This stage was led by the author with support from the MedEx research team following a presentation of preliminary findings from Study 1.

Step 1: Defining the problem in behavioural terms

A review of literature (presented in Chapter 2) along with the results from Study 1 identified sub-optimal level of adherence to rehabilitation programmes and the current model of CCEP.

Step 2 and 3: Selecting and specifying the target behaviour

The target behaviour is adherence to a CCEP including the constructs of initiation, 24-week attendance and retention.

Step 4: Identify what needs to change

The COM-B model was utilised to attain an understanding of the behaviour of adherence in order to identify possible areas of change. The components of capability (physical and psychological), opportunity (physical and social) and motivation (automatic and reflective) are noted as components that offer potential domains to bring about change in the target behaviour. **Table 4.1** outlines the components of the COM-B model and their association to adherence to the CCEP. The theoretical domains framework (TDF) (Cane, O'Connor, & Michie, 2012) has been utilised in many health behaviour research studies and each domain of the TDF relates to a component of the COM-B model. **Table 4.2** outlines the TDF alongside the related components in the COM-B model. While the table identifies how each component of the COM-B model can be utilised to change the behaviours of initiation, attendance and retention, the intervention components of physical and psychological capability, social opportunity, reflective and automatic were also examined. It was not envisaged that the physical opportunity component would change within the scope of current intervention.

Table 4.1 COM-B model components in relation to the current intervention

COM-B component	Intervention component	Examples of change that may result in greater adherence
Capability	**Physical capability**	The skills required to; get to the facility, carry out the exercises.
	Psychological capability	Engaging in necessary mental processes to plan attendance. Understanding the impact of the behaviour of attendance and adherence.
Opportunity	**Physical opportunity**	The availability of the service, available transportation opportunities.
	Social opportunity	Value and cultural norm placed on the behaviour from the participant's peers and family.
Motivation	**Reflective motivation**	Planning and intentions to attend and adhere, belief about consequences.
	Automatic motivation	Emotional reactions of enjoying participation, desire to attend.

Table 4.2 COM-B and TDF utilised in intervention development

COM-B component	TDF domain linking to COM-B	Relevance of domain to the current intervention
Psychological capability	Knowledge	Knowledge of the associated benefits of the behaviour
	Cognitive and interpersonal skills	Ability to carry out the behaviour
	Memory, attention and decision processes	Memory to attend, decision making to make attendance a priority
	Behavioural regulation	Planning and organisation to attend
Social opportunity	Social influences	Social pressure from family or peers, social norms, modelling of others
Physical opportunity	Environmental context and resources	What aspects of the environment hinder or facilitate attendance
Reflective motivation	Social/professional role identity	Does attendance fit with individual's identity- eg. Do they have a perception that only older adults attend?
	Belief about capabilities	Confidence and self-efficacy to carry out the behaviour of attendance and exercise, outcome expectancies of attendance
	Optimism	Confidence of the participant that attendance will have desired outcomes
	Belief about consequences	Similar to above. Belief in outcome of attendance
	Intentions	The intention of the participant to attend
	Goals	Short, medium and long term goals associated with attendance
Automatic motivation	Reinforcement	Intrinsic rewards or incentives to attend
	Emotion	Fear, anxiety, stress or any positive emotions surrounding attendance

Stage 2: Identify intervention options

Stage two included steps involving intervention options. This stage had additions based on the ecological evolvement of the intervention including the identification and observation of findings from informal consultations with MedEx participants and MedEx staff that relate both to; stage two-Intervention options and stage three-Intervention content and implementation. The skills, knowledge and experience from within the MedEx research team was also utilised in this phase of intervention design.

Step 5: Intervention functions

The behaviour change wheel provides a systematic and theoretically guided method for intervention design. The behaviour change wheel synthesises 19 frameworks and contains nine intervention functions; education, persuasion, incentivisation, coercion, training, restriction, environmental restructuring, modelling and enablement. **Table 4.3** presents the intervention component that is recommended to target the respective component of the COM-B model.

Table 4.3 COM-B model and intervention functions

COM-B components	Intervention Functions								
	Education	**Persuasion**	**Incentivisation**	**Coercion**	**Training**	**Restriction**	**Environmental restructuring**	**Modelling**	**Enablement**
Physical capability*					Y				Y
Psychological capability*	Y				Y				Y
Physical opportunity					Y	Y	Y		Y
Social opportunity*						Y	Y	Y	Y
Automatic motivation*		Y	Y	Y	Y		Y	Y	Y
Reflective motivation*	Y	Y	Y	Y					

*= COM-B components that are to be utilised within the intervention.
Y=Intervention strategy to work on corresponding COM-B component.

The APEASE criteria were used to assist in identifying a number of components including the intervention and implementation strategy of the behaviour change wheel. **Table 4.4** outlines if the intervention component meets the APEASE criteria and should be considered for the current intervention. The following intervention functions were selected for inclusion in the present study; education, persuasion, training, modelling, and enablement.

Table 4.4 Intervention functions and the APEASE Criteria

Intervention Functions	**Does the intervention function meet APEASE criteria?**
Education	Yes
Persuasion	Yes
Incentivisation	Not practical in the context of this intervention
Coercion	Not acceptable in the context of this intervention
Training	Yes
Restriction	Not practical as there no option to restrict in this context
Environmental restructuring	Not practical to restructure the environment further for the purpose of the intervention
Modelling	Yes
Enablement	Yes

Table 4.4 outlines the intervention function and the APEASE criteria as they are relevant to this intervention.

Informal consultations with several MedEx participants identified an important observation around returning to MedEx following a period of absence. Participant's cited that they often see a number of their peers stop attending MedEx after a period of Illness. They noted that these participants may need a phone-call "welcoming them back to MedEx" following any absences. While this telephone call component was not deemed feasible at the present time, this point was taken on board in the intervention design. There needed to be a component in the intervention ensuring greater re-uptake following periods of absence.

Similarly, informal consultations with MedEx service staff noted that staff had identified an area that had the potential to improve adherence in the early phases. It was observed by staff that following initiation that it may be difficult for new participants to learn how to use the machines and do the exercises in a large group setting. This is also a challenge for staff as they need to manage an exercise class with new and advanced exercisers. The recommendation was to have an exercise class solely for the new initiators, with the purpose of familiarising participants with the class set up and the exercise machines that are regularly used prior to taking part in a regular MedEx class.

The components that were identified through the ecological nature of the author being embedded in service delivery were taken on board and fall in line with the intervention functions that were identified as feasible including; enablement, modelling, training, education and persuasion.

Step 6: Policy categories

This step encompasses the consideration of the policies that support the delivery of the intervention functions outlined in the previous step. The seven policy categories identified as part of the behaviour change wheel intervention functions were communication, guidelines, fiscal measure, regulation, legislation, environmental/social planning and service provision. These policy categories were identified to assist with delivery of the intervention functions outlined previously. While this intervention may not have the scope to influence or change some policy categories, the service provision policy category has relevance. The intervention is taking place within an existing service, and as part of the intervention, service delivery will be altered in line with the intervention functions.

Stage 3: Identify content and implementation options

Stage three has two steps; identifying behaviour change techniques and model of delivery.

Step 7: Behaviour change techniques

While adhering to the steps of intervention design, the existing evidence base was utilised to identify the perceived best behaviour change techniques to utilise in the current intervention. The selection of the behaviour change techniques was based on findings observed in Study 1, research undertaken by Martin and Woods (2012) and other relevant literature relating to the determinants of adherence (Daly et al., 2002; Jasmine et al., 2012; Sniehotta, Gorski, & Araújo-Soares, 2010) (as outlined in the review of literature). Behaviour change techniques are the smallest active ingredient of the intervention and are linked with the underpinning theory. Underpinning theory guided

the literature searches of potential effective strategies to optimise adherence in similar settings. These searches identified the value of constructs such as self-efficacy, social support, decisional balance, behavioural intentions and action planning in influencing adherence related behaviours. **Table 4.5** identifies BCTs that are proposed to be used in the intervention linking with a theoretical component of the COM-B model, other theory as well as examples of their use and effectiveness from the literature.

Table 4.5 Proposed intervention constructs and the association with BCTs and relevant theory

BCT	Associated constructs	COM-B Component	Link to other theory	Literature supporting the potential effectiveness
1.1 Goal setting behaviour	Self-efficacy, behavioural intentions	Motivation	Theory of planned behaviour and cognitive components of the social cognitive theory	Avery, Flynn, van Wersch, Sniehotta, & Trenell, 2012; Hughes et al., 2007; Kirk et al., 2004
1.2 Problem solving	Self-efficacy	Motivation	Theory of planned behaviour and cognitive components of the social cognitive theory	Avery et al., 2012; Hughes et al., 2007; Kirk et al., 2004
1.4 Action planning	Self-efficacy, behavioural intentions	Motivation	Theory of planned behaviour and cognitive components of the social cognitive theory	Sniehotta, Gorski, & Araújo-Soares, 2010
9.2 Pros and cons	Decisional balance,	Motivation	Theory of planned behaviour and cognitive components of the social cognitive theory	Avery et al., 2012; Adrienne Hughes et al., 2007; Kirk et al., 2004; McGrady et al., 2014
4.1 Instruction on how to perform the behaviour	Self-efficacy (task efficacy and self-regulatory self-efficacy)	Capability and Motivation	Self-efficacy of social cognitive theory	Cheetham et al., 2004; Ringbaek et al., 2010

9.1 Credible source	Self-efficacy	Motivation	Self-efficacy of social cognitive theory	Cheetham et al., 2004; Hughes et al., 2006; Kirk et al., 2004
5.1 Information about health consequences	Self-efficacy, decisional balance	Motivation	Self-efficacy of social cognitive theory, theory of planned behaviour and transtheoretical model	Kirk, Mutrie, MacIntyre, & Fisher, 2004 Hughes, Adrienne and Mutrie, Nanette, 2006
3. Social-support	Social support	Motivation and opportunity	Cognitive components of social cognitive theory	Hughes et al., 2007; Loughlan & Mutrie, 2014; Martin & Woods, 2012
10.4 Social reward	Self-efficacy	Motivation	Self-efficacy of social cognitive theory	\
15.3 Focus on past success	Self-efficacy	Motivation and capability	Self-efficacy of social cognitive theory and theory of planned behaviour	Hughes et al., 2006; Kirk et al., 2004

- These studies are explained in greater detail in the review of literature
- BCTS are not specified in the study, the thesis author coded the techniques used

The proposed intervention included a modified induction session, a baseline exercise consultation, a beginner exercise class, and an exercise consultation at week-4 and week-12. The choice of BCTs as mentioned is based on guiding theory, study 1 and previous research identified in a review of literature. **Table 4.6** outlines the BCTs that were identified through reviewing the literature to be most appropriate for use during various stages of the proposed intervention. The behaviour change techniques are coded as in the taxonomy guide (Michie et al., 2013).

Table 4.6 Behaviour change techniques used in the intervention

Induction	Exercise consultation at induction	Beginner exercise session at induction	Exercise consultation at week-4	Exercise consultation at week-12
5.1 Information about health consequences	1.1 Goal setting behaviour	4.1 Instruction on how to perform the behaviour	1.5 Review behaviour goals	1.5 Review behaviour goals
9.1 Credible source	1.2 Problem solving	3. Social-support	1.1 Goal setting behaviour	1.1 Goal setting behaviour
	1.4 Action planning		1.2 Problem solving	1.2 Problem solving
	9.2 Pros and cons		1.4 Action planning	1.4 Action planning
	4.1 Instruction on how to perform the behaviour		2.2 Feedback on behaviour	2.2 Feedback on behaviour
	1.4 Action planning		10.4 Social reward	10.4 Social reward
			15.3 Focus on past success	15.3 Focus on past success
			1.2 Problem solving	1.2 Problem solving

Step 8: Mode of delivery

The behaviour change wheel outlines various modalities of intervention delivery. The MedEx research team had input in this phase of intervention design, in that they shared knowledge and experience, particularly in the area of exercise consultations. A

senior member of the research team had experience in delivering exercise consultations in phase IV cardiac rehabilitation and recommended this approach. As identified in the review of literature, exercise consultations are routinely used in the area of chronic illness and physical activity and have proven successful in facilitating behaviour change (Hughes, Mutrie, & Thow, 2006; Hughes, Mutrie, & Macintyre, 2007). Exercise consultations are usually delivered on a one to one basis but this is not deemed feasible or practical in this setting due to the large numbers. There may be added value of carrying out an exercise consultation in a group setting as it allows for a problem solving components to identified barriers. As noted previously, informal consultations with staff indicated a need and rationale for a beginner exercise session, this pragmatic recommendation is in line with an intervention goal of optimising early stage attendance as it was observed in Study 1 to result in greater longer term (24 week) adherence. The intervention will be delivered in a variety of ways encompassing the mode of face-to-face as opposed to distance, and encompasses group based delivery with components of individual methods.

4.5.2 Drafting the full intervention

Following completion of the eights steps of the intervention design outlined in the behaviour change wheel; an intervention encompassing all previously discussed components was compiled. An outline of the intervention and its components is outlined in **Figure 4.3** and described herein. There was no cost to the elements of the intervention and participants were strongly encouraged to attend all elements of the intervention.

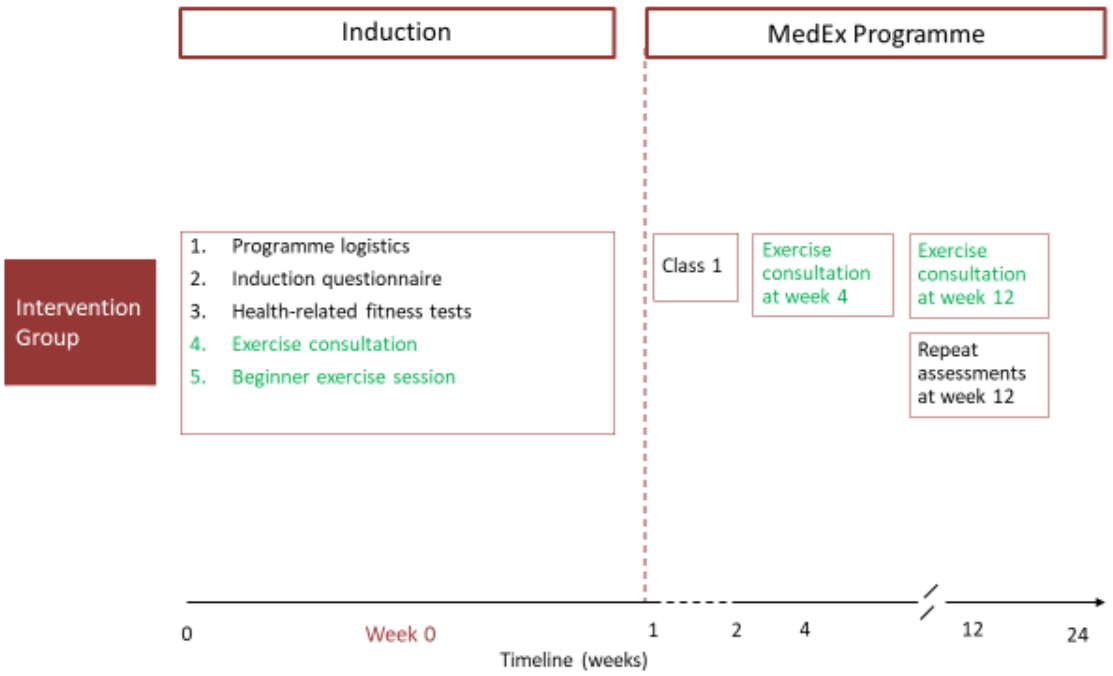


Figure 4.3 Intervention outline

The TIDieR checklist (Hoffmann et al., 2014) and guide is utilised to present and describe the intervention as it was planned and delivered. TIDieR, an acronym for The Template for Intervention Description and Replication, was developed by a team of international experts to promote the complete and accurate description of interventions (Hoffmann et al., 2014). Additional components to this TIDieR checklist have been recommended in recent times (Cotterill et al., 2018) to enhance the reporting of interventions in the applied health settings. These additions and modifications to existing components include;

- Voice (who's voice does the TIDieR description convey?),
- Stage (what stage of implementation does the checklist cover, for example, is it a revision of an earlier checklist?),
- Modification (to identify explanations and descriptions of all modifications to the intervention) and further descriptions of "how well"

(giving the opportunity to provide detail on how well the intervention was delivered as planned).

Figure 4.3 above outlines the participant pathway within the CCEP with the components of the behaviour change intervention in green.

Intervention aims

- The intervention had the aim of optimising rates of initiation, attendance and retention to a CCEP

Intervention objectives

1. Improve self-regulatory self-efficacy
2. Improve peer and staff levels of social-support
3. Improve intentions for exercise
4. Assist in the creation of an action plan
5. Assist in the identification of strategies to overcome barriers to participation in a CCEP
6. Support high attendance in first 4 weeks of a CCEP

4.5.2.1 Intervention as it was designed and delivered

All components of the intervention took place in House 19, of DCU Sports Complex, the main setting for the CCEP. This multicomponent intervention was staffed and facilitated by trained exercise professionals (MedEx staff) and trained behaviour change workers (research team) and overseen by the Medical Director of Medex, Dr. Noel Mc Caffrey. The intervention included a number of components and described

below. All behaviour change techniques, the intervention's active ingredients, are mapped in **Table 4.5.**

A modified induction session:

The induction session served as a welcome to new participants to the facility and the programme. Participants were referred to MedEx by their healthcare professional, they were then invited to attend an induction session at the CCEP prior to initiating the exercise programme. The Medical Director of the CCEP gave a brief overview of the programme and the importance of engaging in regular physical activity for individuals living with chronic illness. He explained that MedEx began in 2006 with only a few participants and has evolved over the years to meet an established need-an exercise programme for individuals with chronic illness. The benefits (physical, mental and social) of being physically active in general were outlined, as well as the need for activity as we age and get chronic illnesses. The safety of exercise for individuals with chronic illness was noted. The above components represent the BCTs of; Information about health consequences and credible source. Baseline physical health-related fitness tests and questionnaires were completed during this induction session with the physical testing forming part of the HSE evaluation study and baseline measures for the feasibility study of this intervention.

Exercise consultations:

Exercise consultations are routinely used in patients with chronic illness prior to commencing a rehabilitation programme and have proven successful (Hughes et al., 2007; Hughes et al., 2006). While adhering to key guidelines (Loughlan & Mutrie, 2014)

there are a number of differences between conventional exercise consultations and the consultation in the present intervention. Researchers were trained in exercise consultation delivery by reading the exercise consultation guidelines (Loughlan & Mutrie, 2014) and discussing as a group. Researchers carried out previous training in motivation interviewing and adopted this style in the exercise consultation delivery. Given the nature of the CCEP, a group exercise consultation was undertaken instead of the more common 1:1 exercise consultation. The group setting for the exercise consultation has a number of potential benefits including fostering group and peer social-support and providing a base for group problem solving while working on barriers obtained in decisional balance work.

Exercise consultations were delivered at baseline, week-4 and week-12. All exercise consultations were based in House 19, the main base for the CCEP. Exercise consultations were facilitated by the author and trained behaviour change post-graduate researchers (MedEx research team). A standardised PowerPoint presentation (**Appendix I)** was compiled and presented as part of facilitating the exercise consultations. The slides used in the presentations along with the goal setting and action planning sheets are presented in the **Appendix I.** With the exception of the first exercise consultation, participants were phoned the week before the week-4 and week-12 exercise consultation to remind them about attending. The individual behaviour change techniques utilised in the exercise consultations include; reviewing behavioural goals, goal setting behaviour, problem solving, action planning, feedback on behaviour, social reward and focus on past success.

The first exercise consultation lasting approx. 30 minutes took place on the same day as induction and focused on optimising the behaviour of initiation. Participants sat in two rows facing a projector screen. The exercise consultation began by the facilitator introducing themselves and explaining the impact exercise consultations can have on subsequent behaviour, it was simply explained that individuals often need help and motivation to start exercising and to remain attending. This first exercise consultation outlined the structured of a regular MedEx class, with pictures included in the slide show of warm-up, aerobic, resistance, cool-down components of the exercise sessions. The decisional balance construct of the consultation was introduced by identifying that there are many things that motivate individuals to attend MedEx, and there are things that can hinder us or be a "con" or a barrier to attending and exercising. Previous participants gave researcher examples of their motivations and these were presented. An example of a motivating factor cited by a previous participant that was highlighted was "you're with like-minded people… you can say something to someone here and you know that they know what you are talking about, they know the background…That's what motivates me to come here" An example of a barrier presented was "molly coddle syndrome-well I really think that people think that when they have something wrong with their heart that they are invalids and many lie down under their illness". The group was then given a work sheet with a space to identify their own motivations and barriers to attending the CCEP. When participants had finished completing their sheets the group was asked if anyone would share their motivations and then following this, their barriers. Participants where then asked to see if they could identify ways to overcome the identified barriers. This shifted to problem solving group work as individuals identified barriers, and solutions. The BCTs utilised in this phase included; Instructions

on how to perform the behaviour, pros and cons and problem solving. Participants were then asked to turn their sheet over to look at the space for them to write down their goal and action plan. Goal setting was outlined via presentation utilising SMART principles in goal setting and the FITT principals for activity. Individuals were then asked to establish and write down their plan for the short term (for the following 4 weeks). This action plan was explained to participants as "a promise to themselves".

