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Exercise referral schemes in the United Kingdom
initial observations from The National Referral Database

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Exercise Referral Schemes in the United Kingdom: Initial Observations from The National Referral Database.

By

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Ethical Approval

Certificate of Ethical Approval

Applicant: Nikita Rowley

Project Title: The Development and Implementation of a Database to Understand What Works in Local Exercise Referral Schemes.

This is to certify that the above-named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Medium Risk

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Declaration

The work submitted within this thesis has been undertaken during the period of my registration. I declare that this work is my own, conducted by myself with assistance where acknowledged.

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There are several people I would like to thank that have helped me complete this thesis. Firstly, I would like to acknowledge the support of my supervisory team; my Director of Studies, Dr Elizabeth Horton, along with my supervisors, Professor Alfonso Jimenez, Dr James Steele, and Dr Steve Mann. Their comments and support has helped me significantly improve my work over the period of this PhD. Staff at ukactive have provided beneficial support and guidance throughout the PhD which has helped me greatly with completing this thesis. Staff at ReferAll have provided support when learning how to use the database I analysed within this thesis. I would also like to thank Professor Gary Liguori from University of Rhode Island, for his support and guidance, especially with preparing papers for publication.

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Abstract

Exercise referral schemes are a widespread intervention aimed to increase physical activity levels in patients referred with medically diagnosed health conditions or risk factors. However, despite evidence of the benefits of physical activity, the clear evidence of whether exercise referral schemes are an effective approach to increase physical activity behaviour is currently limited.

The National Referral Database is a newly formed resource for exercise referral specialists to upload patient data including a variety of health and physical activity outcomes for patients, both pre-and post-exercise referral participation. This database contains data from a large cohort of referral patients to schemes across the United Kingdom. Previous research has never reviewed data from such a large cohort across the United Kingdom. This thesis aims to provide initial observations of what may contribute to an effective exercise referral scheme, by examining key schemes' characteristics, examining whether exercise referral increases physical activity levels, and to review patients' characteristics as predictors of the likelihood of dropout in a larger sample than previously analysed.

This thesis provides novel, scientifically relevant research, as it contains one of the first large-scale studies based on exercise referral, with robust methodologies. These studies provide insights to the varied design, delivery, implementation and evaluation of schemes at present. Firstly, before this research was conducted, there was little recent evidence delivering insights into what is currently happening on the ground, in terms of actual delivery approaches used within schemes. The first study aims to provide insights which would bridge this gap in the literature. It was

found that schemes were typically 12 weeks in length, offering participants bi-weekly (twice a week), unsupervised exercise sessions in a fitness gym, using a combination of cardiovascular, resistance, free weights and body weight exercises. Evaluation techniques varied, along with various methods used to check the fidelity of schemes.

Secondly, there was a lack of literature examining the change in physical activity levels of participants upon completion. The second study found that participants did report a statistically significant change in the total physical activity, which was mostly accounted for by increases in moderate-vigorous physical activity. However, participants were classified as moderately active before participation, therefore, participants did not see sufficient changes to move them from the moderately active, to the highly active category.

Finally, there was a lack of literature examining patients' characteristics to predict the likelihood of dropout in a large cohort. Results found that the key predictors of dropout included reporting mixed ethnicity, reporting disability as a mental health condition, being a student or permanently sick/disabled, referred by a specialist doctor or pharmacist or referred from a medical centre. Characteristics which reduced the likelihood of dropout included being male, aged 30 years or over, retired, reporting moderate physical activity levels, referred by an exercise specialist or health improvement services, or referred from an outreach service. Some of these results show an agreement with past literature, validating findings in a larger cohort than previously examined, but also provides new evidence of some characteristics which have not been associated with dropout previously. This study provides initial evidence from the national database, which could be used to develop prescriptions of exercise which focus on key patients' characteristics to avoid dropout.

The findings from this thesis have identified that there are issues which need to be addressed within the design, delivery, implementation and evaluation of schemes and exercise prescriptions to provide consistent and rigorous evidence for the effectiveness of exercise referral schemes. This thesis also identified that there are issues with national guidelines which at present, are broad; however, without the evidence-base and examples of best practice to enhance guidelines, these national guidelines are potentially ineffective. To clarify, there needs to be a more standardised approach to the implementation of schemes, but allowing for variation in the delivery of individualised exercise prescriptions. Thus, being something that needs further exploration and adaptation within guidelines.