Subsequent exercise consultations (week-4 and week-12) aimed to optimise attendance and retention and reduce potential relapse. The week-4 exercise consultation began with a "well done" to all participants for attending the week-4 exercise consultation. This attendance was acknowledged as a positive, despite the level of attendance at the exercise programme. In behaviour change technique terms this was identified as social reward and feedback on behaviour. There was an opportunity at the start of the exercise consultations for individuals to feedback on any aspect they wish. This included feedback on programme logistics such as car park or class delivery, which were fed back to the MedEx delivery team via the MedEx research meetings. Decisional balance and problem solving was introduced by prompting thinking of an individual's "barriers" to the behaviour of attendance at the programme. Participants were asked to think of a recent barrier to attendance and to then think if they managed to overcome this barrier or not. If this barrier was not overcome, participants were asked to identify ways to overcome these barriers. The group was asked to share a barrier they had, and through problem solving at a group level, strategies to overcome the commonly cited barriers were identified. The BCT utilised here include; problem solving. The group were given back their sheets in which they had outlined their short-term goals and action plan to review. Participants were asked to acknowledge to themselves if they achieved what

they had set out or not. It was noted to participants to internally say well done if you have achieved these goals, but to not be off put or worry if these plans and goals were not achieved. It was noted in the presentation to think about a number of things, such as; were the original goals realistic? Participants were asked to review these goals while thinking about goals for the next 8 weeks (medium term goals). In the presentation it was noted that there is a success in that participants attended the week-4 exercise consultation, however if participants achieved their goals, they were prompted to focus on this success in setting the next goals and planning for the coming weeks. The BCTs utilised here include; review behavioural goals, goal setting behaviour, action planning and focussing on past success.

The final 12-week exercise consultation was identical in its methods and delivery as the 4-week exercise consultation, with amendments to the goal setting and action planning. Goals were explored in terms of maintaining changes and having longer term plans and goals. These were reviewed again based on previous goals set in the baseline and week-4 exercise consultation. A significant addition to the 12-week exercise consultation was presenting results of the 12-week repeat physical testing. As part of the HSE evaluation, this cohort carried out repeat assessments prior to taking part in the exercise consultation. Measures of health and fitness outcomes were undertaken during the induction session and at week-12. Test results were communicated to the participants via a "progress report" and a group discussion as part of the exercise consultation. Participants were invited to ask questions about their progress during the exercise consultation session at week-12. For example, the component of aerobic fitness was explained, and it was explained that an increase in distance was an

improvement, and a decrease in distance was a dis-improvement. It was identified throughout that it is not necessarily an improvement that is the most important factor, in many chronic illnesses maintenance of fitness and function is a successful outcome.

A beginner exercise session:

The beginner exercise session was one hour in duration and adhered to the layout of a regular class delivered as part of the CCEP in the present investigation. The Induction session was on a Thursday and participants attended their beginner exercise session the next day, on the Friday. This one-hour session, delivered by trained exercise professionals, included all components of a usual exercise session but in a slower more in-depth manner. The session began in House 19, the main room of the CCEP.

On arrival participants were welcomed to the session and informed about the importance of pre-screening. Staff explained and demonstrated the use of the manual Blood pressure monitors, and participants had a practice of using these machines. Participants then took part in an incrementally phased warm-up. As these movements and exercises were being demonstrated to participants, the rationale and importance of a warm-up was verbally explained to participants. Following the warm-up participants were invited to observe treadmill set up. Participants gathered around a treadmill where a staff member explained the safety features of the treadmill and noted the importance of using the safety clip on the treadmill at all times. The treadmill instructions included; holding on to the treadmill and starting slowly. It was advised that participants stand tall, shoulders pulled back and chest up to ensure good posture while walking. Participants, with the assistance of a staff member went through these

recommendations and walked on the treadmill for roughly 5-10 minutes (based on ability). The same safety and instructions were given to participants for the aerobic exercise equipment, the bike. Instructions here included set up (height and foot placement). Participants again adopted these recommendations and had a trial of the bike for a period of 5-10 minutes.

Following the aerobic exercise component participants were brought into the weights room for resistance exercise. This room was set up in a circular fashion so that participants can move from one resistance machine to the next. The machines were explained to participants including the body part the machine was focusing on, how to increase/decrease resistance. Self-regulatory behaviours such as breathing was explained and emphasised during the resistance exercises. Participants were advised of the importance of self-regulatory behaviours such as breathing out on the exertion phase of the resistance work, as well as the set and repetition range desired. Participants had the opportunity to try a number of the resistance exercise machines and practice changing the resistance and practicing the correct breathing. Following the resistance phase of the exercise session, participants were invited back into house 19 for a cool-down. The purpose and importance of the cool-down was explained during the demonstration of the exercise.

Upon completion of the beginner exercise session, staff explained to participants that even with small amounts of physical activity such as that completed in the beginner class that there may be delayed onset muscle soreness, and that this is ok and safe.

Participants were recommended to hydrate following the exertion. At the end of this session, there was an opportunity to ask questions such as timetabling etc.

These elements of the intervention served to improve task self-efficacy, self-regulatory self-efficacy and provided a platform to foster social-support between participants and between participants and staff. These components outlined represent the BCTs of; Instruction on how to perform the behaviour (referring to both the exercises themselves as well as the self-regulatory behaviours of breathing correctly) and social-support (from staff and participants).

4.6 Intervention design and development conclusion

Chapter 4 outlined the development and design process of an intervention to optimise adherence at a CCEP. The chapter presented the intervention as it was intended to be delivered and as it was delivered with detail of the guiding theory, the evidence base to support the design phase and the inclusion of specific intervention components.

Chapter 5

Study 2

Feasibility Study

5.1 Introduction

Despite the well-documented benefits of participation in CCEP's, adherence remains sub-optimal as identified in Study 1. In response to these sub-optimal levels of adherence, a behaviour change intervention was designed and delivered (as outlined in **Chapter 4**) with the aim of improving rates of adherence to the CCEP. The intervention, informed by a review of literature and the findings of study 1, was delivered to a sample of 195 participants over a period of 12 months.

The MRC's guidance for developing and evaluating complex interventions (Craig, Dieppe, et al., 2008; Medical Research Council, 2006) was adhered and in line with these recommendations. **Chapter 5** represents Phase 2 in the MRC framework (Medical Research Council, 2006) as outline in **Figure 5.1.** Phase 2, according to the MRC (2006) is the feasibility stage and includes elements such as piloting, testing procedures and estimating recruitment sample size. Feasibility studies are those carried out prior to a main trial in order to answer questions such as "can this be done?" and whether the intervention should be recommended for efficacy testing (Bowen et al., 2009). According to Blatch-Jones, Pek, Kirkpatrick, & Ashton-Key, (2018) feasibility studies can provide methodological information and evidence about the design, planning and justification of a study. This assists in reducing or eliminating problems that inhibit successful delivery of interventions and studies and therefore increase value of the research. The MRC process evaluation framework (Moore et al., 2015) built upon the MRC guidance for developing and evaluating complex health interventions. This framework was utilised in guiding the process evaluation of the intervention as part of the feasibility study.

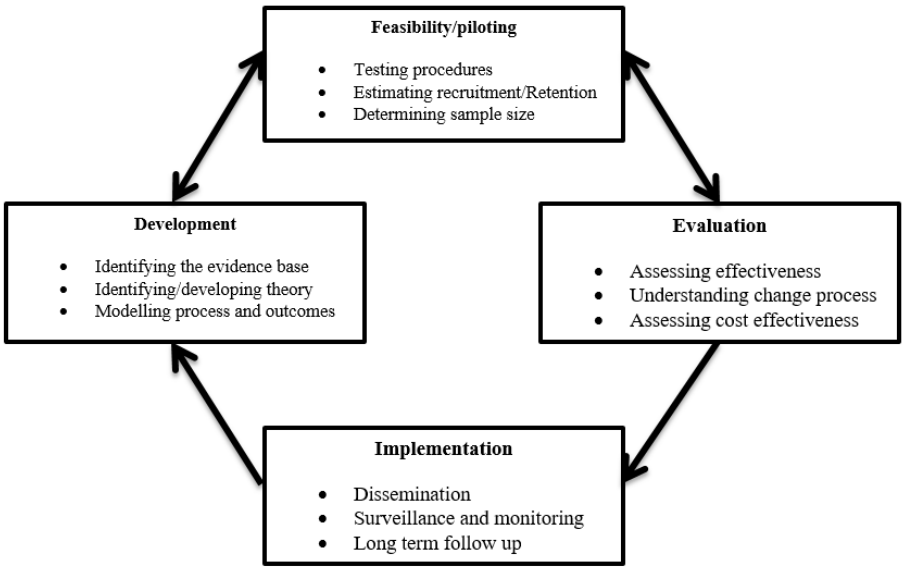


Figure 5.1 Adapted from Medical Research Council guidance

Aims and research questions

Chapter aims

- To evaluate the feasibility of the intervention including a process evaluation.
- Secondary aim: to observe and identify trends in rates of initiation, attendance and retention in those receiving the intervention compared to those who did not receive the intervention.

5.2.2. Research questions

- Is the intervention feasible to implement?
- Was the intervention delivered as planned?
- What was the rate of intervention engagement?
- Were there associations between measured baseline variables and attendance at intervention components?

- Is there an improvement in the hypothesised mediators/mechanisms for change?
- Do trends indicate improvement in adherence in the intervention group compared to the standard group?

5.3 Methodology

5.3.1 Overview of study design

An intervention was designed and implemented **(as presented in Chapter 4)** with the main aim of improving rates of adherence. To answer the research questions, the feasibility study used cross-sectional and observational research designs. A pre-post quasi-experimental research design component was also utilised to identify trends in adherence improvement as a result of the intervention. Study 1 acted as the control or comparison group in order to observe trends in effectiveness on the outcomes of adherence. Study 1 represents the "standard group" and the intervention as part of study 2 represents the "intervention group". **Figure 5.2** outlines an overview of the study design including the components of the behaviour change intervention received by the Intervention group.

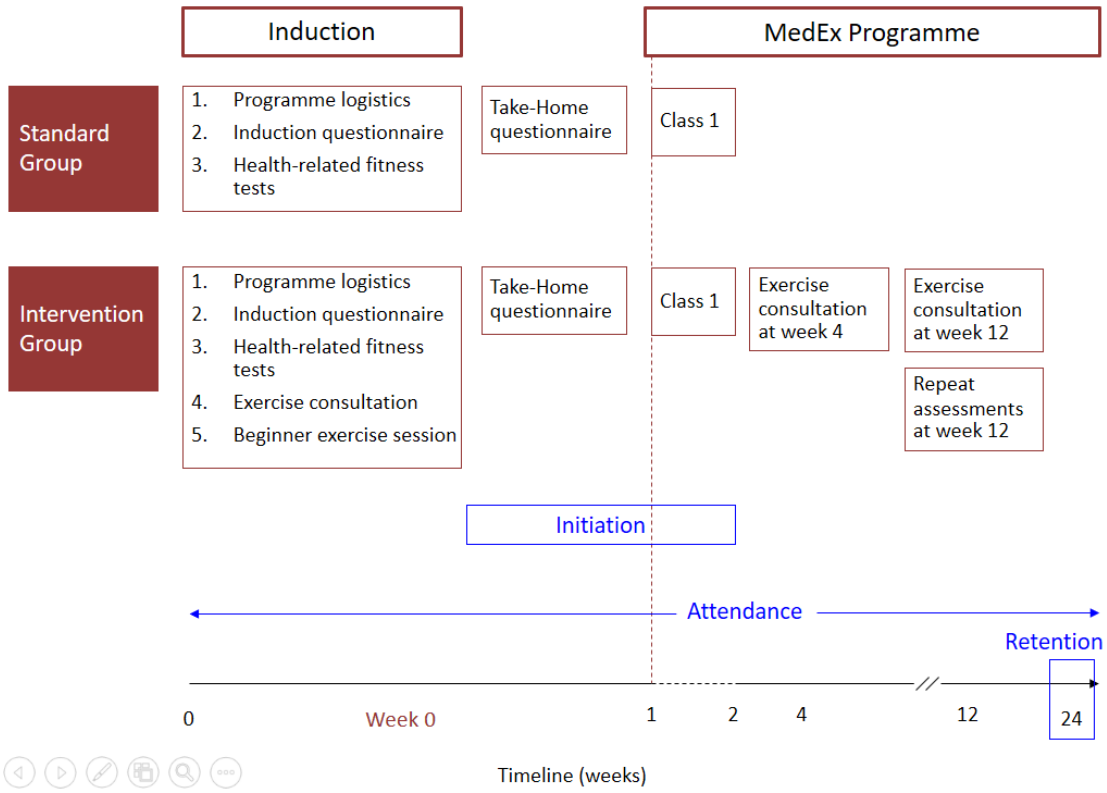


Figure 5.2 Overview of study design

5.3.2 Participant recruitment

A 12 month rolling recruitment period commenced in September, 2014 for the recruitment of the standard group (control group) and 12 month recruitment (from September 2015) for the intervention group. Potential participants with established chronic illness referred to a CCEP attended a standardised induction session prior to commencing the programme. Participants were recruited during the induction session. A plain language statement was provided and participants had the opportunity to ask questions relating to the study. Participants provided written informed consent to participate in the study. All participants that were recruited to the CCEP opted-in to take

part in the research study. The study was approved by the Dublin City University Research Ethics Committee (DCUREC3014227). Participants who were referred in the first year underwent a standard induction to the CCEP programme and those referred in the second year participated in a behaviour change intervention following the induction. Participants referred in the first year were analysed as part of Study 1 and acted as a control group to compare rates of adherence.

5.3.3 Research Setting

CCEP as outlined in Study 1.

5.3.4 Inclusion criteria

Inclusion criteria included the following;

- >18 years of age
- Presence of an established chronic illness
- A referral from a medical professional outlining patient safety to participate in the supervised exercise programme.

5.3.5 Overview of procedures

Participants attended a 2 h induction session staffed at a ratio of 1 tutor to 6 participants. The programme timetable, car parking arrangement, facility access, and costs (€8 per session) were explained to participants. Participants completed a questionnaire and undertook a series of health-related fitness assessments. All elements of the intervention were explained to participants and were provided with the time and date for their first session. Programme initiation was recorded and attendance was monitored over 24 weeks. Participants in the Intervention group received the added

components of the behaviour change intervention including; the beginner exercise sessions and the 3 exercise consultations as outlined in detail in **Chapter 4** using the TIDieR template.

5.3.6 Descriptive and predictor variables

Induction Questionnaire

The questionnaire design and development was very similar to that used in Study 1 but also included a number of additions as will be outlined. The questionnaire data served to inform researchers of the participant characteristics as well as identifying change in the hypothesised mediating variables of self-efficacy, social-support and intentions for exercise. All elements included in the questionnaires were psychometrically valid where appropriate.

Demographics including age, sex, CIG, marital status, employment status and educational attainment were obtained along with referral information and the participant's address. Distance to facility was calculated using Google Maps and recorded in km.

Social-support for exercise from family and friends was assessed using a validated tool (Sallis et al., 1987) with 10 items assessing support from family and 10 items reflecting support from friends. Participants were asked, for example, how frequently over the past three months "*a family member offered to exercise with you*". Responses were recorded on a Likert scale of 1-5, with higher scores representing greater social-support. (Cronbach alpha, family α =.926, friends α =921.)

Intentions for exercise: A modified 6-item measure (Sniehotta, Schwarzer, et al., 2005) was used to assess intentions to exercise as well as intentions to attend the CCEP. Questions included the stem "I intend to" and item examples were "*exercise several times a week*", and "*attend MedEx at least once a week*". Likert scale responses ranged from 1 (completely disagree) to 4 (totally agree) with a higher score indicating greater intentions for exercise (Cronbach alpha, α =.923).

Self-regulatory self-efficacy for exercise was assessed using a modified 11-item scale (Luszczynska & Sutton, 2006; Shields & Brawley, 2006). Items within this scale also provided specific information on task, scheduling, and recovery self-efficacy. Participants were asked the stem "*How confident are you that you can…*" and included items such as "*plan exercise sessions that will be at least moderately difficult (e.g. have you breathing a little hard, your heart rate increases)?*". Participants rated their confidence on a Likert scale from 0 (not confident at all) to 10 (very confident), with a higher score indicating greater self-efficacy for exercise (Cronbach alpha, α =.951).

Barriers specific self-efficacy (BARSE) was assessed using a validated 13 item scale (McAuley, 1992). The scale also assessed the participant's belief about their capability to exercise in the face of common barriers. The questions include the stem of "*I believe that I could exercise 3 times per week for the next 3 months if*: …" and included items such as "*the weather was bad*". Participants rated their confidence on a Likert scale from 0 (not confident at all) to 100 (very confident); with a higher score indicating greater BARSE. (Cronbach alpha, α =.921).

Health-related fitness assessment

Aerobic fitness was assessed using the six minute run-walk time trial (Enright et al., 2003). An Incremental Shuttle Walk Test (Singh et al., 1992) was used to measure aerobic fitness in Study 1. It was decided that the 6-minute time-trial was best suited to the range of abilities in cohort under investigation. Participants were given the instructions to repeatedly walk a stretch of 30m for a period of 6 minutes at a pace that is exerting them. Standardised encouragement was given to participants every minute. Number of meters walked or ran over the 6 minutes was recorded.

Lower body strength was assessed using a sit to stand test (Csuka & McCarty, 1985). From a seated position with their arms crossed and their right and left hand placed on left and right shoulder respectively, participants were instructed to stand and sit 10 times as fast as possible. The test commenced following a "3, 2, 1, Go" countdown by the examiner. The test was monitored to ensure that participants stood up fully and placed their buttocks completely on chair during each repetition. The time taken to complete the task was recorded to the nearest .01 second with a stop watch.

Flexibility was assessed using a modified sit and reach test (Baumgartner & Jackson, 1998). Participants sat on a flat bench with their legs fully extended and feet against a sit and reach box (Eveque Leisure Equipment Ltd, Cheshire, UK) Participants reached forward as far as possible while sliding their fingers along the measurement scale on top of the sit and reach box and exhaling. Measurements were recorded to the nearest cm. Each participant performed 3 trials with the best score recorded for analysis. When the maximal reach distance was short of the sit and reach box, the

distance between the fingers and the box was measured with a tape measure and a negative distance was recorded.

Body Mass Index (BMI) was measured by assessing a participant's height (cm) and weight (kg) to the nearest 0.1 cm and 0.1 kg, respectively, using a stadiometer and scale (SECA Leicester Height Measure). BMI was calculated as body mass (kg) divided by squared body height in metres.

Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ) short form (Craig et al., 2003). Responses were converted to Metabolic Equivalent Task (MET) minutes and are presented as total MET minutes, walking MET minutes, vigorous MET minutes and moderate MET minutes.

5.3.7 Outcomes

Primary outcome measure: Intervention feasibility

Components of the intervention feasibility, both fidelity of delivery and engagement were explored. Intervention fidelity refers to the level of how well an intervention is delivered and received by participants as planned and intended. The effectiveness of any intervention depends on the providers delivering it as planned and the participants engagement with the intervention (Walton, Spector, Tombor, & Michie, 2017). Furthermore, it is important to measure the extent the intervention is delivered and received as intended by protocol to ensure intervention effectiveness (Walton et al., 2017).

Delivery

Approximately 50% of intervention components were observed by an additional member of the research team. Weekly meetings between members of the research team provided a platform for feedback relating to the delivery of intervention components.

Participant engagement

Attendance at all components of the intervention was objectively monitored using attendance records. The following components of the intervention were monitored for attendance.

- Exercise consultation at baseline
- Beginner exercise session
- Exercise consultation at week-4
- Exercise consultation at week-12

Secondary outcome measure: Trends of intervention effectiveness

A secondary aim of this study was to observe and identify trends in rates of initiation, attendance and retention between the intervention group and the standard group. This was measured by comparing rates of initiation, rates of attendance for 24 weeks and rates of retention in the Intervention group to the sample outlined in Study 1; the Standard group.

Initiation as a binary variable represents whether the participant attended an exercise session following induction. Initiation was objectively monitored. Upon

presentation to the facility, a participant scanned a wristband fob which they received at induction at reception of the facility to book into their class and gain access. Initiation rates were monitored for a period of 12 months post recruitment. .

Attendance was defined as a physical presence at an exercise session and was reported as the total attendance throughout the 24-week period. Attendance rates were monitored using the data provided by the wristband fob that was used by each participant to access the facility at each visit.

Retention was defined as attending a CCEP session during week 24. Again, caution is required in interpreting this construct as it may not reflect a true retention. The participant may be engaged with the programme but be absent at week 24.

5.3.8 Data treatment

5.3.8.1 Data storage

Hard copies of data including questionnaires and physical measurement record sheets were stored in a locked secure area in the School of Health and Human Performance at Dublin City University. An electronic copy of data were saved in Statistical Package for Social Sciences (SPSS v.21) (IBM Corp, Armonk, NY) and included unique participant ID numbers to ensure participant confidentiality.

5.3.8.2 Data entry

Data input was undertaken by the author and designated undergraduate and graduate level students. All researchers were trained in the use of SPSS for the purpose

of data input. The author prepared a blank SPSS template file with pre-entered variable names, values, labels. This blank template was provided to the input team. An additional SPSS template file was given to the research team to record ID numbers and sensitive personal data (names and date of birth), independent of the main survey data. Responses to open-ended questions were typed in full into the dataset. The data was inputted in batches by members of the research team. Approximately 5% of each questionnaire input batch was selected at random by the author and checked for quality and accuracy by comparing to the hard copy data. Each "batch" of questionnaires was compiled based on the recruitment week. If there were any errors in the questionnaire input, the full batch was examined for further errors. The author failed to record the percentage of agreement.

5.3.8.3 Data cleaning and scoring

Data were screened for outliers, irregular data and missing data using descriptive statistics. (e.g. means, frequencies, standard deviations, minimum values, maximum values, skewness, kurtosis). Expectation maximisation was used to impute minimal missing data, on the tools of social-support from family, social-support from friends, self-efficacy and intentions when a minimum of 70% of responses were made on each scale for each participant. A number of measures within the questionnaire required scoring and were done so using recommended scoring protocols.

5.3.8.4 Data analysis

Data were analysed using SPSS v.21 (IBM Corp, Armonk, NY). Descriptive statistics including mean, standard deviations, median, proportions and bivariate correlations were performed and reported as appropriate. Independent samples t-tests

were used to assess difference in age, distance to facility, behaviour change and health-related fitness measures between the Standard group and the Intervention group. Chi-square analysis was utilised to explore difference in proportions such as gender and CIG in the Standard and Intervention group. Paired-samples t-tests were used to identify change in the process measures (health-related fitness and behaviour change scores) of those in the Intervention group. The internal consistency of self-report measurement scales was tested using Cronbach Alpha (α) where applicable. Binary logistic regression was used for multivariate analysis on the dichotomous outcome of attendance at intervention components or not, with Lemeshow and Homer's test statistic used to assess the goodness of fit.

5.4 Results

Results are presented in terms of intervention delivery and engagement along with aspects of process evaluation. To fulfil a secondary research aim, the differences in rates of adherence between the intervention group and the standard group are presented.

5.4.1 Primary outcome: feasibility

This section is responding to and in line with the first aim of Study 2

- To evaluate the feasibility of the intervention including a process evaluation.

Delivery

The research team were satisfied with the level of fidelity of the intervention delivery as obtained from subjective review of delivery.

Engagement

One hundred and ninety-five participants agreed to take part in the intervention. The full sample attended the first two components of the intervention including the exercise consultation and beginner exercise session. Attendance at the week-4 and week-12 exercise consultation fell significantly to 52 % and 40% respectively (**Table 5.1**).

Table 5.1 Attendance at intervention components

Component of intervention	Total in attendance	Percentage of full sample in attendance (%)
Exercise consultation at baseline	195	100
Beginner exercise session	195	100
Exercise consultation at week-4	101	52
Exercise consultation at week-12	78	40

Characteristics of attendance at exercise consultations at week-4 and 12

Given the significantly lower attendance at the exercise consultation session at week-4 and week-12, further descriptive analysis was undertaken to compare attributes of those who attended each of the intervention components and those who did not attend and serves as a component of process evaluation as well as a feasibility analysis.

Exercise consultation at week-4

Those who attended the week-4 exercise consultation were significant older (t (158.94) =3.13, p=.002) that those who did not attend. There were no gender differences between attenders and non-attenders at the 4-week exercise consultation (X (1) =4.09, p=.058). Further descriptive statistics are presented in **Table 5.2.**

Table 5.2 Descriptive statistics of attendance versus non-attendance at the 4-week exercise consultation

	Attended		Did not attend		
	N=101	Mean ± SD, median, percentage (%)	N=94	Mean ± SD, median, percentage (%)	P value
Chronic illness group	96		87		.87 [b]
HeartSmart	41	42.7	34	39.1	
BreatheSmart	27	28.1	26	29.9	
SmartSteps	16	16.7	13	14.9	
DiabetesHealth Steps	12	12.5	14	16.1	
Sex:	101	93	94		.06 [b]
Men	66	65.3	46	51.1	
Women	35	34.7	46	48.9	
Age (years)	98	67.39±9.27, 69	86	62.38±12.04, 64	.002** [a]
Distance to facility (km)	98	13.49±19.71, 6.6	88	9.42±8.65, 6.25	.06 [a]
Behaviour change variables					
Self-efficacy	84	7.58±1.97, 7.96	63	7.33±2.03, 7.9	.45 [a]
Social-support family	93	2.22±1.12, 1.95	80	2.39±1.23	.32 [a]
Social-support friends	59	1.95±1.04, 1.41	50	2.20±1.08, 2	.23 [a]
Intentions	96	3.36±.50, 3.37	84	3.34±.53, 3.37	.80 [a]
BARSE	95	61.32±23.58, 61.4	78	59.35±23.72, 61.54	.58 [a]
Health-related fitness					
Lower body strength (sec)	97	23.41±8.09, 21.97	84	23.19±8.70, 20.47	.96 [a]
BMI	96	29.05±7.05, 29.20	90	28.78±11.69, 30.10	.85 [a]
Flexibility (cm.)	96	6.11±8.94, 6.75	83	5.07±9.85, 5	.33 [a]
6-min time trial (m)	90	434.65±112.16, 458	75	452.12±120.55, 463	.34 [a]

BARSE=barriers self-efficacy, BMI=Body Mass Index.

[a] p-value following undertaking independent samples t-tests between gender

[b] p-value following undertaking Chi-square test between gender and variables

* $P < 0.05$; ** $P < 0.01$

Prediction of attendance at exercise consultation at week-4

The variables of age, gender, CIG and distance to facility were included in the logistic regression model. The model was statistically significant (p=.002) and based on the Hosmer and Lemeshow test statistic (p=.545) was deemed to be a good fit. The model accounted for between 11 - 15% of the variance in attendance at the 4-week exercise consultation session. Gender and age appeared to be independently contributing to the model as presented in **Table 5.3** with women 50% less likely to attend the exercise consultation and for every year older there is a 6% increase in the likelihood of attendance to the exercise consultation.

Table 5.3 Logistic regression predicting attendance at the 4-week exercise consultation

Variable	**Odds ratio**	**95% CI for odds ratio**		**P**
		Lower	**Upper**	
Age	1.061	1.025	1.098	.001
Gender	.505	.236	.971	.040
HeartSmart				.623
BreatheSmart	.691	.321	1.488	.345
SmartSteps	1.220	.464	3.205	.687
DiabetesHealth Steps	1.221	.437	3.410	.704
Distance to facility	1.025	.996	1.056	.096
Constant	.026			.002

*p<0.5, **p<0.01

Exercise consultation at week-12

There was a significant difference in the baseline aerobic fitness level of those who attended the week-12 exercise consultation and those who did not attend (t (162.25) =2,15, p=.03). Further descriptive statistics are presented in **Table 5.4**.

Table 5.4 Descriptive statistics of attendance versus non-attendance at the week-12 exercise consultation

	Attended Exercise consultation at week-12		**Non-attendance at exercise consultation at week-12**		
	N= 78	Mean ± SD, median, percentage (%)	N=117	Mean ± SD, median, percentage (%)	P value
Chronic illness group:	77		106		.15 [b]
HeartSmart	39	50.6	36	34	
BreatheSmart	18	23.5	35	33	
SmartSteps	10	13	19	17.9	
DiabetesHealth Steps	10	13	16	15.1	
Gender:	78		117		.24 [b]
Men	50	64.1	64	54.7	
Women	28	35.9	53	45.3	
Age (years)	74	66.47±9.60, 68.5	110	64.09±11.67, 66	.15 [a]
Distance to DCU (km)	74	11.65±12.35, 9	112	11.51±17.46, 5.5	.95 [a]
Behaviour change variables					
Self-efficacy	69	7.35±1.82, 7.6	78	7.58±2.16, 8.1	.49[a]
Social-support family	71	2.28±1.03, 2	100	2.31±1.26, 2.06	. 86 [a]
Social-support friends	43	2.00±.92, 2	66	2.10±1.15, 1.84	. 65 [a]
Intentions	74	3.29±.58, 3.31	106	3.40±.52, 3.37	23 [a]
BARSE	71	56.71±21.25, 57.69	102	63.03±24.87, 65.38	.08 [a]
Health-related fitness					
Lower body strength (sec)	75	22.76±5.51, 21.97	106	23.70±9.90, 20.86	.42 [a]
BMI	78	28.79±8.06, 29.25	108	29.01±10.55, 29.40	.89 [a]
Flexibility (cm)	75	5.78±9.35, 5	104	5.52±9.41, 5.75	.85 [a]
6 min time trial (meters)	72	463.63±93.10, 477.5	93	426.31±129.16, 443	03* [a]

BARSE= barrier self-efficacy, BMI=Body Mass Index.
[a] p-value following undertaking independent samples t-tests between gender
[b] p-value following undertaking Chi-square test between gender and variables
* $P < 0.05$; ** $P < 0.01$*p<0.5, **p<0.01

Prediction of attendance at exercise consultation at week-12

The variables of age, gender, CIG, and 6 min time trial were included in a logistic regression model. The model was statistically significant (p=.03) and based on the Hosmer and Lemeshow test statistic (p=.07) was deemed to be a good fit. The model

accounted for 11 - 15% of the variance in attendance at the 12-week exercise consultation session. Baseline 6-minute time trial score was the only variable adding a statistically significant contribution to the model (**Table 5.5**), with every additional lap in the 6MTT resulting in .004% increase in likelihood of attending the 12-week exercise consultation. Gender, the BreatheSmart group and barrier self-efficacy score showed a trend towards statistical significance.

Table 5.5 Logistic regression predicting attendance at week-12 exercise consultation

Variable	**Odds ratio**	**95% CI for odds ratio**		**P value**
		Lower	**Upper**	
Age	1.030	.992	1.070	.125
Gender	.505	.244	1.043	.065
HeartSmart				.310
BreatheSmart	.465	.195	1.115	.086
SmartSteps	.488	.173	1.377	.175
DiabetesHealth Steps	.729	.238	2.234	.580
Distance to facility	.996	.975	1.018	.715
6 MTT	1.004	1	1.007	.027
BARSE	.987	.972	1.002	.083
Constant	.102			.206

Characteristics of those who attended some components compared to all components of the intervention

Only 50 participants (25.6%) attended all components of the intervention as per protocol. A total of 28 participants (14.4%) attended only the baseline exercise consultation and beginner exercise session components of the intervention. Fifty-one participants attended the baseline exercise consultation, beginner session and the four-week exercise consultation (26.2%). A total of 28 participants attended the baseline exercise consultation, the beginner exercise session and the 12-week exercise consultation (33.8%). Given the small numbers in each group additional analysis was undertaken to identify if there were any baseline differences between those who

attended all the components of the intervention (as analysed in per-protocol analysis) compared to those who only attended partial components of the intervention. There were significant group differences in age (t (182) =-2.137, p=.034) and social-support from friends (t (65.23) =-2.483, p=.016). Those who attended all elements of the intervention (as per protocol) were significantly older (mean age (years) 67.92+9.43 vs 64.04+11.27) and had significantly lower social-support from friends (1.70+.80 vs 2.19+1.12).

5.4.1.1 Process measures

Baseline measures were repeated at week-12 in the Intervention group. **Table 5.6** identifies baseline behaviour change and health-related fitness in the intervention group at baseline and presents repeated measures of these variables week-12. The 12-week re-test results are sub-divided between "Intention to treat" (entire sample) and "per protocol" (those who attended all components of the intervention as per intervention protocol). Social-support from friends increased in "per-protocol" group with no change in the other hypothesised variables. Both intention to treat and per protocol analysis resulted in improved aerobic fitness, and lower body strength.

Table 5.6 Intervention process measures

	Baseline		12 weeks				
			Intention to treat			As per protocol	
Variable	n= 186	Mean ± SD, median	n= 145	Mean ± SD, median	P value	n= 50	Mean ± SD, median	P value
Psychosocial								
Social-support family	172	2.3 ± 1.17, 2	101	2.46± 1.06, 2.25	.38 [a]	43	2.48±.95, 2.25	.46 [b]
Social-support friends	109	2.06± 1.06 , 1.87	94	2.28± .98, 2.06	.12 [a]	39	2.19± .90, 2.12	.001* [b]
Intentions	180	3.35 ± .54, 3.37	104	3.3± .52, 3.25	.54 [a]	45	3.31± .39, 3.25	.79 [b]
Self-efficacy (self-regulation)	147	7.47 ± 1.99, 7.9	97	7.37± 17.84, 7.63	.24 [a]	44	7.22± 1.72, 7.36	.14 [b]
BARSE	173	60.43 ± 23.59, 61.5	99	57.88± 21.17, 57.69	.17 [a]	43	54.47± 18.03, 53.84	.60 [b]
Health-related fitness								
Six-minute time trial	165	442.59± 116.02, 460	106	501.46± 152.55, 511	.000** [a]	49	487.78± 139.84, 510	.03* [b]
Strength	181	23.31± 8.36, 21.26	117	28.31± 90.75, 19.1	.000** [a]	49	20.10± 4.75, 20.15	.000** [b]
Flexibility	180	5.63±9.36, 5.5	110	17.87± 90.39, 7	.19 [a]	49	5.72± 9.48, 8	.86 [b]
BMI	176	30.56± 6.7, 29.8	131	29.78± 5.86, 29.2	.911 [a]	48	29.67± 6.06, 29.4	.42 [b]
IPAQ								
Moderate MET minute	173	758.29± 1588,60	101	839.09± 1462.83, 360	.16 [a]	42	536.66± 650.40, 340	.10 [b]
Vigorous Met Minutes	174	875.63± 2171.9, 0	101	1224.16± 1633.91, 960	.01* [a]	43	893.02± 864.40, 960	.22 [b]
Walking MET minutes	177	812.28± 1151.88, 462	99	804.74± 870.90, 528	.89 [a]	43	671.51± 685.31, 528	.64 [b]
Total MET minutes	162	2449.38± 4193.44, 973	97	2915.25± 3118.96, 2115	.03* [a]	42	2122.31± 1516.54, 1730.25	.19 [b]

Abbreviation list: BARSE= Barriers self-efficacy, BMI=Body Mass Index, MET=

[a] p-value following undertaking paired samples t-tests between baseline and 12 weeks, [b] p-value following undertaking paired samples t-tests between baseline and 12 weeks, * $P < 0.05$; ** $P < 0.01$*p<0.5, **p<0.01

5.4.2 Secondary outcomes: trends towards intervention improving adherence

This section is responding to and in line with the secondary aim of Study 2

- Secondary aim: to observe and identify trends in rates of initiation, attendance and retention in those receiving the intervention compared to those who did not receive the intervention.

Of the 576 participants inducted, 381 were enrolled during 2014/15 and belong in the Standard group. A total of 195 participants were enrolled in 2016 and allocated to the Intervention group.

Descriptive statistics (including means, medians and standard deviations) of the Standard group and the Intervention group are presented in **Table 5.7**. There was a statistically significant difference in social-support from friends (t (302) =-3.303, p=.001), lower body strength (t (500) =-4.831, p=.000) and flexibility (t (342.119) =2.762, p=.006) between the two groups.

Table 5.7 Baseline descriptive characteristics of Standard and Intervention groups

	Standard Group N=381	Mean ± SD, median, percentage (%)	Intervention Group N=195	Mean ± SD, median, percentage (%)	P value
Chronic illness group:					.053
HeartSmart	150	39.4	75	41	
BreatheSmart	145	38.1	53	29	
SmartSteps	55	14.4	29	15.8	
DiabetesHealthSteps	31	8.1	26	14.2	
Employment status	264		195		.12
Unemployed	11	4.2	8	4.5	
Working	41	15.5	41	23.3	
Retired	121	45.8	85	48.3	
Looking after home	22	8.3	16	9.1	
Unable to work due to illness.	53	20.1	18	10.2	
Other	16	6.1	8	4.5	
Marital status	262		166		.16
In a relationship	173	69.8	114	68.7	
Education	256		173		.81
Leaving cert or greater	152	59.4	104	60.1	
Gender					.79
Men	218	57.2	114	58.5	
Women	163	42.8	81	41.5	
Age (years)	380	64.0 ± 11.59, 65	184	65.05± 10.92, 67	.34 [a]
Distance to DCU (km)	381	10.03±15.77, 5.5	186	11.57± 15.59, 6.4	.27 [a]
Behaviour change					
Self-efficacy	265	7.31± 2.27, 7.7	147	7.47± 1.99, 7.9	.45 [a]
Social-support family	266	2.16± 1.01, 2	172	2.3± 1.17, 2	.21 [a]
Social-support friends	195	1.68±.89, 1.3	109	2.06± 1.06, 1.87	.002* [a]
Intentions	268	3.30±.63, 3.33	180	3.35± .54, 3.37	.37 [a]
Health-related fitness					
Lower body strength (seconds)	321	20.09±6.36, 19.1	181	23.31± 8.36, 21.26	.000** [a]
BMI	345	28.89± 6.48, 29	186	28.92± 9.56, 29.30	.22 [a]

Flexibility (cm)	337	7.96± 8.74, 8	179	5.63± 9.36, 5.5	.005** [a]
6 MTT (m)	59[c]	459.76± 131.32, 482	165	442.59± 116.02, 460	.35 [a]

Abbreviation list: BMI=Body Mass Index.
[a] p-value following undertaking independent samples t-tests between gender
[b] p-value following undertaking Chi-square test between gender and variables
[c] Only n=59 due to a change in mode of assessment of aerobic fitness
* $P < 0.05$; ** $P < 0.01$

Adherence related outcomes

The outcomes of initiation, attendance and retention were observed in an attempt to identify trends in intervention effectiveness. Rates of initiation, attendance and retention to the Intervention group compared to the Standard group are outlined in **Table 5.8.** The table presents the adherence related outcomes by those who attended all components of the intervention, as per protocol, and intention to treat (the full intervention group).

Table 5.8 Outcomes of initiation, attendance and retention

	Intervention group				**Standard group**	
	Intention to treat		**Per-protocol**			
Initiation (%)	N=195	76.9%	N=50	96%	N=381	73.2%
Attendance mean± SD (median)	N=150	8.7±9.9 (5)	N=48	22.2±12.6 (23.5)	N=279	11.1±12.4 (6)
Retention (%)	N=150	38.7%	N=48	56.3%	N=279	28.7%

5.5 Conclusion to Study 2

The intervention in its current form is not feasible. Given the number of components to the intervention, and the low numbers attending all components it is considered that further research and investigation in warranted prior to considering the intervention feasible. Significantly lower number of participants attended the week-4 and week-12 exercise consultations (approx. 50%) compared to the baseline intervention components. Men and those who were older were more likely to attend the exercise consultation at week-4. However, those with greater aerobic fitness were associated with attendance at the week-12 exercise consultation. Qualitative exploration of the acceptability of the intervention and its components is recommended and warranted as well as consultation with participants in order to modify to intervention. This is required in order to establish a feasible implementation prior to moving forward in the MRC Frameworks guidance (Craig, Dieppe, et al., 2008; Medical Research Council, 2006) of carrying out the full trial of intervention effectiveness.

5.6 Recommendations for the progression of intervention development

Based on the findings of the feasibility study and process evaluation elements it is evident that further work is required prior to moving forward in the MRC's guidance (Craig, Dieppe, et al., 2008; Medical Research Council, 2006) of carrying out the full trial of complex intervention effectiveness. The recommendations are as follows:

- Qualitative exploration of intervention acceptability is recommended to explore an examine participant's perceptions of the intervention components. Focus groups are recommended in a sample of those who attended only some components and a sample who attended all components of the intervention.

- There was a low attendance rate at the week-4 and week-12 exercise consultations, and a lower rate of attendance at all components of the intervention. This indicates that there may be too many components to the intervention to be feasible in its current form. A recommendation is to explore this in some qualitative research with a sample of participants who attended only some components and a sample who attended all components of the intervention.
- Furthermore, based on outcomes of this qualitative exploration it may be deemed appropriate to alter the intervention delivery modality. Given the low attendance at the 4 and 12-week consultation, much of the intervention should be delivered at baseline as possible. The rationale for the exercise consultation at week-4 and 12 was to foster sustained adherence and provide an opportunity to re-engage with the CCEP if absent for a period so it may be detrimental to eliminate these components completely. A telephone call with participants that would utilise the same BCT's as the exercise consultation may be more acceptable for participants but exploration of the feasibility is warranted.

Chapter 6

Discussion and conclusion

6.1 Introduction

The twentieth century was characterised by a global epidemiological transition, whereby chronic non-communicable diseases, primarily cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes (WHO, 2014) overtook infectious diseases as the leading cause of morbidity and mortality (Lim et al., 2012). With 87% of all death in Europe due to non-communicable conditions, the emergence of chronic diseases as the predominant challenge to the health of European citizens is undisputed (Darker et al., 2015; Task force on Major and Chronic Diseases of DG SANCO's Health Information Strand, 2007). The rapid increase in the prevalence of chronic diseases impose large human, social and economic costs, that place additional pressure on already overstretched health and social care systems.

The increase in chronic disease burden is attributable to many factors such as population demographics, including ageing, health disparities and lifestyle risk factors particularly, excess alcohol consumption, excess caloric intake, chronic levels of psychological stress, smoking and physical inactivity. Physical activity, in particular may be an important factor for improving general health and preventing the development of many of the chronic illnesses.

Secondary and tertiary disease prevention involves managing chronic diseases post-diagnosis to slow or stop disease progression promote the patient's adjustments to their condition, reduce the risk of a recurring event and improve quality of life. There is a large body of evidence supporting the role of hospital and community-based exercise rehabilitation programmes in the secondary prevention of chronic illness

(Anderson et al., 2016; Costa Da Silva et al., 2017; Desveaux, Beauchamp, Goldstein, & Brooks, 2014; McCarthy et al., 2015; Weinrich, Stuart, & Benvenuti, 2014). The benefits associated with participation in hospital-based and community-based exercise rehabilitation programmes is however, largely related to uptake and adherence (Murphy et al., 2012), which are presently sub-optimal (Cockram et al., 2006; Costa Da Silva et al., 2017; Harwood et al., 2016; Keck & Budde, 1999). Surprisingly, relatively few studies have evaluated the factors that are associated with low adherence to community-based exercise rehabilitation programmes. The aim of this PhD thesis was to determine the rates and correlates of adherence to a chronic illness community-based exercise programme and to design and evaluate the feasibility of a behaviour change intervention to improve adherence.