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Publications

Papers

Rowley, N., Mann, S., Steele, J., Horton, E. and Jimenez, A. (2018). The effects of exercise referral schemes in the United Kingdom in those with cardiovascular, mental health, and musculoskeletal disorders: a preliminary systematic review. *BMC public health*, *18*(1), p.949. See appendix 1.

Rowley, N. and Liguori, G. (2019). Exercise referral schemes: Is the United Kingdom model a potential global solution? *ACSM's Health and Fitness Journal.*

Rowley, N., Steele, J., Wade, M., Copeland, R.J., Mann, S., Liguori, G., Horton, E. and Jimenez, A., 2020. Are exercise referral schemes associated with an increase in physical activity? Observational findings using individual patient data meta-analysis from The National Referral database. *Journal of Physical Activity and Health*, *1*(aop), pp.1-11.

Conference presentations

Price, N., Williams, T., Horton, E., Liguori, G., Mann, S., Jimenez, A. (2018). Effects of exercise referral schemes on physical activity levels. Poster presentation at the ACSM Annual Meeting, Minnesota, USA.

Rowley, N., Steele, J., Mann, S., Liguori, G., Jimenez, A., Horton, E. (2019). Examining the effects of exercise referral schemes on changes in physical activity levels. Poster presentation at the ACSM Annual Meeting, Orlando, USA.

Rowley, N., Steele, J., Mann, S., Liguori, G., Jimenez, A., Horton, E. (2020). Observing Key Characteristics of Exercise Referral Schemes in the United Kingdom- Delivery Approaches Currently Used in England. Poster presentation at ACSM 2020 Virtual Experience

Abbreviations

%	percent or percentage
BHF	British Heart Foundation
BHFNC	British Heart Foundation National Centre
BP	blood pressure
BMI	body mass index
BREQ	Behavioural Regulation in Exercise Questionnaire
CERT	Consensus on Exercise Reporting Template
CHD	coronary heart disease
CMO	Chief Medical Officer
CV	cardiovascular
CVD	cardiovascular disease
ERSs	exercise referral schemes
EU	European Union
GP	general practitioner
HADS	Hospital Anxiety and Depression Scale
IPAQ	International Physical Activity Questionnaire
Kg	kilogram

M	metres
METS	metabolic equivalent
MH	mental health
mm/pw	MET-minutes per week
MSK	musculoskeletal
MVPA	moderate to vigorous physical activity
NCDs	non-communicable diseases
NHS	National Health Service
NICE	National Institute of Health and Care Excellence
NRD	National Referall Database
NQAF	National Quality Assurance Framework
PA	physical activity
PHE	Public Health England
PRISMA	Preferred Reporting Items for Systematic Review and Meta-Analyses
QALY	quality adjusted life year
RA	rheumatoid arthritis
RCTs	randomised controlled trials
REPs	Register of Exercise Professionals
RHR	resting heart rate

SDT	self-determination theory
SVS	Subjective Vitality Scale
UK	United Kingdom
WHO	World Health Organization

Chapter 1:

Introduction

Chapter 1: Introduction

This chapter briefly introduces the issues examined within this thesis, and provides context and rationale for the research conducted. The purpose of this chapter is to introduce this thesis with a statement of purpose, along with the main aims and objectives of the thesis.