6.2 Study 1

6.2.1 Population characteristics

This initial cross-sectional descriptive analysis provided demographic, behaviour change, health-related fitness, health-related wellness and health service usage information on men and women who were referred to a CCEP and who attended the induction session. A total of 381 individuals with a mean (± SD) age of 64.07 ± 11.59 years who were referred to a CCEP attended the induction session. Almost 50% were retired and a further 20% were unable to work due to illness. Almost two-thirds had a full medical card or a GP visit card and one in five had a third level qualification. In contrast to other single chronic illness rehabilitation programmes, the proportion of men (57%) that attended induction was only slightly higher than women. There was a

higher proportion of men in each chronic illness group except BreatheSmart where men and women were surprisingly, similarly represented. In a recent systematic review of the efficacy of maintenance exercise programmes for individuals with pulmonary disorders, six out of eight studies had a higher proportions of men than women (Jenkins et al., 2018).

Phase III hospital-based programmes, general practitioners and hospital-based consultants (attending physicians) were the primary sources of referral for both men and women. The fact that some participants were referred directly from hospital-based cardiac or pulmonary rehabilitation programmes while others had not participated in any formal rehabilitation programme highlights the importance of identifying referral sources and developing flexible and sustainable referral processes to optimise engagement with CCEP.

Approximately one-third of referrals who completed the induction session at the CCEP reported moderate depressive symptoms. This proportion is much higher than the 10% of Irish adults >50 years who report having clinically significant depressive symptoms (TILDA, 2014). It is well documented that depression is a frequent comorbidity in chronically ill population (Kang et al., 2015) and should therefore, be addressed when referring patients to a chronic illness community-based exercise programme.

The mean (± SD) number of nights spent in hospital in the previous 12 months was 6.4 ± 12.1, with 63% spending between 1 and 10 nights and 37% > 10 nights in hospital. The proportion of the participants who spent >10 nights in hospital per annum

is higher than the national average of 29% in adults > 50 years (TILDA, 2014). The difference is likely due to the presence of a documented chronic illness in all participants in the current study. Surprisingly, the number of annual GP visits (6.57±5.62) were lower than that values previously reported for adults with chronic illness (van Oostrom et al., 2014).

Based on a modified two item screening measure, 37% of referrals who attended the induction session met the recommended daily physical activity guidelines of 30 minutes of moderate to vigorous intensity. This proportion is very similar to the national average (~33%) reported for adults >50 years (McKee et al., 2015). The daily physical activity levels of those who initiated on the programme was calculated using the IPAQ questionnaire as was used in McKee, Kearney, & Kenny (2015). Only 22% of those who initiated on the programme met the physical activity guidelines. The original two-item screening tool was designed for use in adolescence (Prochaska et al., 2001) and has been validated in 10-18 year old sample in Ireland (Hardie Murphy, Rowe, Belton, & Woods, 2015). It may not however, be a valid measure of physical activity in adults with chronic illness. It is also possible that those who decided to initiate following induction may have done so due their perceived low levels of daily physical activity.

BreatheSmart, although not the oldest cohort, had the lowest physical activity and aerobic fitness levels. In formal or institutional rehabilitation setting it has been found that pulmonary rehabilitation participants had a significantly lower functional status than their cardiac rehabilitation counterparts (Reardon et al., 1995). Chronic lung disease and any consequent disease-related muscle myopathy can cause both dyspnoea

and/or leg discomfort during exertion. These unpleasant experiences frequently lead an individual to reduce or even eliminate daily tasks which adversely impacts their daily physical activity levels. A more sedentary lifestyle results in further deconditioning and promotes a downward spiral of progressive breathlessness and loss of aerobic fitness. While BreatheSmart participants had the lowest overall physical activity and aerobic fitness levels, SmartSteps has the lowest walking MET minutes, an activity that is recommended for those with claudication (Lane, Harwood, Watson, & Leng, 2017). However, walking is also likely to induce claudication related pain and deter individual participation.

Self-efficacy and behavioural intentions for exercise were found to be high in individuals attending the induction day (discussed further in **Section 7.2.3**), with men reporting higher levels of self-efficacy and intentions for exercise than women. The level of social-support from both family and friends was low. The is a concern as low levels of social-support have previously been associated with poorer outcomes (Wang, Wu, & Liu, 2003) and higher levels of social-support associated with physical activity participation (Smith, Banting, Eime, O'Sullivan, & van Uffelen, 2017). There was a low response level to the measure of social-support from friends. This finding may be explained by the fact that some participants indicated they did not have friends and others did not think it was relevant to answer this component of the questionnaire. This was established as a result of the researcher asking a number of participants if they realised they did not complete one section of the questionnaire. It is possible that the true level of social-support from friends is even lower than that recorded, as those who

do not have friends chose to not complete the measure (discussed further in limitations **Section 6.6**).

6.2.2 Rates of adherence

Almost three quarters of the referred patients who completed the induction commenced the programme. The relatively high commencement rate may indicate that a large proportion of this cohort may have already initiated the processes of behaviour change or made their decision about the programme prior to attendance. Further research is warranted to explore those referred who did not attend the induction day. It is difficult to interpret findings from studies that have examined initiation in established hospital-based chronic illness rehabilitation programs or in community-based settings of rehabilitation due to differences in measurement and model of delivery. A UK based pulmonary rehabilitation programme reported an initiation rate of 68% following referral (Hayton et al., 2013). In Germany, only 30% of individuals commenced a phase IV cardiac rehabilitation programme following discharge from a phase III programme (Keck & Budde, 1999).

Although not statistically significant, more women than men initiated the CCEP. This is a welcome finding considering that men are more likely than women to initiate hospital-based cardiac rehabilitation programmes (Lieberman, Meana, & Stewart, 1998). There is presently no clear consensus on the proportion of men and women referred who initiate community-based chronic illness rehabilitation programmes. Out of the eight studies included in a recent review of community-based pulmonary rehabilitation, six had a greater proportion of men than women (Jenkins et al., 2018).

However, Andersen et al., (2016) found that in general, men are under-represented in health enhancing programmes (Anderson, Seff, Batra, Bhatt, & Palmer, 2016).

Patients referred to the DiabetesHealthSteps programme had a much lower rate of initiation than any of the other MedEx CIGs. This is a cause for concern considering that an estimated 60 million Europeans or about 10% of adults aged 25 years and over have diabetes (Tamayo et al., 2014). In addition, diabetes is among the leading causes of death in Europe. Lifestyle management including nutrition therapy, physical activity, smoking cessation counselling, and psychosocial care is recommend as a fundamental component of diabetes care (American Diabetes Association, 2017). It is possible that the factors that influence initiation to community-based chronic illness rehabilitation programmes are disease specific and warrant further investigation.

Despite patients being referred by a medical professional, completing a resource intensive induction process and having somewhat positive rates of initiation, the subsequent attendance rates were sub-optimal. On average, participants attended only 11 sessions over the 24-week period representing a 12.5% compliance rate to the recommended two sessions per week. The majority of previous studies evaluating compliance have used hospital-based single disease rehabilitation programmes and community-based exercise for single chronic illnesses. In contrast, the MedEx CCEP is a multi-disease model of community-based exercise and thus does not enable effective comparison. Cockram et al., (2006) reported an adherence rate of 55% at 4-year follow-up in patients with moderate to severe chronic obstructive pulmonary disease who attended a community-based maintenance exercise programme. Similarly high

compliance rate of 70% at 1 year in a long-term community-based post-rehabilitation programme for those with COPD (Beauchamp, Francella, et al., 2013). In this programme, individuals were encouraged to attend the local authority leisure centre twice a week and complete the prescribed exercise programme.

Understanding rates of attendance at different time periods during the 24-week period has added value to this analysis. Attendance was further reported for the first 4 weeks, weeks 5 to 12 and weeks 13 to 24. There is a downward trend in the attendance numbers in the 24-week period with the largest decrease occurring in the early stages of the program. The rates began to plateau by week-2. Time to dropout and retention present similar constructs and caution must be taken in interpreting the attendance data, as they may not be truly representing a dropout or retention. While dropout as defined in the present study reflects attendance during week 24, it does not however, consider absences due to illness exacerbations. The sub-optimal attendance and retention rates may result in poorer outcomes for the individuals with chronic illnesses. Furthermore, induction process may represent a significant waste of time and resources.

6.2.3 Factors associated with adherence

None of the demographic factors measured as part of this study (age, gender, distance to facility, marital status, educational attainment, employment status) were related to initiation. While more women than men initiated the programme, the difference did not reach statistical significant. A slightly higher level of social-support from family was observed in initiators vs non-initiators, but again the difference did not

reach statistical significance. Higher social-support has been associated with greater likelihood of participating in physical activity and exercise (Resnick, Orwig, Magaziner, & Wynne, 2002) and as a result it was hypothesised that initiators would have higher levels of social-support than non-initiators. In unadjusted analysis, initiators had significantly higher scores for intentions for exercise and self-efficacy for exercise as well as having a lower BMI (closer to healthy ranges) than those who did not initiate. These variables no longer remained statistically significant following adjusted analysis. The research sample were referred patients who attended the induction day and may therefore have already formed intentions to attend the programme. While further research is warranted on the correlates of initiation, the referral process should be an important element of any future research design.

In bivariate analysis age, chronic illness group, distance to facility, behavioural intentions and self-efficacy for exercise were related to attendance. Adjusted analysis identified the non-modifiable factors of age and distance to facility as the primary correlates of attendance. Age and distance to facility have been identified in previous studies examining attendance (Jackson et al., 2004; Sun et al., 2017) and represent key domains within both the Social Cognitive Theory (Bandura, 1998) and the COM-B model (Michie, van Stralen, et al., 2011) that are used to explain behaviour. The present findings present a unique contribution to the literature in the context of community-based multi chronic illness rehabilitation.

Employment status, programme of enrolment, the SF-12 and PHQ8 as measured by the take-home questionnaire were identified as having bivariate associations with

24-week attendance. However, following adjusted analysis they no longer remained significant contributors to attendance. The lack of an association between attendance and health-related wellness was a surprise finding. Findings from studies examining the association between attendance and health-related wellness are equivocal with some studies showing an association (Casey, Hughes, Waechter, Josephson, & Rosneck, 2008; Caulin-Glaser, Maciejewski, Snow, LaLonde, & Mazure, 2007), and others showing no association (Grace et al., 2002). In line with social ecological theories guiding our understanding of health and behaviour, it is evident that a large number of factors having varying levels of influence on the behaviour of initiation and subsequent adherence.

In both bivariate and multivariate analysis, attendance during the first 4 weeks was identified as the most significant correlate of week-24 attendance. Service providers should be aware of the importance of providing support to participants during the early stages of community-based chronic illness exercise programme in order to improve long term attendance. The MedEx CCEP does not currently have an established mechanism to promote habit formation which is important in health behaviour change interventions (Rothman, Sheeran, & Wood, 2009).

6.3 Intervention design

The intervention had a strong theoretical underpinning and its design was based on the findings from Study 1, and published studies. Both the social cognitive theory (Bandura, 1998) and the COM-B model (Michie, van Stralen, & West, 2011) were used to underpin and guide the intervention design along with the behaviour change wheel

(Michie, van Stralen, & West, 2011). Both theories acknowledge a range of personal, environmental and behavioural factors that influence and individual's capability, opportunity and motivations to behave in a certain way. Behavioural intention as a proximal antedate to behaviour was also a component of the theoretical underpinning of the intervention. The behaviour change wheel (Michie, van Stralen, West, et al., 2011) provided a strong framework and enabled the systematic design of the intervention and it's components. The taxonomy of behaviour change techniques (Michie et al., 2013) was utilised in the design phase ensuring transparency within the intervention. The behaviour change techniques have been similarly mapped to an intervention designed underpinned by the social cognitive theory to increase physical activity in older adults (Tully et al., 2018).

The intervention design components of Study 2 align to the development phase (phase one) of the MRC guidance for development and evaluation of complex interventions (Craig, Dieppe, et al., 2008; MRC, 2006). While phase one of the MRC guidance phase also represents the research carried out in Study 1 of this thesis, the design component of Study 2 synthesised the evidence required to change behaviour and optimise initiation and adherence. The MRC has presented a framework (Moore et al., 2015) that builds on themes described in the 2008 MRC complex interventions guidance (Craig et al., 2008). One of the primary aims of this framework was to identify the underpinning causal pathways of adherence and contextualise the factors associated with the outcomes. Recommendations were formulated and planned causal pathways for the behaviour change and intervention efficacy was outlined in the intervention design part of Study 2. This adheres to recommendations and best practice

to plan for process, impact and outcome evaluation in the planning phases of intervention design.

6.4 Study 2

6.4.1 Intervention feasibility

The intervention consisted of a number of components. Participants were invited to attend all or as many elements as possible. There was no financial cost to the participants for attending any component of the intervention. Participant engagement with all components of the intervention was lower than anticipated with only 26% attending all components as planned. A little over half (52%) of the participants attended the week-4 exercise consultation and this proportion decreased to 40% attendance at week-12. Age and gender were independent predictors of attendance at the week-4 exercise consultation, with men and younger participants more likely to attend the exercise consultation. Participants with greater aerobic fitness levels were more likely to attend the week-12 exercise consultation. The findings add to the feasibility results obtained in Study 2 and provide a rationale for focusing on older patients, female patients and those with lower levels of aerobic fitness populations to ensure engagement with the intervention as planned. Given the low number of participants attending all components of the intervention, further exploration should be undertaken regarding the acceptability and design of the intervention in order to improve adherence rates. Perhaps, the number of intervention components need to be reduced or the existing components could be better integrated into the class structure

With the exception of social-support, no other behaviour change scores improved over the 12 weeks. Social-support for exercise from friends/peers was a key element of the intervention and increased in those who attended all components of the intervention. Caution is advised in interpreting these findings as the improvement in social-support could be due to attendance at the CCEP and not the intervention *per se*. However, the fact that social-support from friends increased only the "per-protocol" group would indicate an association between attending all elements of the intervention and increased social-support from friends.

Social-support has been consistently associated with greater likelihood of attending rehabilitation programmes (Bramwell, 1990; Moore, Dolansky, Ruland, Pashkow, & Blackburn, 2003) as well improving health-related quality of life (Woodgate, Brawley, & Shields, 2007). Social-support can be a source of self-efficacy information (Bandura, 1986). Although not statistically significant, self-efficacy decreased in those who attended all elements of the intervention (per-protocol) and remained the same in the intention to treat group. A lowering of self-efficacy has been noted in other physical activity interventions involving chronic-illness groups. Moore et al., (2006) found that both barrier and self-efficacy was lowered following an 8-week intervention to improve exercise maintenance (Moore et al., 2006) whereas McAuley et al, (2011) found a drop in efficacy at the end of a 6 month exercise intervention in older adults.

It could be speculated that the high baseline score may not have been a true representation of self-efficacy and that following commencement of the programme, the participants acquired a better understanding of the construct, resulting in a drop in

the score. Mapping the levels of self-efficacy at initiation, attendance and retention would help to improve knowledge around how self-efficacy may change at various stages of the rehabilitation journey. Increased proxy-efficacy as a result of the increased support during the intervention may also have affected the self-efficacy score. Despite the form of efficacy utilised it has been noted that both proxy and self-efficacy result in health behaviour (McAuley & Blissmer, 2000).

6.4.2 Improvements in adherence as a result of the intervention

The Standard group and the Intervention group were broadly matched in terms of demographic information and primary chronic illness. The groups differed in terms of social-support from friends, lower body strength and flexibility. Those in the Intervention group had higher social-support from friends and poorer lower body strength and flexibility than the Standard group. These differences, once acknowledged, are acceptable due to nature of the quasi-experimental research design.

The intervention was associated with positive effects on initiation, attendance and retention. Attendance at all components of the intervention, as per-protocol, appears to be superior and participants should be encouraged to adhere to all elements of the intervention to ensure optimum initiation, attendance and retention rates. The various components of the intervention acknowledge the different strategies and BCTs that are required to target different health behaviours. The development of targeted strategies for each component of the CCEP journey is important, but the strategies should be undertaken to maximise integration of each component. For example, there is no point in improving initiation if attendance or retention are suboptimal. A significant

finding in Study 1 was the identification of 4-week attendance as a significant predictor of 24-week attendance. This finding provided the rationale for the design of the intervention, in terms of aiming to improve of attendance and retention.

According to Rotter (1960) the likelihood of performing a certain behaviour at a certain time in a given context is known as a "behavioural potential". It appears that the period of early attendance has a behavioural potential. To date, there is a lack of theoretical elaboration on the processes of behaviour maintenance following initial change (Kwasnicka, Dombrowski, White, & Sniehotta 2016). Although explored in the current study, little clarity has been brought to the putative mechanisms. The 56% retention rate in those attending all elements of the intervention is a significant finding, and represents a greater rate of retention to physical activity programmes than in the general population (Dishman, 1982). The MedEx model of CCEP has enormous potential to provide a non-hospital based model of health care delivery in people with chronic illness. While slowing or stopping disease progression, reducing the risk of a recurring event and improving quality of life may be the primary aim of CCEP's, they may also have a role in social and community connectedness and connectedness with the health service.

6.5 Thesis strengths

The objective measurement of attendance by means of a fob used by participants is a strength of this study and has been recommended as a more accurate measure of attendance than self-report (Prince et al., 2008). The length of observation of attendance is a further strength to Study 1. Few studies have evaluated CCEP

attendance for 24-weeks. Another strength of this study is the large range of variables examined. Guiding theory and the existing evidence base suggests the diverse factors that are associated with adherence to CCEP. This gives a holistic insight into the sample and the potential of these variables as correlates of initiation and adherence to the community-based chronic illness rehabilitation programme. This sample size is relatively large for a community-based model of rehabilitation. This was a convenience sample based on one year's recruitment and was restricted to one year due to time constraints. Changes to service delivery were able to be implemented as the evidence emerged given the strategic partnership between the research and operational delivery team. Given the reach of the service (approx. 700 patient visits weekly), the immediate translation of the evidence base to service delivery allows immediate benefits at an individual and public health level. The programme has been recently been extended to an additional four locations in Ireland.

Further strengths include the pragmatic intervention design utilising the COM-B model of behaviour change and the behaviour change wheel (Michie, van Stralen, West, et al., 2011). This model has been reviewed for its use and association with moderate to vigorous physical activity behaviour (Howlett, Schulz, Trivedi, Troop, & Chater, 2017). The mapping of behaviour change techniques is a significant strength of the study. The identification of intervention techniques has been a notable problem until relatively recent times (Aberham and Michie, 2008). This lack of systematic identification of the mechanisms for action limits the ability to replicate the intervention. A taxonomy of 93 BCTs was developed (Michie et al., 2013) in an attempt to address this problem. BCTs are integral to complex health interventions (Duff et al., 2017). This recommendation

of identifying the BCTs utilised within an intervention has been adopted by researchers, with more emerging studies including the BCTs in their intervention design and reporting (Tully et al., 2018). Utilising and reporting the BCTs that make-up the intervention helps to ensure intervention transparency and encourage researchers to do the same. A further strength of Study 2 is the involvement of multiple stakeholders in the research agenda and utilisation of results. While researchers delivered all aspects of research, there was "buy-in" from those running the programme and from programme participants. Furthermore, this involvement ensured the new evidence could be implemented into service delivery and practice with almost immediate effect ensuring the programme was providing a service with a strong evidence base.

6.6 Thesis limitations

A limitation of this study is the lack of exploration into the potential barrier of cost. While researchers acknowledged cost as a potential factor influencing initiation, attendance and retention, it was not under the control of the research team. However, if cost has been identified as a barrier, then value for money could potentially have been explored. While the behaviour change intervention included an educational component on the efficacy of exercise programmes, it was not focused on cost as a potential barrier unless it was brought to the attention of the researchers by participants.

A further limitation exists around the choice of measures used to assess psychological wellbeing. While the study of depression in this population is an important component, the levels of anxiety were not assessed in the study. Given that

anxiety is more prevalent than depression in the Irish older adult population, (TILDA 2014) the lack of inclusion of this measure was a limitation.

An important limitation of Study 1 is related to area of research design and administration. Due to the large range of measures being assed via questionnaires, a decision was made to reduce participant burden and split the questionnaire into two parts. A small pilot study requested a group of potential participants (n=20) to complete all questions in a single questionnaire. This questionnaire was sent to participants along with an invitation to induction. Since attendance at the induction was very low, and in response to participants feedback (via phone) a decision was made to split the questionnaires into two parts. The induction questionnaire was completed at induction and the take-home questionnaire was taken home to be completed and returned on day one of attendance. The second questionnaire was however, not returned by those who attended induction but did not initiate. Consequently, health-related wellness and health service usage data, components of the second questionnaire were not captured. Furthermore, a number of participants who did initiate on the programme did not return their questionnaire despite prompting from staff and researchers. Splitting of the questionnaire achieved the aim of reducing participant burden but may have resulted in loss of important baseline information. Follow up phone calls, providing the participants with a stamped addressed envelope or collection of the questionnaire are potential alternative methods of data capture.

The outcome measures of adherence that were used in the current study included: initiation, attendance and retention. The outcome measure “retention” was

used to identify engagement with the programme at week 24. Using the outcome measure of retention is a limitation as it may not accurately reflect retention. A participant may be in attendance at week 23 and week 25 but not in week 24 and so are defined as a non-retention.

Results were presented by sub-group in Study 1. However, caution is advised in interpreting the generalisability of some of the findings due to the small sample size in some of the groups, primarily the DiabetesHealth Steps CIG. The MedEx model of CCEP used a common exercise programme with a shared infrastructure for all CIG. It is possible that the delivery of disease specific interventions may enhance the overall experience of participants and increase adherence.

This study did not follow dropouts or identify rationale for dropout or non-attendance. Appropriate caution is warranted in interpreting the results of bivariate analysis. Likewise, the associated level of chance findings is also increased when performing multiple bivariate analyses. The research design did not include a re-assessment of baseline measures for the standard group in Study 2. This was because the Study 1 participants were assigned as the standard group in Study 2. Baseline (Study 1) measures of behavioural change were assessed in the Standard group for the purpose of identifying their predictive ability on adherence and were not remeasured as part of Study 2. As a result, it was not possible to perform between group comparisons at 12 weeks. Social-support from friends was the only behaviour change variable that improved in the intervention group at 12 weeks. It was not possible to determine if the

standard group had similar increases in social-support or if there were changes in other behaviour change variables such as self-efficacy or behavioural intentions.

There is a lack of further exploration and analysis into the acceptability of the intervention as delivered in Study 2 and is a limitation of this thesis. This was however, outside of the scope of the current project.

6.7 Recommendations for future research

Cost: While the cost of attendance at a community- based chronic illness rehabilitation programme may seem modest to those who are highly aware of the associated benefits, evidence suggests cost can be a barrier to attendance at some exercise programmes (Morgan et al., 2013). Cost and cost perception was not examined as part of this research but it is recommended to explore this in future research.

Rationale for non-attendance or dropout: This present thesis did not explore the reasons for non-attendance or dropout. Reasons for dropout or non-attendance has been identified in community-based pulmonary rehabilitation including exacerbations, over-performing, fatigue, comorbidities and weather (Desveaux, Beauchamp, Rolfe, Goldstein, & Brooks, 2014) In a diabetes CCEP dropouts had lower self-efficacy, lower fitness and poorer body composition (Nam, Dobrosielski, & Stewart, 2012). Understanding the reason for drop-out may enable service providers to ensure optimum support for attendance, and limit non-attendance or dropout.

Referral: While induction was a pragmatic first step in terms of the CCEP, it poses further questions about the rates of referral and dropout prior to attendance at

induction. The modality of the MedEx CCEP differs from other established programmes of chronic illness exercise in that the journey starts with a referral from a health care practitioner. This is followed by an invitation to an induction session followed by potential initiation, and subsequent potential attendance. In other established forms of chronic illness rehabilitation, for example phase III cardiac rehabilitation, there is no induction session. Initiation is first step following referral. Referral to institutional forms of rehabilitation tends to be low and subsequent initiation following referral poor. Women and those who are older and from ethnic minorities are less likely to be referred to cardiac rehabilitation (Beswick et al., 2004). This type of information is not presently known in relation to CCEPs and warrants further research. An informative and valuable piece of research would include the referral rate to community-based chronic illness rehabilitation programmes along with the factors associated with referral rate and subsequent engagement. While beyond the scope of the current research project, comparing the rates of attendance between the Intervention group and Standard group from 12-24 weeks would be provided important information.

Forms of efficacy at different time-points: Given the nature of chronic illness and the potential reliance on the healthcare system by those with established chronic illness, the proxy efficacy and support systems are worthy of research. Although it did not reach statistical significance, self-efficacy decreased in the Intervention group at 12 weeks into the CCEP. This may be due to an inflated self-efficacy at baseline or to the proxy expertise available. The concept of proxy efficacy in CCEP poses further questions in relation to which form of efficacy is more important for longer term adherence. It also poses questions related to the types of CCEP programmes delivered. Is the ultimate

aim of CCEP's to promote self-regulatory skills to enhance abilities to maintain healthy participation in physical activity and exercise, or is it to provide a space for supported exercise and sustained engagement? Self-efficacy is clearly linked with exercise adherence (McAuley & Blissmer, 2000). It is likely that proxy-efficacy would supplement self-efficacy in health-care settings (Thompson, Sobolew-Shubin, Galbraith, Schwankovsky, & Cruzen, 1993).

Modality of transport: While distance from the facility was identified as a correlate of attendance, information on the modality of transport may also be insightful. In Ireland a total of 89% of adults over the age of 50 years travel primarily by car. In the Dublin area, 25% of adults over the age of 50 years rely on public transport (TILDA, 2017(Barrett et al., 2011)(Barrett et al., 2011)(Barrett et al., 2011)(Barrett et al., 2011)(Barrett et al., 2011)(Barrett et al., 2011)(Barrett et al., 2011)). As people get older they are less likely to drive and therefore, rely on others. This is the most evident in women. Among women between the age of 50-64 years, 72% drive themselves compared to only 30% among women ≥75 years of age (TILDA, 2017). Additional programme should be established to limit travel distance. Furthermore, home-based programme may better suit individuals who cannot or may chose not to exercise in a community facility. While home-based programmes have been shown to be effective for cardiac rehabilitation, they lack the social-support element that may be an important component of community-based programmes.

Intervention acceptability: Given that the intervention in its current form is not feasible, further research exploring the acceptability of the intervention and its components is

warranted. This should provide clarity and aid in the design and development of an amended intervention.

6.8 Conclusion

This model of CCEP has the potential to regularly engage those individuals with chronic illness who would greatly benefit from physical activity. While the exercise programme may be seen as the primary aim and focus of CCEPs, they may have a much greater role in social and community connectedness with the health service than previously thought. CCEPs have the potential to provide a unique access to healthcare outside of the formal health service system and demonstrates the value of reorienting the health services in Ireland to meet the demand of chronic illness management. This research has highlighted the sub-optimal levels of adherence to CCEP. Importantly, it provides information that will help guide allied health professionals develop strategies to optimise adherence rates. While further research should explore the feasible intervention components, this research indicates the positive potential of behaviour change interventions to increase rates of adherence. Future studies should investigate the factors associated with both referral and adherence to CCEP as well as further intervention acceptability research to ensure feasibility of the intervention. Given the potential benefits to be gained from participation in CCEP, effective strategies to ensure high levels of adherence is of great importance.

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Appendices

A. Dublin City University Ethics Committee ethical approval letter

B. MedEx timetable (front and back)

C. Questionnaires part 1 (study 1)

D. Questionnaire part 2 (study 1)

E. Physical data collection sheets (study 1)

F. Physical data collection sheets (study 2)

G. Questionnaire part 1 (study 2)

H. Questionnaire part 2 (study 2)

I. Exercise consultation 1 slides

J. Exercise consultation 2 and 3 slides

K. Exercise consultation goal sheets

L. Exercise consultation decisional balance sheets

M. Exercise consultation physical activity guidelines education sheet

Appendix A: Ethical Approval letter

Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

DCU

Dr Catherine Woods
School of Health & Human Performance

12th January 2015

REC Reference: **DCUREC/2014/227**

Proposal Title: **An evaluation of the effects of the MedEx programme on physical, clinical and psychosocial outcomes and an examination of determinants of adherence to MedEx**

Applicant(s): **Dr Catherine Woods; Dr Noel McCaffrey; Ms. Emer O'Leary; Dr Lorraine Boran; Dr Brona Furlong; Prof. Niall Moyna; Dr Donal O'Gorman.**

Dear Catherine,

Further to full review, the DCU Research Ethics Committee approves this research proposal. Materials used to recruit participants should note that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee. Should substantial modifications to the research protocol be required at a later stage, a further submission should be made to the REC.

Yours sincerely,

Dónal O'Mathúna

Dr. Donal O'Mathuna
Chairperson
DCU Research Ethics Committee

DCU
Research & Innovation

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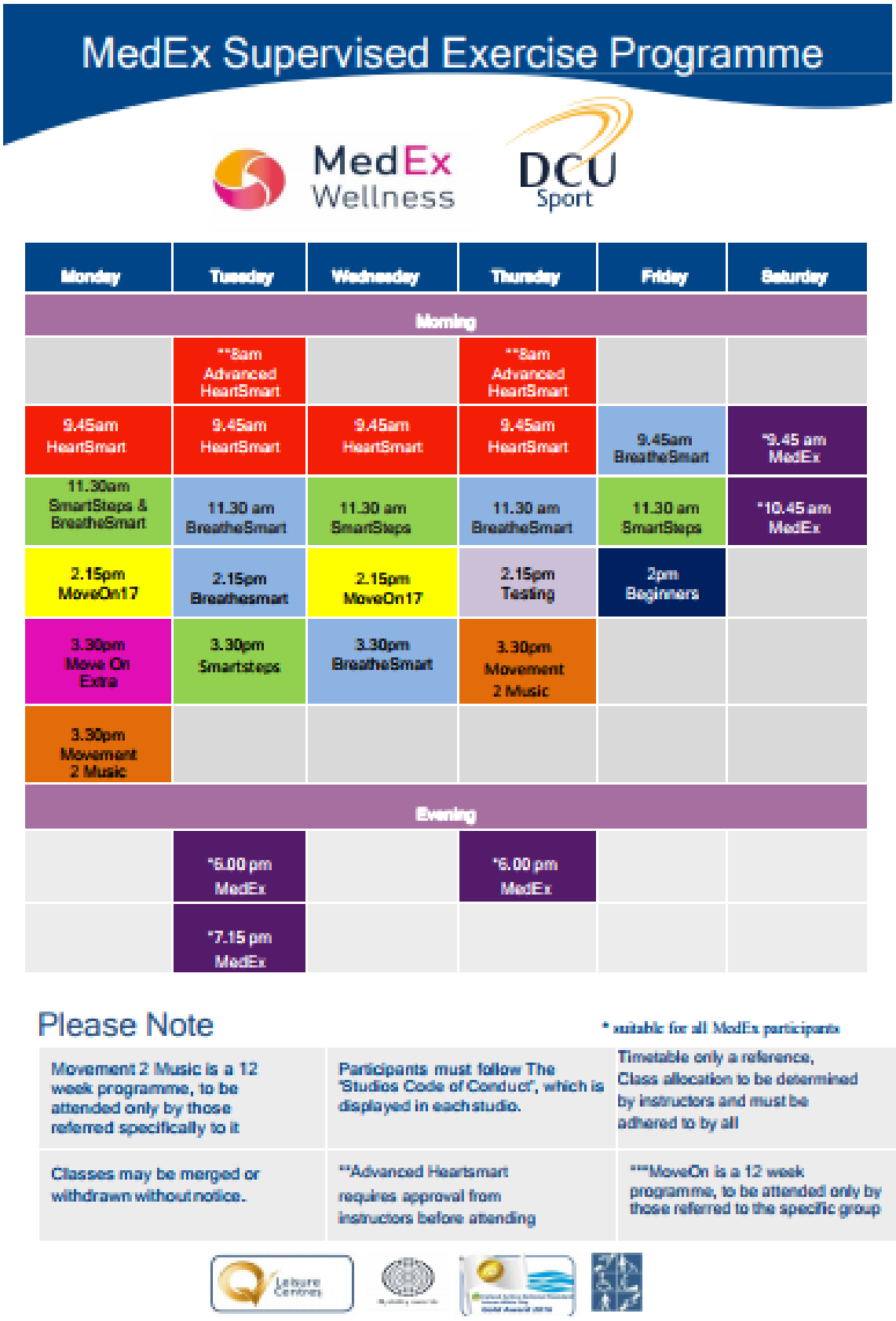
Appendix B: MedEx Timetable (front)



MedEx Supervised Exercise Programme

MedEx Wellness

DCU Sport

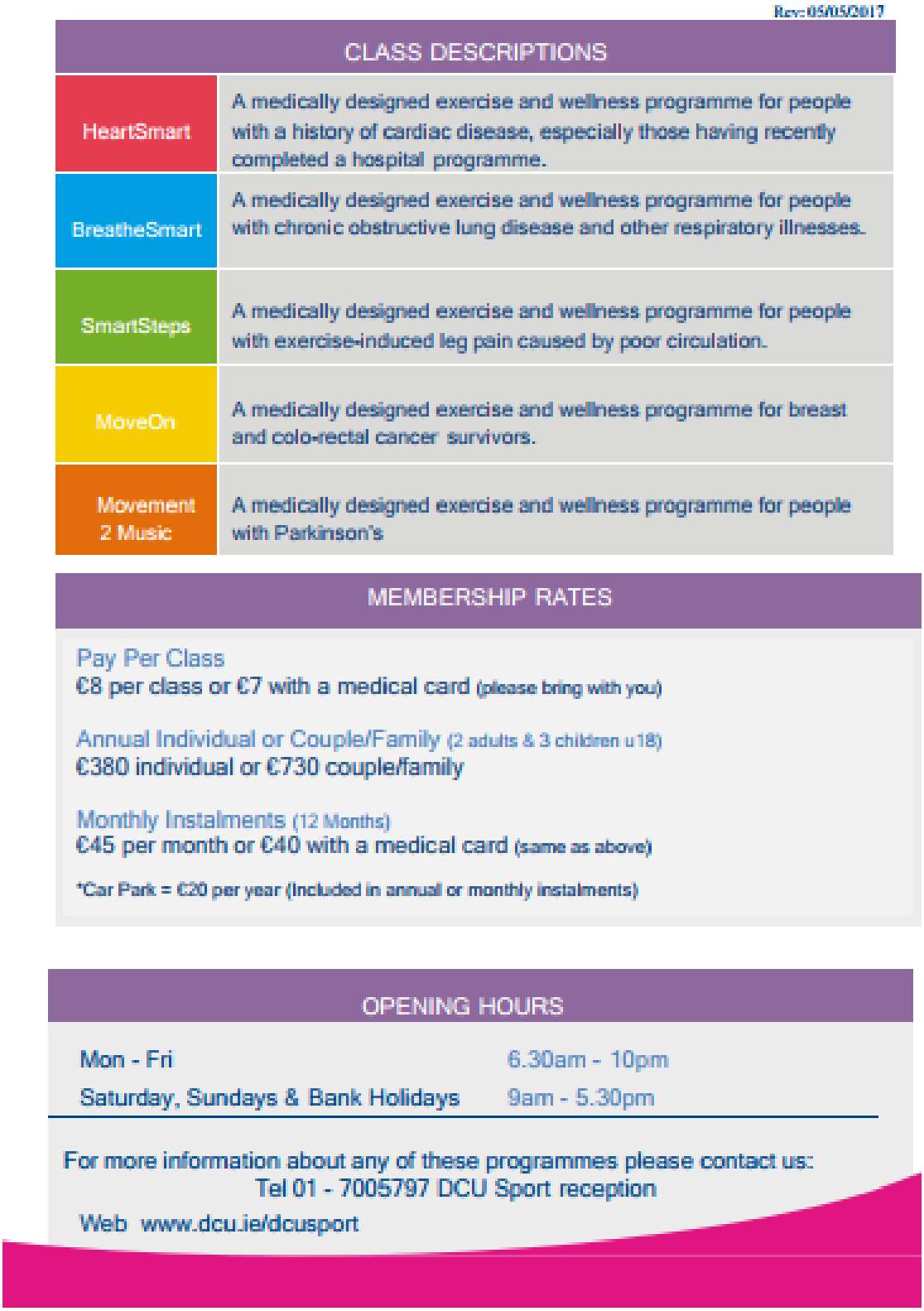
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Morning					
	**8am Advanced HeartSmart		**8am Advanced HeartSmart		
9.45am HeartSmart	9.45am HeartSmart	9.45am HeartSmart	9.45am HeartSmart	9.45am BreatheSmart	*9.45 am MedEx
11.30am SmartSteps & BreatheSmart	11.30 am BreatheSmart	11.30 am SmartSteps	11.30 am BreatheSmart	11.30 am SmartSteps	*10.45 am MedEx
2.15pm MoveOn17	2.15pm Breathesmart	2.15pm MoveOn17	2.15pm Testing	2pm Beginners	
3.30pm Move On Extra	3.30pm Smartsteps	3.30pm BreatheSmart	3.30pm Movement 2 Music		
3.30pm Movement 2 Music					
Evening					
	*6.00 pm MedEx		*6.00 pm MedEx		
	*7.15 pm MedEx				

Please Note

* suitable for all MedEx participants

Movement 2 Music is a 12 week programme, to be attended only by those referred specifically to it	Participants must follow The 'Studios Code of Conduct', which is displayed in each studio.	Timetable only a reference, Class allocation to be determined by instructors and must be adhered to by all
Classes may be merged or withdrawn without notice.	**Advanced Heartsmart requires approval from instructors before attending	***MoveOn is a 12 week programme, to be attended only by those referred to the specific group

Appendix B: MedEx Timetable (back)



Rev: 05/05/2017

CLASS DESCRIPTIONS

HeartSmart	A medically designed exercise and wellness programme for people with a history of cardiac disease, especially those having recently completed a hospital programme.
BreatheSmart	A medically designed exercise and wellness programme for people with chronic obstructive lung disease and other respiratory illnesses.
SmartSteps	A medically designed exercise and wellness programme for people with exercise-induced leg pain caused by poor circulation.
MoveOn	A medically designed exercise and wellness programme for breast and colo-rectal cancer survivors.
Movement 2 Music	A medically designed exercise and wellness programme for people with Parkinson's

MEMBERSHIP RATES

Pay Per Class
€8 per class or €7 with a medical card (please bring with you)

Annual Individual or Couple/Family (2 adults & 3 children u18)
€380 individual or €730 couple/family

Monthly Instalments (12 Months)
€45 per month or €40 with a medical card (same as above)

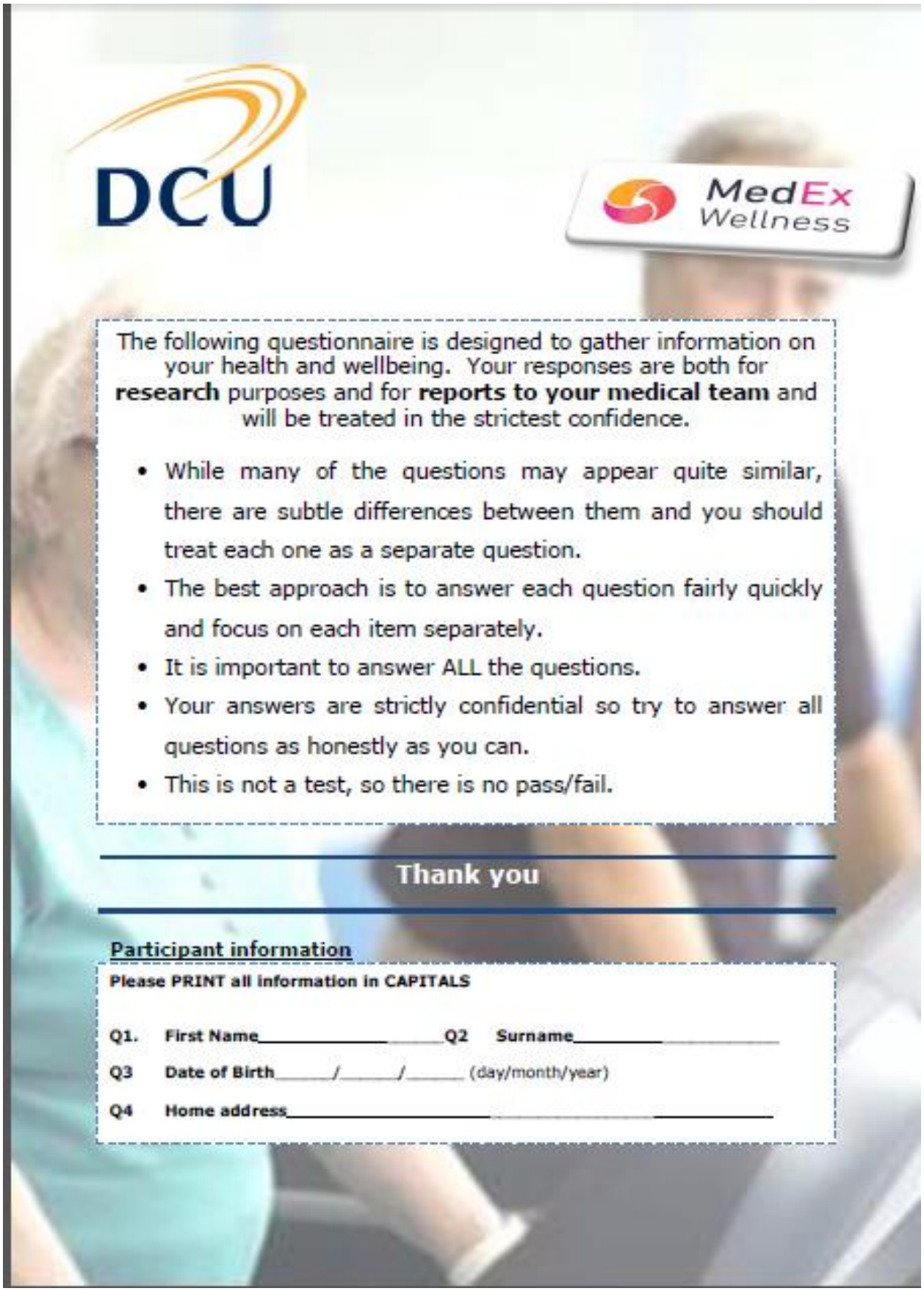
*Car Park = €20 per year (Included in annual or monthly instalments)

OPENING HOURS

Mon - Fri	6.30am - 10pm
Saturday, Sundays & Bank Holidays	9am - 5.30pm

For more information about any of these programmes please contact us:
Tel 01 - 7005797 DCU Sport reception
Web www.dcu.ie/dcusport

Appendix C: Questionnaire Part 1



DCU

MedEx Wellness

The following questionnaire is designed to gather information on your health and wellbeing. Your responses are both for **research** purposes and for **reports to your medical team** and will be treated in the strictest confidence.