1.1 Statement of purpose

Within the United Kingdom (UK), exercise referral schemes (ERSs) are a popular way to promote getting physically active (British Heart Foundation National Centre: BHFNC 2010; National Institute for Health and Care Excellence: NICE 2014, 2018). ERSs were designed with the primary aim of managing and treating specific health disorders, long-term health conditions, and non-communicable diseases (NCDs). ERSs also aim to increase physical activity (PA) levels of participants (Fox, et. al. 1997; NICE 2014, 2018; Pavey, et al. 2011). ERSs provide patients with an introduction to becoming physically active, which could potentially act as a facilitator to long-term behaviour change, with the aim of preventing and managing health conditions referred with (BHFNC 2010). ERSs provide patients with an opportunity to engage in a structured, and usually supervised, prescription of exercise. Despite variation in the specific models of exercise referral delivery, patients are typically referred via primary care health professionals to third-party service providers, such as exercise referral specialists within leisure centres. The evidence to support the use of ERSs to promote increases in PA is conflicting and has been described as 'inadequate' (NICE 2014, 2018; Duda, et al. 2014), along with little research documenting change in PA levels upon completion (Chalder, et al. 2012; Murphy, et al. 2012; Pavey, et al. 2011; Webb, et al. 2016). Exercise prescriptions are supposed to be tailored to suit the requirements of those referred, and to the community where the scheme is based (Oliver, et al. 2016; Public Health England: PHE 2014a), therefore, examining effectiveness on a large scale has been an issue. Schemes have been described as 'wild and woolly', with a lack of agreement between stakeholders on how to determine impact sufficiently (Henderson, et al. 2018). There is an increasing need to provide consistent and rigorous evidence of the effectiveness of ERSs in the UK. To date, the literature regarding the impact of exercise on referral is limited and not always encouraging due to small sample sizes, a lack of exercise prescription details and inconsistencies in findings (Duda, et al. 2014; NICE 2014, 2018; Shore, et al. 2019). There are other factors that affect the impact of ERSs which include inconsistency in outcome measures used, and a lack of consistent data collection across the UK (Shore, et al. 2019), which have both contributed to the lack of development of sufficient and descriptive exercise referral guidelines.

Current guidelines provide a lack of consistent evidence and recommendations of how an ERS should be effectively implemented, delivered and evaluated (NICE 2014, 2018). These guidelines do not provide recommendations for specific individualised exercise prescriptions to suit an array of health conditions and do not define distinct subpopulations for whom ERSs may be effective, for improving PA and health outcomes (NICE 2014, 2018; Oliver, et al. 2016). The current delivery of ERSs are not providing sufficient rigorous evidence of the appropriate development of effective exercise prescriptions, which have led to a lack of significant changes in PA levels and health outcomes. NICE guidelines (2014, 2018) do not provide guidance on key schemes' characteristics which can provide the ideal PA and health outcomes. With a lack of consistent evidence of how schemes across the UK are constructed, encouraging referrals to adhere and complete a prescription of exercise may also be an issue. Research is required to observe how schemes are currently constructed to examine what is happening on the ground, before making assumptions on what recommendations are required to update current exercise referral guidelines.

It is evident that although the literature is not always encouraging, ERSs are considered an imperative component to increase PA and tackle NCDs (Jones, et al. 2005). NICE have specified that the inconsistent nature of ERSs makes it difficult to distinguish between effectiveness and adequacy of different schemes (NICE 2014). Past research has failed to determine if exercise on referral has been effective in changing self-report PA levels of participants (Pavey, et al. 2011). Previous research found that there were still some uncertainties in the effectiveness of ERSs (Henderson, et al. 2018; Pavey, et al. 2011), however, previous research has used smaller sample sizes (Crone, et al. 2011: *n*=2901; Hanson, et al. 2013: *n*=2233; Murphy, et al. 2012: *n*=2160; Tobi, et al. 2012: *n*=701) and not reported the detailed description of the exercise prescription (Hanson, et al. 2013; Murphy, et al. 2013; Webb, et al. 2016), which both can affect the overall effectiveness.

The purpose of this thesis is to observe what is currently happening within local ERSs across the UK, to provide insights into what may make an effective exercise prescription, especially in providing positive changes in PA levels. Effectiveness of an ERS is usually influenced by an individual deciding to take part and adhere to an exercise prescription (Pavey, et. al. 2012); this is assuming that the scheme is efficacious. It is important to distinguish the difference between effectiveness and efficacy, as these can typically be confused for one another, especially in using exercise as a public health tool (Glasgow, et al. 2003). An exercise intervention that lacks efficacy, but is implemented perfectly, including high uptake and adherence rates, will ultimately lack effectiveness. Efficacy is the degree to which an exercise intervention has the competence to produce its predicted effect in the ideal environments; whereas, effectiveness refers to the degree which an exercise intervention achieves its predicted effects in the usual environments (Hill, et al. 2016). It is important for research to focus on providing rigorous evidence for the effectiveness of ERSs on changes in PA, which will also meet one of the further research recommendations from NICE (2014); guidelines suggest that changes in PA levels should be the primary outcome measure used (NICE 2014), however, there is a lack of sufficient reporting (Gidlow, et al. 2005; Shore, et al. 2019).