- While many of the questions may appear quite similar, there are subtle differences between them and you should treat each one as a separate question.
- The best approach is to answer each question fairly quickly and focus on each item separately.
- It is important to answer ALL the questions.
- Your answers are strictly confidential so try to answer all questions as honestly as you can.
- This is not a test, so there is no pass/fail.

Thank you

Participant information

Please PRINT all information in CAPITALS

Q1. First Name_____ **Q2 Surname**_____

Q3 Date of Birth____/____/____ (day/month/year)

Q4 Home address_____

Q5 Gender (Please tick (✓) one box): Male 1☐ Female 2☐

Q6 What is your marital status
(Use "✓" to indicate your answer)

Married ..... 1☐
Living with partner ..... 2☐
Single (never married) ..... 3☐
Separated ..... 4☐
Divorced ..... 5☐
Widowed ..... 6☐

Q7 What is the highest level of education you have completed? (Use "✓" to indicate your answer)

Some primary (not completed)..... 1☐
Intermediate/junior/group certificate or equivalent... 2☐
Leaving certificate or equivalent..... 3☐
Diploma/certificate..... 4☐
Primary degree..... 5☐
Postgraduate/ higher degree ..... 6☐
None..... 7☐
Don't know ..... 8☐

Q8 How would you describe your present principle status? (Use "✓" to indicate your answer)

Working for payment or profit..... 1☐
Looking for first regular job..... 2☐
Unemployed..... 3☐
Student or pupil..... 4☐
Looking after home or family..... 5☐
Retired from employment..... 6☐
Unable to work due to permanent sickness or disability..... 7☐
Other..... 8☐

Q9 What is (was) your occupation in your main job?

Write in your main occupation? _____

Q10 Sometime in the future we may want to contact you to follow up on this research. Would that be OK? (Please tick (✓) one box): Yes 1☐ No 2☐

e (Right Arrow)

SECTION 1: Referral process

Q1. Who referred you to MedEx?

(Use "✓" to indicate your answer)

Phase III Cardiac Rehab (Beaumont) 1☐

Phase III Cardiac Rehab (Mater)..... 2☐

Hospital Consultant..... 3☐

General practitioner (GP)... 4☐

Other (Please outline) _____ 5☐

Q2 . Which MedEx programme were you referred to? (Use "✓" to indicate your answe

HeartSmart ..... 1☐ → *Proceed to Q3*

BreatheSmart..... 2☐

DiabetesHealthsteps... 3☐

SmartSteps..... 4☐

MoveOn..... 5☐ *Skip to Section 2*

Living Life..... 6☐

Other ..... 7☐

Don't Know..... 8☐

Q3. If referred to HeartSmart through GP or consultant, have you ever attended hospital based phase III Cardiac rehabilitation? (Use "✓" to indicate your answer)

Yes 1☐ No 2☐

Q4. If referred to HeartSmart from Phase III Cardiac rehabilitation please give an approx time between finishing cardiac rehabilitation and now?

_____months_____weeks

SECTION 2: Chronic conditions

Q1. Please indicate which chronic condition(s) you have (tick all that apply).

None ..... 1☐

Type 2 diabetes..... 2☐

Type 1 diabetes..... 3☐

Asthma..... 4☐

Chronic Bronchitis, emphysema, or COPD ..... 5☐

Other lung disease *Type of lung disease*_____ 6☐

Heart Disease *Type of heart disease* _____ 7☐

Arthritis or other rheumatic disease *Specify Type* _____ 8☐

Cancer *Specify type* _____ 9☐

Depression ..... 10☐

Anxiety or other emotional mental health condition ..... 11☐

Peripheral arterial disease/ claudication 12☐

Other Chronic condition *Specify* ..... 13☐

Section 3: Physical activity behaviour

Physical activity is any body movement.

It can be done at different levels of effort:

- **Vigorous Effort** makes your heart rate much faster and you have to breathe deeper and faster than normal. You will probably sweat.
  E.g. playing football, squash, heavy lifting, digging or fast bicycling.
- **Moderate Effort** makes your heart rate and breathing rate faster than normal. You may also sweat a little. E.g. brisk walking, jogging or carrying light loads.
- Physical activity includes:
  Exercise Weight training, aerobics class, jogging, dancing, etc.
  Sports Hurling, football, athletics, swimming, etc.
  General Brisk walking, washing the car, walking or cycling to school, etc.

Please try and think carefuly and be as accurate as possible with your answers. For these next two question, add up all the time you spend in physical activity each day.

Only include activities of either moderate or vigorous effort.

Q1a During the **last 7 days**, on how many days were you physically active for a total of at least 30 minutes a day? Please circle one number.

0 days 1 2 3 4 5 6 7 days

Q1b Over a typical or usual week, on how many days are you physically active for a total of at least 30 minutes per day? Please circle one number.

0 days 1 2 3 4 5 6 7 days

SECTION 4: General

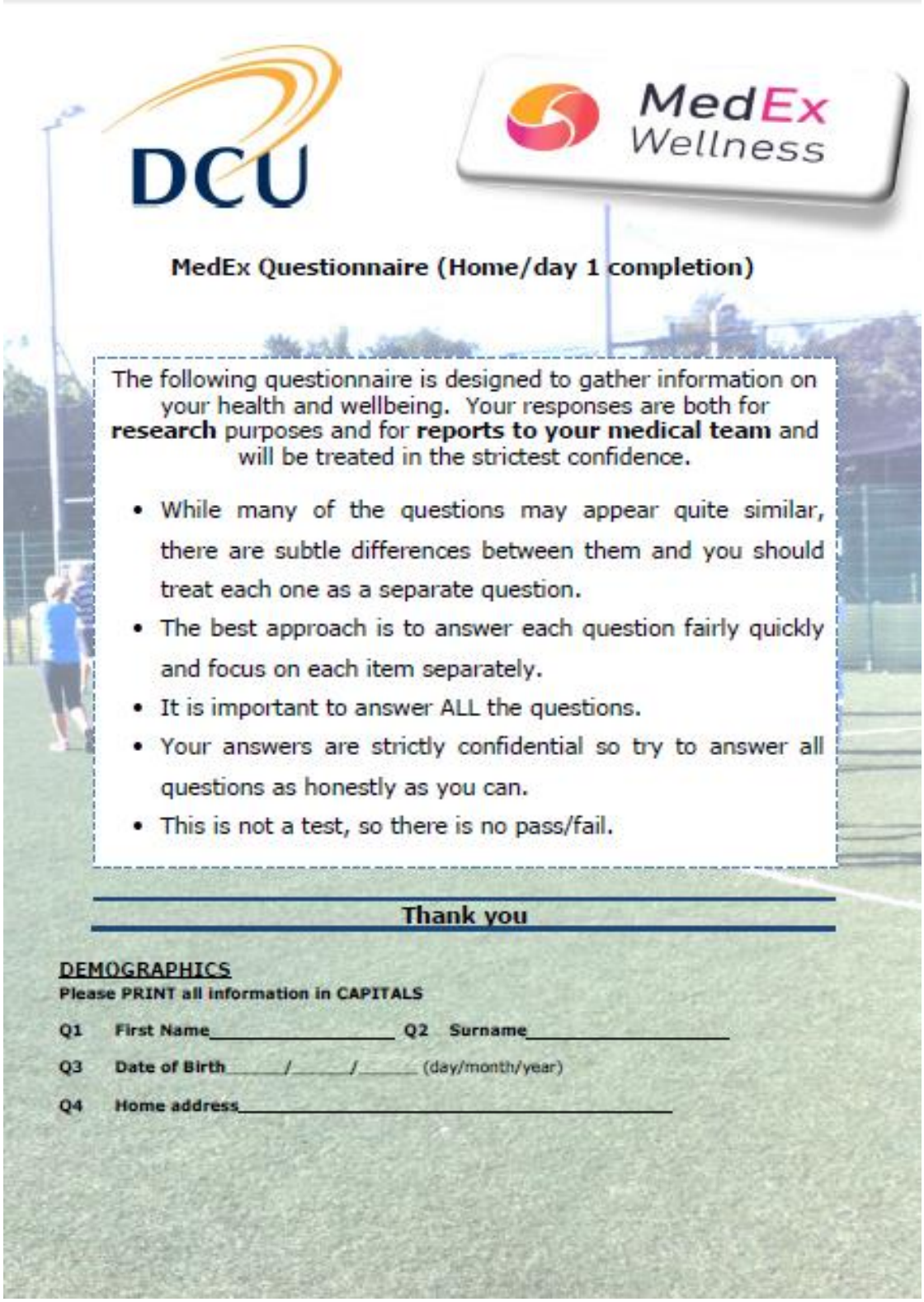
I intend to... (Use "✓" to indicate your answer)	**Completely disagree** 1	**Disagree** 2	**Agree** 3	**Totally agree** 4
Q1. Exercise several times a week	☐	☐	☐	☐
Q2. Work up a sweat regularly	☐	☐	☐	☐
Q3. Exercise regularly	☐	☐	☐	☐
Q4. To adhere to the exercise regimen prescribed to me.	☐	☐	☐	☐
Q5. Attend MedEx classes at least once a week	☐	☐	☐	☐
Q6. To adhere to attending MedEx classes.	☐	☐	☐	☐

This section is about exercise support from FAMILY and FRIENDS. Please use a "✓" to indicate how much of the time the following statements relate. If these statement do not relate to either family or friends please tick "none" instead of leaving it blank.

How much of the time during the past three months, my family (or members of my household) or friends (this can include fellow MedEx participants)...		**None**	**Rarely**	**A few times**	**Often**	**Very often**
		1	**2**	**3**	**5**	**5**
Q1. Exercised with me	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q2. Offered to exercise with me	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q3. Gave me helpful reminders to exercise ("Are you going to exercise tonight?")	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q4. Gave me encouragement to stick with my exercise program	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q5. Changed their schedule so we could exercise together	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q6. Discussed exercise with me	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q7. Complained about the time I spent exercising	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q8. Critised me or made fun of me for exercising	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q9. Gave me rewards for exercising (bought me something or gave me something I like)	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q10. Planned for exercise on recreational outings	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q11. Helped me plan activities around my exercise	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q12. Asked me for ideas on how THEY can get more exercise	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐
Q13. Talked about how much they like exercise	**Family**	1☐	2☐	3☐	4☐	5☐
	Friends	1☐	2☐	3☐	4☐	5☐

How confident are you that you can ... (Use "✓" to indicate your answer)	**Not at all confident** → **Somewhat confident** → **Very confident** **0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Q1. Motivate yourself to get at least 30 minutes of activity a day, 5 times per week?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Q2. Motivate yourself to attend at least 1 MedEx class a week?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Q3. Use safe, effective exercise technique (e.g., warm-up, stretching?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Q4. Plan exercise sessions that will be at least moderately difficult (e.g., have you breathing a little hard, your heart rate increases)?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Q5. Monitor your exercise progress by recording what exercises you do, how often you do them and for how long?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Q6. Set realistic, weekly exercise goals for yourself (e,g" exercising 3 days/week)?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Q7. Monitor and regulate the intensity of your exercise so that it is moderately difficult?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Q8. Develop solutions to cope with potential barriers that can interfere with your exercise?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Q9. Schedule exercise sessions into your weekly routine so that you get at least 30 minutes of exercise a day, 5 times per week?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Q10. You can return to exercise even if you have relapsed (returned to a sedentary state/ physically inactive state) for several weeks	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Q11. You can return to exercise even if you have relapsed (returned to a sedentary/ physically inactive state) several times	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Appendix D: Questionnaire part 2



DCU

MedEx Wellness

MedEx Questionnaire (Home/day 1 completion)

The following questionnaire is designed to gather information on your health and wellbeing. Your responses are both for **research** purposes and for **reports to your medical team** and will be treated in the strictest confidence.

- While many of the questions may appear quite similar, there are subtle differences between them and you should treat each one as a separate question.
- The best approach is to answer each question fairly quickly and focus on each item separately.
- It is important to answer ALL the questions.
- Your answers are strictly confidential so try to answer all questions as honestly as you can.
- This is not a test, so there is no pass/fail.

Thank you

DEMOGRAPHICS

Please PRINT all information in CAPITALS

Q1 First Name_____ **Q2 Surname**_____

Q3 Date of Birth ____/____/____ (day/month/year)

Q4 Home address_____

SECTION 1: Wellness

Please use "✓" to indicate your answer in the following section.

Q1. In general, would you say your health is;

Excellent	Very good	Good	Fair	Poor
1☐	2☐	3☐	4☐	5☐

Q2. The following questions are about activities you might do during a typical day

	Yes, limited a lot	Yes, limited a little	No, not limited at all
a Moderate activities, such as moving a table, pushing a vacuum, bowling or playing golf.	1☐	2☐	3☐
b Climbing several flights of stairs	1☐	2☐	3☐

Q3. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	Yes	No
a Accomplished less than you would like	1☐	2☐
b Were limited in the kind of work or other activities	1☐	2☐

Q4. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

	Yes	No
a Accomplished less than you would like	1☐	2☐
b Didn't do work or other activities as carefully as usual	1☐	2☐

Q5. During the past 4 weeks how much of the time did pain interfere with your normal work (including work both outside the home and housework)?

Not at all	A little bit	Moderately	Quite a bit	Extremely
1☐	2☐	3☐	4☐	5☐

Q6. These questions are about how you feel and how things have been with you during the past month. For each question, please indicate the one answer that comes closest to the way you have been feeling.

	All of the time	Most of the time	A good bit of the time	Some of the time	None of the time
a Have you felt calm and peaceful?	1☐	2☐	3☐	4☐	5☐
b Did you have lots of energy?	1☐	2☐	3☐	4☐	5☐
c Have you felt downhearted and low?	1☐	2☐	3☐	4☐	5☐
d Has your health limited your social activities (like visiting friends or close relatives)?	1☐	2☐	3☐	4☐	5☐

2

Q7. Over the last two weeks how often have you been bothered by any of the following problems?

		Not at all	Several days	More than half the days	Nearly every day
A	Little interest or pleasure in doing things	1☐	2☐	3☐	4☐
B	Feeling down, depressed, or hopeless	1☐	2☐	3☐	4☐
C	Trouble falling or staying asleep, or sleeping too much	1☐	2☐	3☐	4☐
D	Feeling tired or having little energy	1☐	2☐	3☐	4☐
E	Poor appetite or overeating	1☐	2☐	3☐	4☐
F	Feeling bad about yourself- or that you are a failure or have let yourself or you family down	1☐	2☐	3☐	4☐
G	Trouble concentrating on things such as reading the newspaper or watching television	1☐	2☐	3☐	4☐
H	Moving or speaking so slowly that other people could have noticed? Or the opposite-being so fidgety or restless that you have been moving around a lot more than usual	1☐	2☐	3☐	4☐

I	**If you checked off ANY problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?**			
	Not difficult at all	**Somewhat difficult**	**Very difficult**	**Extremely difficult**
	1☐	2☐	3☐	4☐

Q8. In the last 7 days, about how many hours per 24 hour period did you spend sleeping?

	3 or less hours	4 hours	5 hours	6 hours	7 hours	8 hours	9 hours	10 hours	11 hours	12 or more hours
Weekdays	1☐	2☐	3☐	4☐	5☐	6☐	7☐	8☐	9☐	10☐
Weekends	1☐	2☐	3☐	4☐	5☐	6☐	7☐	8☐	9☐	10☐

Q9. During the past week, how would you rate your sleep quality overall (how well you sleep)?

Very bad	Fairly bad	Fairly good	Very good
1☐	2☐	3☐	4☐

If any of your answers give you concern please contact a member of MedEx staff or Dr. Noel McCaffrey who can deal with these concerns.

3

Section 2: Physical activity behaviour

Q1a During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics or fast bicycling? Think about *only* those physical activities that you did for at least 10 minutes at a time. Please circle one number.

0 days 1 2 3 4 5 6 7 days

Q1b How much time did you usually spend on one of those days doing **vigorous** physical activities? _____hours____minutes **per day**

Q2a Again, think about *only* those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or double tennis? Please do not include walking. Please circle one number.

0 days 1 2 3 4 5 6 7 days

Q2b How much time did you usually spend on one of those days doing **moderate** physical activities? _____hours_____minutes ***per day***

Q3a During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time? This includes walking at work, at home, walking to travel from place to place, or for recreational, exercise or leisure purposes. Please circle one number.

0 days 1 2 3 4 5 6 7 days

Q3b How much time did you usually spend on one of those days **walking on one of those days**? _____hours_____minutes ***per day***

Q3c Which of the following best describes your usual **walking pace?**

A slow pace	A steady average pace	A fairly brisk pace	A fast pace (at least 4mph)
1☐	2☐	3☐	4☐

TIME SPENT SITTING

Q4 During the last 7 days, how much of the time did you usually spend sitting on **one** week day? (Includes time spent at a desk, visiting friends, reading, travelling, or sitting or lying down to watch television). _____hours____minutes ***per day***

4

SECTION 3: Health service usage

Q1 Are you covered by: (Use "✓" to indicate your answer)

Full Medical Card or equivalent	GP visit card	Neither	Don't know
1☐	2☐	3☐	4☐

Q2. In the last 12 months, about how often did you visit your GP?

0-200_____

Don't know 1☐

Q3 In the last 12 months, how many times did you visit a hospital emergency department as a patient?

0-200_____

Don't know 1☐

Q4. In the last 12 months, about how many visits did you make to a hospital as an outpatient? (Include all types of consultations, tests, operations, procedures or treatments)

0-200_____

Don't know 1☐

Q5. When you went to hospital as an outpatient, was this as a: (Use "✓" to indicate your answer)

As a public patient 1☐

As a private patient 2☐

Don't know 3☐

Q6. In total, about how many nights did you spend in hospital in the last 12 months?

0-200_____

Don't know 1☐

Q7. When you stayed overnight in hospital, was this as a:(Use "✓" to indicate your answer)

As a public patient 1☐

As a private patient 2☐

Don't know 3☐

Q8. In total during the last 12 months about how many days have you taken off work (If working) due to illness?

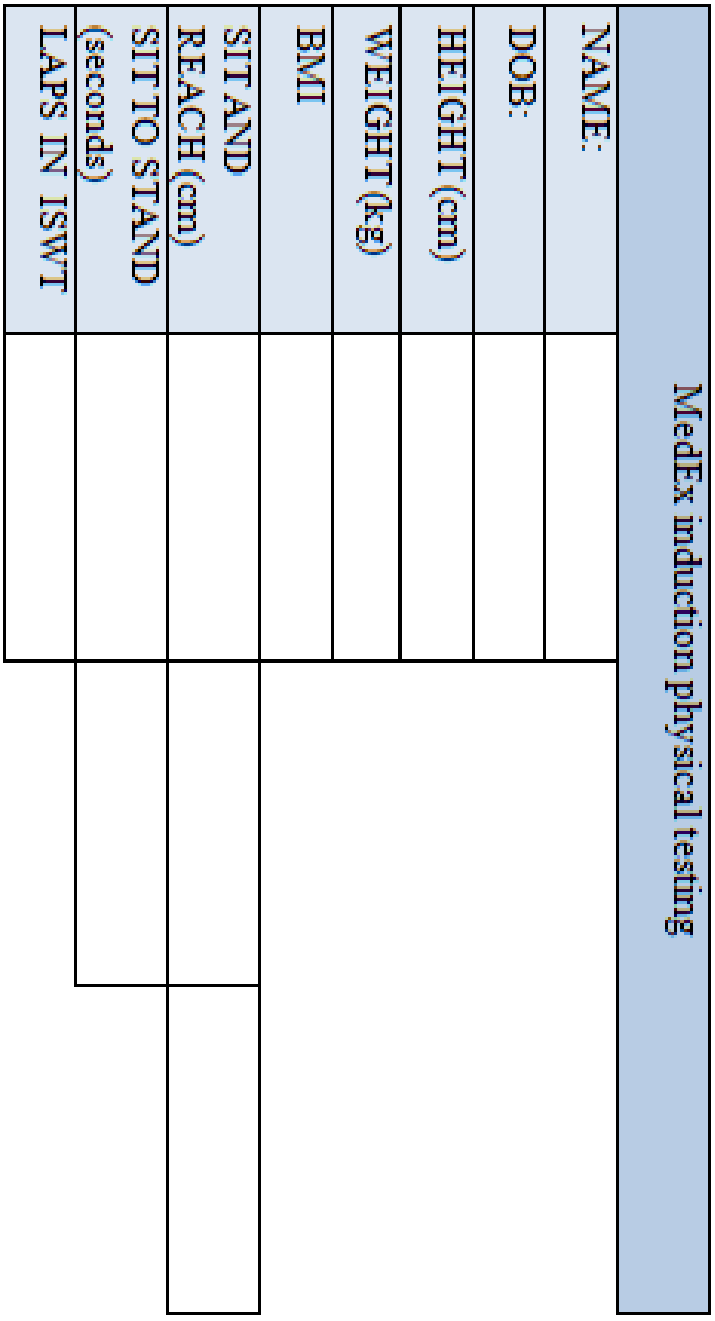
0-200_____

Don't know 1☐

The questionnaire is now complete, Thank you very much for your time. Please return to MedEx staff member.

5

Appendix E Physical testing sheet Study 1



Appendix F Physical testing sheet Study 2

MedEx Wellness

Physical Testing Data Collection Sheet

Name		ID NO			
Date					
Timepoint (Circle)	Baseline / 3 months / 6 months				
Height	cm	Weight	kg	BMI	
Waist	cm	Hip			cm

If the answer is yes to any of the follow 4 questions do not perform the sit and reach.

1. Back pain which is worsened by stooping or bending forward. YES/NO	2. Sciatica. (Leg pain caused by a bulging lumber disc. YES/NO	3. A known lumber disc bulge. YES/NO	4. Cancer affecting your spin. YES/NO

Sit-and-reach	Trial 1:	
	Trial 2:	
	Trial 3:	
	Best Result:	
Sit-to-stand	Trial 1:	
	Trial 2:	
	Best Result:	
Handgrip	Trial 1:	
Dominant hand (Circle) R L	Trial 2:	
	Trial 3:	
	Mean of 3 trials:	

Appendix G Questionnaire Part 1 (Study 2)

Q5 Gender (Please tick (✓) one box): Male ☐ Female ☐

Q6 What is your marital status (Use "✓" to indicate your answer)

- Married ☐ 1
- Living with partner ☐ 2
- Single (never married) ☐ 3
- Separated ☐ 4
- Divorced ☐ 5
- Widowed ☐ 6

Q7 What is the highest level of education you have completed? (Use "✓" to indicate your answer)

- Some primary (not completed) ☐ 1
- Intermediate/junior/group certificate or equivalent ☐ 2
- Leaving certificate or equivalent ☐ 3
- Diploma/certificate ☐ 4
- Primary degree ☐ 5
- Postgraduate/ higher degree ☐ 6
- None ☐ 7
- Don't know ☐ 8

Q8 How would you describe your present principle status? (Use "✓" to indicate your answer)

- Working for payment or profit ☐ 1
- Looking for first regular job ☐ 2
- Unemployed ☐ 3
- Student or pupil ☐ 4
- Looking after home or family ☐ 5
- Retired from employment ☐ 6
- Unable to work due to permanent sickness or disability ☐ 7
- Other ☐ 8

Q9 What is (was) your occupation in your main job?

Write in your main occupation? _____

Q10 Sometime in the future we may want to contact you to follow up on this research. Would that be OK? (Please tick (✓) one box): Yes ☐ No ☐

SECTION 1

Q1. Who referred you to MedEx?

(Use "✓" to indicate your answer)

Hospital Consultant
Please list:_____ 1 ☐

General practitioner (GP)
Please list:_____ 2 ☐

Phase III Cardiac Rehab (Beaumont) 3 ☐

Phase III Cardiac Rehab (Mater) 4 ☐

Other
Please list:_____ 5 ☐

SECTION 2

Q1. Please indicate which chronic condition(s) you have (tick all that apply).

None	☐ 1
Heart Disease *Type of heart disease*	☐ 2
Peripheral arterial disease/claudication	☐ 3
Chronic bronchitis, emphysema or COPD	☐ 4
Asthma	☐ 5
Other lung disease *Type of lung disease*	☐ 6
Cancer *Specify type*	☐ 7
Type 2 diabetes	☐ 8
Type 1 diabetes	☐ 9
Depression	☐ 10
Anxiety or other emotional mental health condition	☐ 11
Arthritis or other rheumatic disease *Specify type*	☐ 12
Other chronic condition *Please specify*	☐ 13

Section 3

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

Q1a During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling? Please circle one number.

0 days 1 2 3 4 5 6 7 days

Q1b How much time did you usually spend on one of those days doing **vigorous** physical activities?

_____hours_____minutes ***per day***

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

Q2a. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking. Please circle one number.

0 days 1 2 3 4 5 6 7 days

Q2b How much time did you usually spend on one of those days doing **moderate** physical activities?

_____hours_____minutes ***per day***

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

Q3a During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time? Please circle one number.

0 days 1 2 3 4 5 6 7 days

Q3b How much time did you usually spend **walking** on one of those days?

_____hours_____minutes ***per day***

Q3c Which of the following best describes your usual **walking pace?**

A slow pace	A steady average pace	A fairly brisk pace	A fast pace (at least 4mph)
1☐	2☐	3☐	4☐

TIME SPENT SITTING

Q4 During the **last 7 days**, how much of the time did you usually spend **sitting** on **one** week day? (Includes time spent at a desk, visiting friends, reading, travelling, or sitting or lying down to watch television).

____hours_____minutes ***per day***

SECTION 4

The following items reflect situations that are listed as common reasons for preventing individuals from participating in exercise sessions or, in some cases, dropping out. Using the scales below please indicate how confident you are that you could exercise in the event that any of the following circumstances were to occur.

Please indicate the degree to which you are confident that you could exercise in the event that any of the following circumstances were to occur by ticking the appropriate %. Select the response that most closely matches your own, remembering that there are no right or wrong answers.

FOR EXAMPLE: In question #1 if you have complete confidence that you could exercise even if "the weather was very bad," you would tick 100%. If however, you had no confidence at all that you could exercise (that is, confidence you would not exercise), you would circle 0%.

I believe that I could exercise 3 times per week for the next 3 months if:

1. The weather was very bad (hot, humid, rainy, cold).

Not at all Confident 0% 10 20 30 40 50 (Moderately Confident) 60 70 80 90 100% Highly Confident

2. I was bored by the program or activity.

Not at all Confident 0% 10 20 30 40 50 (Moderately Confident) 60 70 80 90 100% Highly Confident

3. I was on vacation.

Not at all Confident 0% 10 20 30 40 50 (Moderately Confident) 60 70 80 90 100% Highly Confident

4. I was not interested in the activity.

Not at all Confident 0% 10 20 30 40 50 (Moderately Confident) 60 70 80 90 100% Highly Confident

5. I felt pain or discomfort when exercising.

Not at all Confident 0% 10 20 30 40 50 (Moderately Confident) 60 70 80 90 100% Highly Confident

6. I had to exercise alone.

Not at all Confident 0% 10 20 30 40 50 (Moderately Confident) 60 70 80 90 100% Highly Confident

7. It was not fun or enjoyable.

Not at all ___:____:____:_____:____:____:_____:_____:_____:_____:_____: Highly Confident
0% 10 20 30 40 50 60 70 80 90 100%
Moderately Confident

8. It became difficult to get to the exercise location.

Not at all ___:____:____:_____:____:____:_____:_____:_____:_____:_____: Highly Confident
Confident 0% 10 20 30 40 50 60 70 80 90 100%
Moderately Confident

9. I didn't like the particular activity program that I was involved in.

Not at all ___:____:____:_____:____:____:_____:_____:_____:_____:_____: Highly Confident
0% 10 20 30 40 50 60 70 80 90 100%
Moderately Confident

10. My schedule conflicted with my exercisesession.

Not at all ___:____:____:_____:____:____:_____:_____:_____:_____:_____: Highly Confident
Confident 0% 10 20 30 40 50 60 70 80 90 100%
Moderately Confident

11. I felt self-conscious about my appearance when I exercised.

Not at all ___:____:____:_____:____:____:_____:_____:_____:_____:_____: Highly Confident
0% 10 20 30 40 50 60 70 80 90 100%
Moderately Confident

12. An instructor does not offer me any encouragement.

Not at all ___:____:____:_____:____:____:_____:_____:_____:_____:_____: Highly Confident
Confident 0% 10 20 30 40 50 60 70 80 90 100%
Moderately Confident

13. I was under personal stress of some kind.

Not at all ___:____:____:_____:____:____:_____:_____:_____:_____:_____: Highly Confident
0% 10 20 30 40 50 60 70 80 90 100%
Moderately Confident

Please continue to the next page

SECTION 5

The following items reflect activities surrounding exercise, physical activity and MedEx class attendance. Please indicate the degree to which you intend to do the following items by ticking the appropriate box. Select the response that most closely matches your own. Remember there is no right or wrong answers.

I intend to... (Use "✓" to indicate your answer)	Completely disagree 1	Disagree 2	Agree 3	Totally agree 4
Q1. Exercise several times a week	1☐	2☐	3☐	4☐
Q2. Work up a sweat regularly	1☐	2☐	3☐	4☐
Q3. Exercise regularly	1☐	2☐	3☐	4☐
Q4. Be physically active regularly for a minimum of 30 minutes 3 times a week	1☐	2☐	3☐	4☐
Q5. To increase my leisure time Activity	1☐	2☐	3☐	4☐
Q6. To adhere to the exercise regimen prescribed to me	1☐	2☐	3☐	4☐
Q7. Attend MedEx classes at least once a week	1☐	2☐	3☐	4☐
Q8. To stick to MedEx classes	1☐	2☐	3☐	4☐

Section 6

Q1 Have you fallen in the last 12 months?

Yes 1☐ No 2☐

Q2 In total, about how many times have you fallen in the last 12 months?

_____

Don't know 1☐

Q3 Are you afraid of falling?

Yes 1☐ No 2☐

Q4 Do you have any problems with your walking or balance?

Yes 1☐ No 2☐

SECTION 7

This section is about exercise support from FAMILY. Please use a "✓" to indicate how much of the time the following statements relate. If these statements do not relate to family please tick "none" instead of leaving it blank.

How much of the time during the past three months, my family (or members of my household)...		None	Rarely	A few times	Often	Very often	Does Not Apply
		1	2	3	4	5	6
Q1. Exercised with me	**Family**	1☐	2☐	3☐	4☐	5☐	6☐
Q2. Offered to exercise with me	**Family**	1☐	2☐	3☐	4☐	5☐	6☐
Q3. Gave me helpful reminders to exercise ("Are you going to exercise tonight?")	**Family**	1☐	2☐	3☐	4☐	5☐	6☐
Q4. Gave me encouragement to stick with my exercise program	**Family**	1☐	2☐	3☐	4☐	5☐	6☐
Q5. Changed their schedule so we could exercise together	**Family**	1☐	2☐	3☐	4☐	5☐	6☐
Q6. Discussed exercise with me	**Family**	1☐	2☐	3☐	4☐	5☐	6☐
Q7. Planned for exercise on recreational outings	**Family**	1☐	2☐	3☐	4☐	5☐	6☐
Q8. Helped me plan activities around my exercise	**Family**	1☐	2☐	3☐	4☐	5☐	6☐

Please continue to the next page

SECTION 8

Please answer the following questions in relation to smoking, alcohol consumption and diet.

Q1. On how many days during a typical week did you usually drink alcohol, on average?

Number of Days.....

Q.2 On the days that you drank alcohol, how many drinks did you have on average?

A drink is: a half pint/glass of beer, lager, stout or cider
a single measure of spirits (whiskey, rum, vodka, gin)
a single glass of wine, sherry, port

Number of drinks.....

Q.3 Do you smoke cigarettes now?

- ☐ No → Go to Question 6
- ☐ Yes, regularly
- ☐ Yes, occasionally (usually less than 1 per day)

Q.4 In a day, how many of the following do you usually smoke? (Please write a number)

..... branded cigarettes
..... hand rolled cigarettes

Q.5 How long have you been a cigarette smoker for?

..... years

Q.6 Did you ever smoke cigarettes in the past?

- ☐ No, never
- ☐ Current smoker
- ☐ Occasionally (usually less than 1 cigarette per day)
- ☐ Yes, regularly

Q.7 How often do you eat convenience food (i.e. fast food or 'take-away': e.g. Chinese, Indian, pizza, burgers, chips, etc.)

☐ Daily ☐ 4-6 times a week ☐ 1-3 times a week ☐ Less than once a week ☐ Never

Q.8 How often do you prepare food from fresh ingredients rather than pre-prepared food?

☐ Daily ☐ 4-6 times a week ☐ 1-3 times a week ☐ Less than once a week ☐ Never

The questionnaire is now complete. Thank you very much for your time.

Appendix H Questionnaire Part 2 (Study 2)

DCU

MedEx Wellness

MedEx Take Home Questionnaire

The following questionnaire is designed to gather information on your health and wellbeing. Your responses are both for **research** purposes and for **reports to your medical team** and will be treated in the strictest confidence.

- While many of the questions may appear quite similar, there are subtle differences between them and you should treat each one as a separate question.
- The best approach is to answer each question fairly quickly and focus on each item separately.
- It is important to answer ALL the questions.
- Your answers are strictly confidential so try to answer all questions as honestly as you can.
- This is not a test, so there is no pass/fail.

Thank you

DEMOGRAPHICS

Please PRINT all information in CAPITALS

Q1 First Name_____ Q2 Surname_____

Q3 Date of Birth_____/_____/_____ (day/month/year)

Q4 Home address_____

For Official Use Only: ID Number_____ Class:_____ Date:_____

SECTION 1

Please use "✓" to indicate your answer in the following section.

Q1. In general would you say your health is;

Excellent	Very good	Good	Fair	Poor
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

Q2. The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so how much?

		Yes, limited a lot	Yes, limited a little	No, not limited at all
a	Moderate activities, such as moving a table, pushing a vacuum, bowling or playing golf.	1 ☐	2 ☐	3 ☐
b	Climbing several flights of stairs	1 ☐	2 ☐	3 ☐

Q3. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

		Yes	No
a	Accomplished less than you would like	1 ☐	2 ☐
b	Were limited in the kind of work or other activities	1 ☐	2 ☐

Q4. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

		Yes	No
a	Accomplished less than you would like	1 ☐	2 ☐
b	Didn't do work or other activities as carefully as usual	1 ☐	2 ☐

Q5. During the past 4 weeks how much of the time did pain interfere with your normal work (including work both outside the home and housework)?

Not at all	A little bit	Moderately	Quite a bit	Extremely
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

Q6. These questions are about how you feel and how things have been with you during the past month. For each question, please indicate the one answer that comes closest to the way you have been feeling.

		All of the time	Most of the time	A good bit of the time	Some of the time	None of the time
a	Have you felt calm and peaceful?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
b	Did you have lots of energy?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
c	Have you felt downhearted and low?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
d	Has your health limited your social activities (like visiting friends or close relatives)?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

2

Q7. Over the last two weeks how often have you been bothered by any of the following problems?

		Not at all	Several days	More than half the days	Nearly every day
A	Little interest or pleasure in doing things	1☐	2☐	3☐	4☐
B	Feeling down, depressed, or hopeless	1☐	2☐	3☐	4☐
C	Trouble falling or staying asleep, or sleeping too much	1☐	2☐	3☐	4☐
D	Feeling tired or having little energy	1☐	2☐	3☐	4☐
E	Poor appetite or overeating	1☐	2☐	3☐	4☐
F	Feeling bad about yourself- or that you are a failure or have let yourself or you family down	1☐	2☐	3☐	4☐
G	Trouble concentrating on things such as reading the newspaper or watching television	1☐	2☐	3☐	4☐
H	Moving or speaking so slowly that other people could have noticed? Or the opposite-being so fidgety or restless that you have been moving around a lot more than usual	1☐	2☐	3☐	4☐

I	**If you checked off ANY problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?**			
	Not difficult at all	**Somewhat difficult**	**Very difficult**	**Extremely difficult**
	1☐	2☐	3☐	4☐

Q8. In the last 7 days, about how many hours per 24 hour period did you spend sleeping?

	3 or less hours	**4 hours**	**5 hours**	**6 hours**	**7 hours**	**8 hours**	**9 hours**	**10 hours**	**11 hours**	**12 or more hours**
Weekdays	1☐	2☐	3☐	4☐	5☐	6☐	7☐	8☐	9☐	10☐
Weekends	1☐	2☐	3☐	4☐	5☐	6☐	7☐	8☐	9☐	10☐

Q9. During the past week, how would you rate your sleep quality overall (how well you sleep)?

Very bad	**Fairly bad**	**Fairly good**	**Very good**
1☐	2☐	3☐	4☐

If any of your answers give you concern, please contact a member of MedDr staff or Dr. Neal McCaffrey who can deal with these concerns.

SECTION 2

Q1 Are you covered by: (Use "✓" to indicate your answer)

Full Medical Card or equivalent	GP visit card	Neither	Don't know
1 ☐	2 ☐	3 ☐	4 ☐

Q2. In the last 12 months, about how often did you visit your GP?

0-200_____

Don't know 1 ☐

Q3 In the last 12 months, how many times did you visit a hospital emergency department as a patient?

0-200_____

Don't know 1 ☐

Q4. In the last 12 months, about how many visits did you make to a hospital as an outpatient? (Include all types of consultations, tests, operations, procedures or treatments)

0-200_____

Don't know 1 ☐

Q5. When you went to hospital as an outpatient, was this predominantly as a: (Use "✓" to select one answer only)

As a public patient 1 ☐

As a private patient 2 ☐

Don't know 3 ☐

Not applicable 4 ☐

Q6. In total, about how many nights did you spend in hospital in the last 12 months?

0-364_____

Don't know 1 ☐

Q7. When you stayed overnight in hospital, was this predominantly as a: (Use "✓" to select one answer only)

As a public patient 1 ☐

As a private patient 2 ☐

Don't know 3 ☐

Not applicable 4 ☐

Q8. (If retired – Not Applicable)
In total during the last 12 months about how many days have you taken off work (If working) due to illness?

0-364_____

Don't know 1 ☐

Not applicable 2 ☐

SECTION 3

By placing a tick in one box in each group below, please indicate which statements best describe your own health state today.

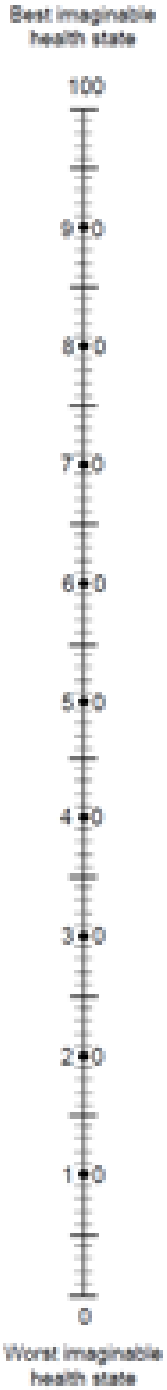
Mobility	
I have no problems walking about	☐
I have some problems walking about	☐
I am confined to bed	☐
Self-Care	
I have no problems with self-care	☐
I have some problems washing or dressing myself	☐
I am unable to wash or dress myself	☐
Usual Activities (e.g. work, study, housework, family or leisure activities)	
I have no problems with performing my usual activities	☐
I have some problems with performing my usual activities	☐
I am unable to perform my usual activities	☐
Pain/Discomfort	
I have no pain or discomfort	☐
I have moderate pain or discomfort	☐
I have extreme pain or discomfort	☐
Anxiety/Depression	
I am not anxious or depressed	☐
I am moderately anxious or depressed	☐
I am extremely anxious or depressed	☐

SECTION 4

To help people say how good or bad a health state is, we have drawn a scale (rather like a thermometer) on which the best state you can imagine is marked 100 and the worst state you can imagine is marked 0.

We would like you to indicate on this scale how good or bad your own health is today, in your opinion. Please do this by drawing a line from the box below to whichever point on the scale indicates how good or bad your health state is today.

Your own health state today



SECTION 5

Below are five statements that you may agree or disagree with. Using the 1 - 7 scale below, indicate your agreement with each item by circling the appropriate number on each line. Please be open and honest in your responding.

In most ways my life is close in ideal.

Strongly disagree 1	Disagree 2	Slightly disagree 3	Neither agree nor disagree 4	Slightly agree 5	Agree 6	Strongly agree 7

The conditions of my life are excellent.

Strongly disagree 1	Disagree 2	Slightly disagree 3	Neither agree nor disagree 4	Slightly agree 5	Agree 6	Strongly agree 7

I am satisfied with my life.

Strongly disagree 1	Disagree 2	Slightly disagree 3	Neither agree nor disagree 4	Slightly agree 5	Agree 6	Strongly agree 7

So far I have gotten the important things I want in life.

Strongly disagree 1	Disagree 2	Slightly disagree 3	Neither agree nor disagree 4	Slightly agree 5	Agree 6	Strongly agree 7

If I could live my life over, I would change almost nothing.

Strongly disagree 1	Disagree 2	Slightly disagree 3	Neither agree nor disagree 4	Slightly agree 5	Agree 6	Strongly agree 7

SECTION 6

Below are some statements about feelings and thoughts. Please tick the box that best describes your experience of each over the last 2 weeks

Statements	None of the time	Rarely	Some of the Time	Often	All of the Time
I've been feeling optimistic about the future					
I've been feeling useful					
I've been feeling relaxed					
I've been dealing with problems well					
I've been thinking clearly					
I've been feeling close to other people					
I've been able to make up my own mind about things					

7

SECTION 7

Using the scales below please indicate how confident you are in the following items by ticking the appropriate %. Select the response that most closely matches your own, remembering that there are no right or wrong answers.

How confident are you that you can...
(Please use "✓" to indicate your answer)

1. Motivate yourself to get at least 30 minutes of activity a day, 3 times per week?

Not at all Confident ___:___:___:___:___:___:___:___:___:___:___: Completely Confident
0% 10 20 30 40 50 60 70 80 90 100%
Somewhat Confident

2. Motivate yourself to attend at least 1 MedEx class a week?

Not at all Confident ___:___:___:___:___:___:___:___:___:___:___: Completely Confident
0% 10 20 30 40 50 60 70 80 90 100%
Somewhat Confident

3. Use safe, effective exercise technique (e.g. warm-up, stretching)?

Not at all Confident ___:___:___:___:___:___:___:___:___:___:___: Completely Confident
0% 10 20 30 40 50 60 70 80 90 100%
Somewhat Confident

4. Plan exercise sessions that will be at least moderately difficult (e.g. have you breathing a little hard, your heart rate increases)?

Not at all Confident ___:___:___:___:___:___:___:___:___:___:___: Completely Confident
0% 10 20 30 40 50 60 70 80 90 100%
Somewhat Confident

5. Monitor your exercise progress by recording what exercises you do, how often you do them and for how long?

Not at all Confident ___:___:___:___:___:___:___:___:___:___:___: Completely Confident
0% 10 20 30 40 50 60 70 80 90 100%
Somewhat Confident

6. Set realistic, weekly exercise goals for yourself (e.g. exercising 3 days/week)?

Not at all Confident ___:___:___:___:___:___:___:___:___:___:___: Completely Confident
0% 10 20 30 40 50 60 70 80 90 100%
Somewhat Confident

7. Monitor and regulate the intensity of your exercise so that it is moderately difficult?

Not at all Confident ___:___:___:___:___:___:___:___:___:___:___: Completely Confident
0% 10 20 30 40 50 60 70 80 90 100%
Somewhat Confident

8. Develop solutions to cope with potential barriers that can interfere with your exercise?

Not at all Confident ___:___:___:___:___:___:___:___:___:___:___: Completely Confident
0% 10 20 30 40 50 60 70 80 90 100%
Somewhat Confident

9. Schedule exercise sessions into your weekly routine so that you get at least 30 minutes of exercise a day, 3 times per week?

Not at all ___:___:___:___:___:___:___:___:___:___:___: Completely Confident
0% 10 20 30 40 50 60 70 80 90 100%
Somewhat Confident

10. You can return to exercise even if you have relapsed (returned to a sedentary/physically inactive state) for several weeks?

Not at all Confident ___:___:___:___:___:___:___:___:___:___:___: Completely Confident
0% 10 20 30 40 50 60 70 80 90 100%
Somewhat Confident

11. You can return to exercise even if you have relapsed (returned to a sedentary/physically inactive state) several times?

Not at all ___:___:___:___:___:___:___:___:___:___:___: Completely Confident
0% 10 20 30 40 50 60 70 80 90 100%
Somewhat Confident

Please continue to the next page

SECTION 8

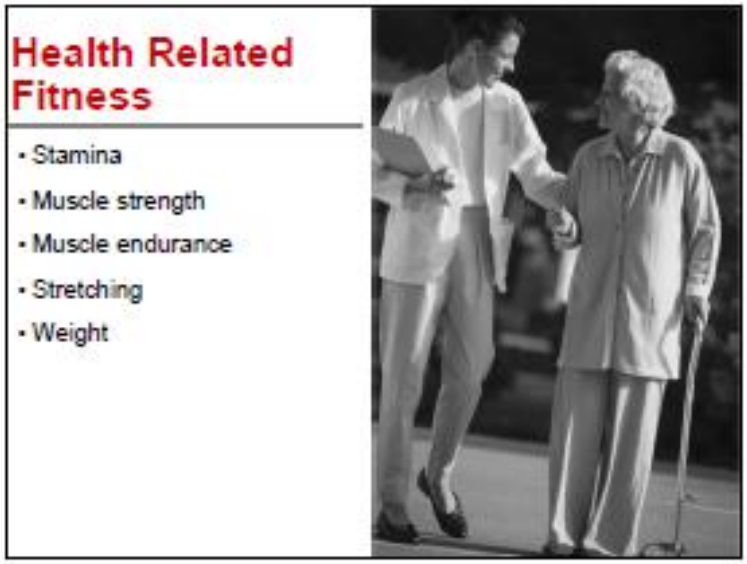
This section is about exercise support from FRIENDS. Please use a "✓" to indicate how much of the time the following statements relate. If these statements do not apply please tick 'none'

How much of the time during the past three months, friends (this can include fellow MedEx participants)...		None	Rarely	A Few Times	Often	Very Often
Q.1 Exercised with me	**Friends**	1☐	2☐	3☐	4☐	5☐
Q.2 Offered to exercise with me	**Friends**	1☐	2☐	3☐	4☐	5☐
Q.3 Gave me helpful reminders to exercise ("are you going to exercise tonight?")	**Friends**	1☐	2☐	3☐	4☐	5☐
Q.4 Gave me encouragement to stick with my exercise program	**Friends**	1☐	2☐	3☐	4☐	5☐
Q.5 Changed their schedule so we could exercise together	**Friends**	1☐	2☐	3☐	4☐	5☐
Q.6 Discussed exercise with me	**Friends**	1☐	2☐	3☐	4☐	5☐
Q.7 Planned for exercise on recreational outings	**Friends**	1☐	2☐	3☐	4☐	5☐
Q.8 Helped me plan activities around my exercise	**Friends**	1☐	2☐	3☐	4☐	5☐

The questionnaire is now complete. Thank you very much for your time.

10

Appendix I : Exercise consultation 1 (Baseline) slides



1

4 2

3

The Cool Down…

And post class review!

Overview

- Exercise Consultation
  - Let's look at the pros and cons (Decisional Balance)
  - Let's get a concrete plan (Goal Setting)
  - Coming up with ideas and solutions together (Group work)

5

Why Give Exercise a Try?

- Routine
  - "It is the time, the regularity, the craic of the same people and your meeting up and its very, very enjoyable and that's the reason that I come…
- Other Participants
  - "you're with like minded people… you can say something to someone here and know that they know what your talking about, they know the background … That's what motivates me to come here"
- Sense of 'wellbeing' post class
  - "The way I feel after [the class], It' s a great feeling, I must honestly say, when you 're doing the exercise you' re nearly falling, but it' s absolute great feeling when you get home you could clean the house from top to bottom, it gives you great energy".

What's Stopping You?

- Molly Coddle Syndrome
  - "Well I really think that people think that when they have something wrong with their heart that they' re invalids and a lot of people I would think, lie down under their illness".
- Ill Health
  - Illness. I was sick. That' s how I stopped coming.
- The 'Mingle' Effect
  - "… there are some people who might not be able to mix easily…**it might be a barrier for them**…a barrier for them, yes"
- Boredom
  - "You enjoy doing your exercise and all that, but after a couple of weeks you get tired and you want a break from it".

6

Group work

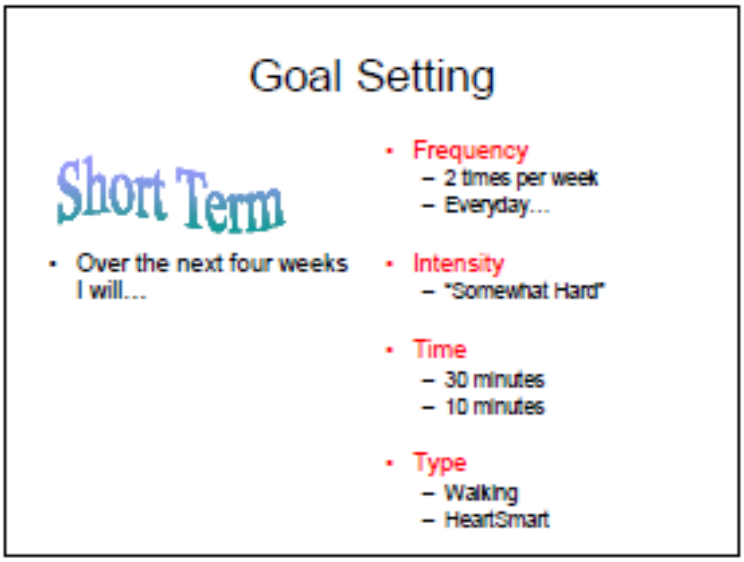
- Share your thoughts on motivations and barriers
- Write down a few ideas on your handout

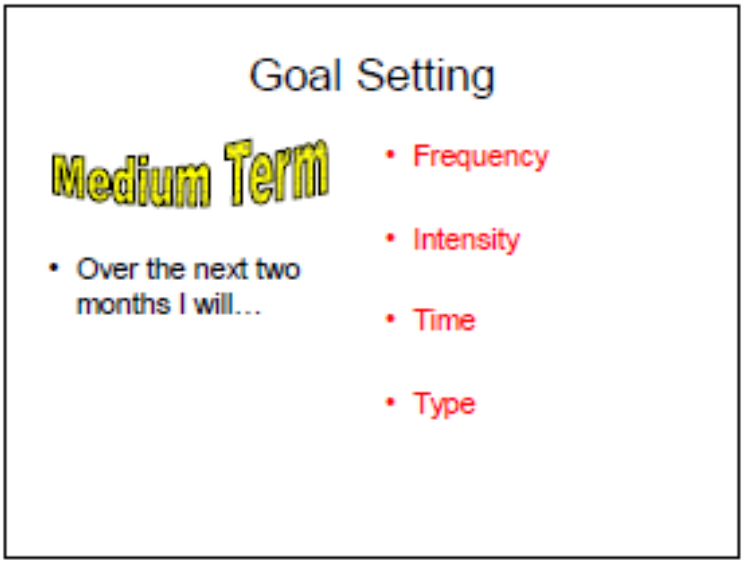
How can I plan my exercise to benefit me the most?

Think about being **FITT…**

- Frequency (how often do I plan to go?)
- Intensity (will I be going for a stroll or pushing myself and sweating?)
- Time (how long would I like to exercise for?)
- Type (will I go for a walk or swim?)

7


Goal Setting
Short Term
• Over the next four weeks I will…
• Frequency
– 2 times per week
– Everyday…
• Intensity
– "Somewhat Hard"
• Time
– 30 minutes
– 10 minutes
• Type
– Walking
– HeartSmart


Goal Setting
Medium Term
• Over the next two months I will…
• Frequency
• Intensity
• Time
• Type

8

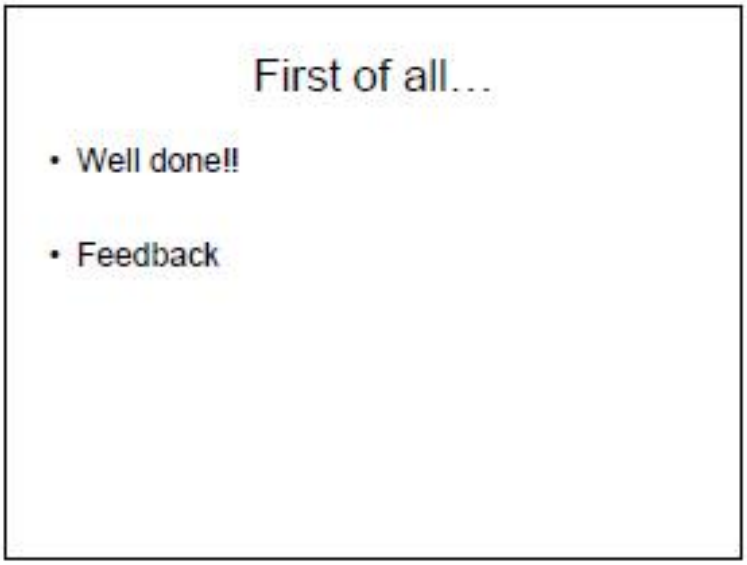
Think about some exercise goals and make that promise to yourself…

Complete the goal-setting handout☺

Thank you.
Questions

9

Appendix J: Exercise consultation 2 and 3 slides



1

What achievements did you accomplish?

-Think of a time in the last 12 weeks that you **achieved your physical activity goal**?

-How did you feel?

-How can you make this happen again?

What barriers did you come up against trying to reach your goals?

-think of a time when you **did not overcome** that barrier in the last 12 weeks?

-what could you do differently?

2

How can I plan my exercise to benefit me the most?

Think about being **FITT…**

- Frequency (how often do I plan to go?)
- Intensity (will I be going for a stroll or pushing myself and sweating?)
- Time (how long would I like to exercise for?)
- Type (will I go for a walk or swim?)

Goal Setting

Medium Term

- Over the next three months I will…

- Frequency
- Intensity
- Time
- Type

3

This is all about YOU!

- You are here
- You came back
- You are making a change
- You DESERVE the credit!!!!
- You will see the rewards

Results

4

Sit to Stand

- Time taken to complete 10 repetitions
- Indicator of lower body strength
- Quicker time = improved performance.
- Improvements relate to improved ability to be functional independent, e.g. get out of the car, get off the follet etc.

Hand-Grip Test

- Maximal amount of force produced from the hand.
- Indicator of upper body strength
- Higher number = increased strength
- Improvements relate to improved ability to be functionally independent, e.g. carry the shopping bags, open a jar etc.

7

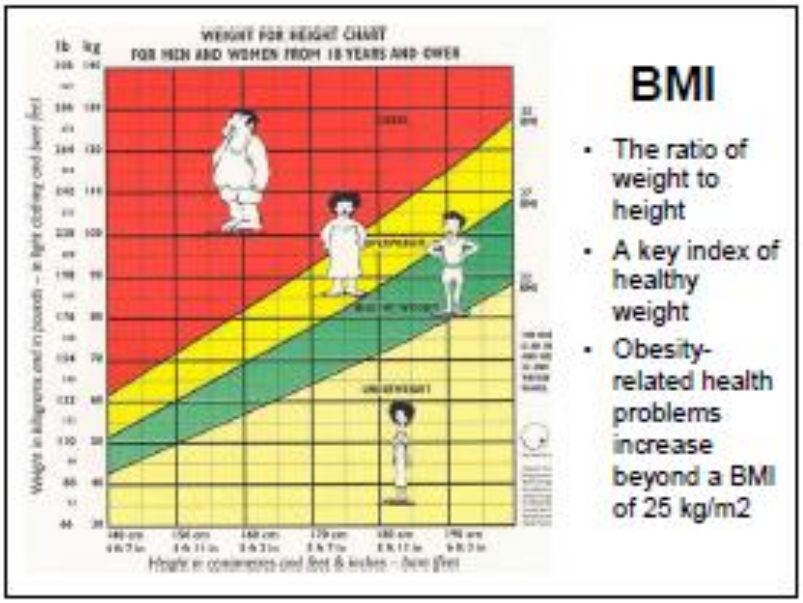
6 min walk test

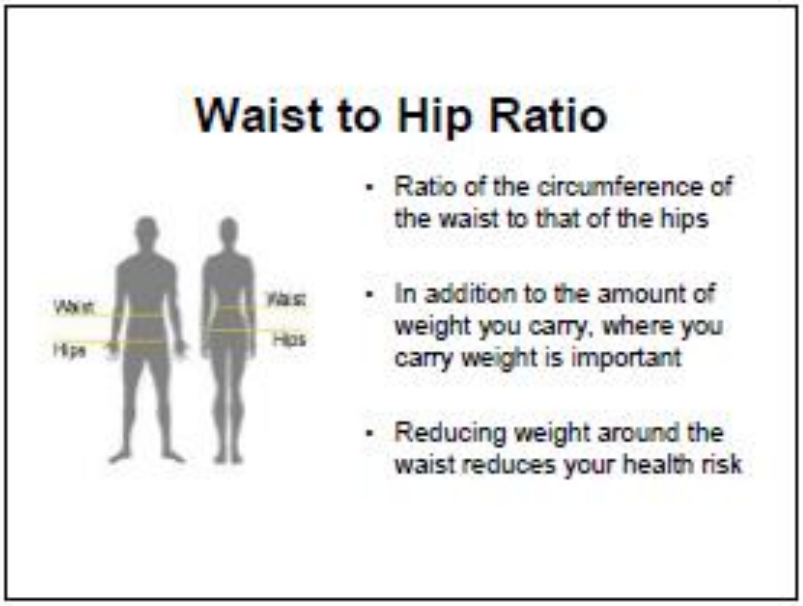
- Total distance covered in 6 minutes
- Indicator of aerobic fitness (fitness of heart and lungs)
- Improvements will relate to improved ability to exercise, do the housework and gardening, etc.

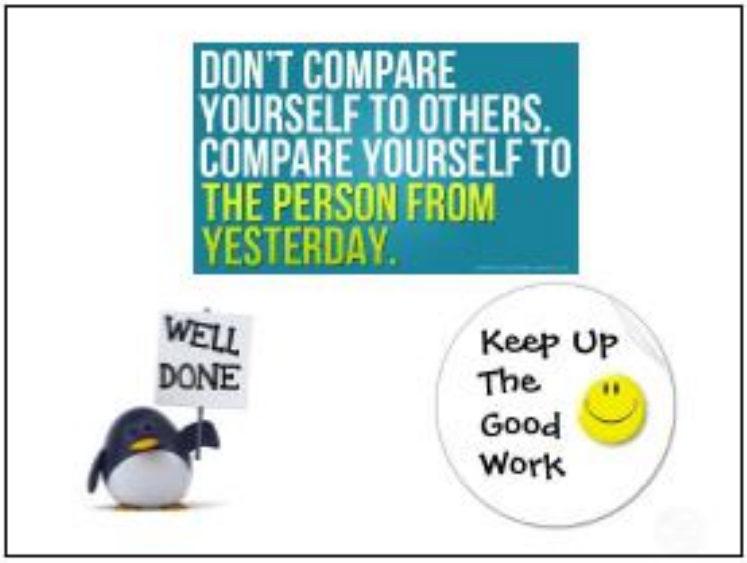
Sit and Reach

- Measure of flexibility or range of motion
- Improvements will relate to improvements in ability to bend and reach, e.g. tie your shoe laces, reach the top shelf etc.

6


WEIGHT FOR HEIGHT CHART
FOR MEN AND WOMEN FROM 18 YEARS AND OVER
lb
kg
OBESITY
OVERWEIGHT
UNDERWEIGHT
Height in centimetres and feet & inches – (here given)
BMI
The ratio of weight to height
A key index of healthy weight
Obesity-related health problems increase beyond a BMI of 25 kg/m2


Waist to Hip Ratio
Waist
Hips
Waist
Hips
Ratio of the circumference of the waist to that of the hips
In addition to the amount of weight you carry, where you carry weight is important
Reducing weight around the waist reduces your health risk
5


DON'T COMPARE YOURSELF TO OTHERS. COMPARE YOURSELF TO THE PERSON FROM YESTERDAY.
WELL DONE
Keep Up The Good Work


DCU
THANK YOU

8

Appendix K: Exercise consultation Physical activity guidelines educational sheet

Benefits and Barriers to becoming more Physically Active

What are the benefits to you of becoming more physically active?

1_____

2_____

3_____

4_____

What are the barriers preventing you from becoming more physically active?

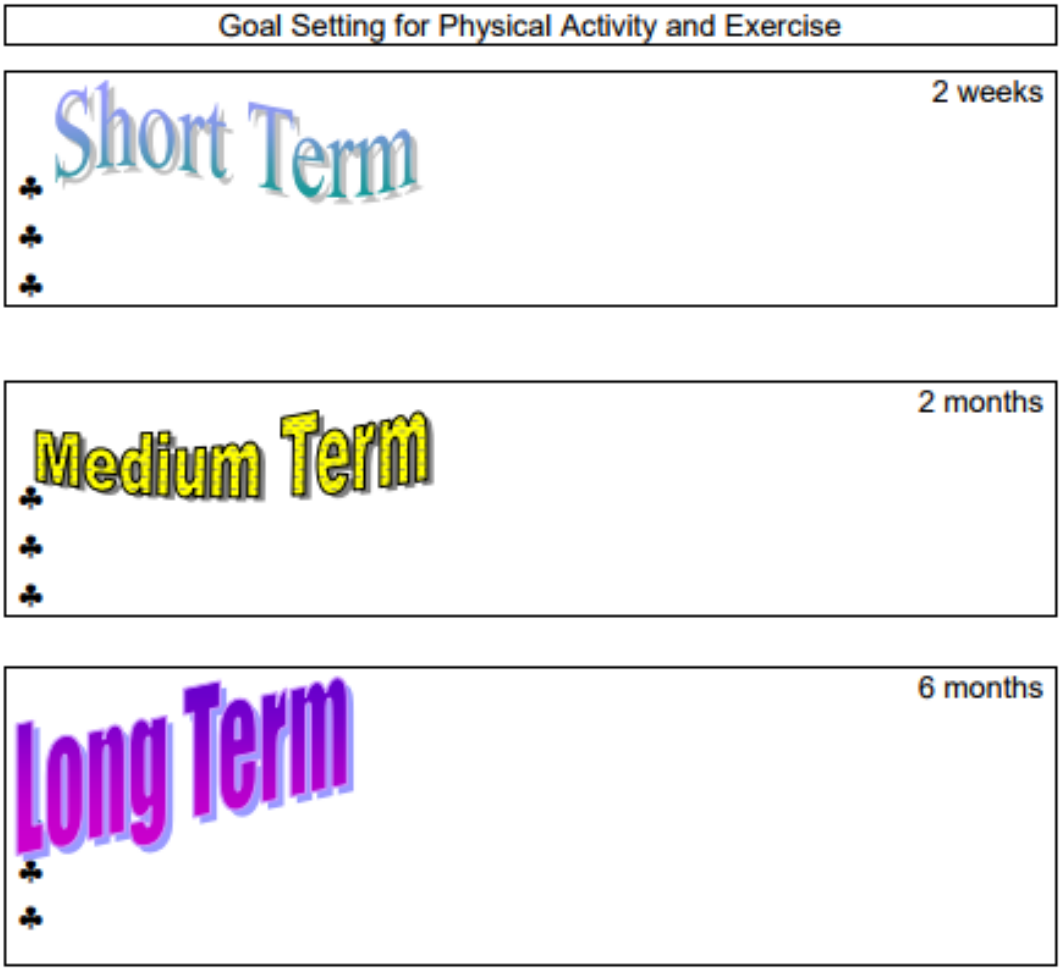
1_____

2_____

3_____

4_____

Appendix L: Exercise consultation Physical activity guidelines educational sheet



Appendix M: Exercise consultation Physical activity guidelines educational sheet