Even though ERSs have been active since the early 1990s (Department of Health 2001), there has been a lack of research observing what is happening within current practice. It was reported that there were approximately 600 schemes in operation across the UK in 2011 (Pavey, et al. 2011); although, there was no evidence to support where this figure came from. With this lack of mapping, there is also a lack of understanding of how schemes are currently constructed, including the length of schemes, the types, modes, and intensity of exercise (including effort and load), frequency of exercise, and duration of each exercise session within the prescription. Without this information, it is not known whether schemes are providing patients with the optimal PA and health outcomes from participation. Therefore, it is important to begin the line of studies within this thesis by providing some insights into what is happening within exercise referral practice in terms of delivery approaches. It is important to understand which key characteristics are common within schemes at present (Shore, et al. 2019), which could then provide evidence of how broad and diverse the implementation, delivery and evaluation is within the UK.

There is limited research examining key patients' characteristics as predictors of the likelihood of dropout from a large cohort of patients across the UK. This research could provide fresh evidence from a large cohort of patients, which uncovers key characteristics relating to the likelihood of dropout which could be translated to help exercise providers to reduce drop out from their schemes. This evidence could also provide a catalyst for the need to tailor exercise prescriptions to avoid drop out.

There is limited, but valuable research examining the effects of exercise referral participation on health outcomes (Morgan 2005; NICE 2006; Pavey, et al. 2011; Williams, et al. 2007). Studies were mainly small randomised controlled trials (RCTs) or systematic reviews, and not necessarily reflective of current exercise referral delivery and practice across the UK. The purpose of this thesis is to review exercise referral data of a larger cohort of participants from multiple schemes across the UK, to provide insights and an updated overview of the effectiveness of schemes, specifically focusing on PA levels.

1.2 Aims and objectives

The overall aim of this thesis is to provide insights from a national database of exercise referral patient data, which contribute to the literature on the effectiveness of exercise referral schemes in the UK from a large cohort of exercise referral patients.

The National Referral Database (NRD), which will be used within this thesis, was developed by ReferAll in collaboration with ukactive, and the National Centre for Sport and Exercise Medicine in Sheffield. This thesis evaluates data from a large cohort of participants from multiple ERSs from across the UK, which were exported from the database in October 2017. Thus, being the first large-scale evaluation in the UK.

The primary outcome measure used to measure PA levels was the International Physical Activity Questionnaire (IPAQ: see appendix 3) which included metabolic equivalent (MET/min/week) outcome.

The specific aims and objectives of this thesis were to:

- Provide insights to how schemes are currently operating, including observing the type, mode, intensity, duration and frequency of exercise prescribed. This aims to provide vital information on the key characteristics of schemes which have not been observed previously.
- Examine the effects of ERSs on changes in PA levels of participants who completed a 12-week exercise prescription in the UK.

- To examine key patients' characteristics of participants to predict the likelihood of dropout from an ERS in the UK.
- To provide an update to the evidence base which could potentially impact future direction of research, and in theory, support improved design and implementation of schemes throughout the UK, by providing evidence for national guidelines to be updated accordingly.

1.3 Structure of the thesis

The structure of this thesis includes:

- Chapter two which focuses on a review of the current literature examining ERSs, and provides a rationale for the thesis. Key areas include PA and physical inactivity, key policies, purpose of ERSs, theory, adherence and general practitioners (GPs) views on ERSs.
- Chapter three focuses on the effects of ERSs within specific populations: patients referred with cardiovascular, mental health and musculoskeletal conditions. This systematic review examines the empirical evidence currently available.
- Chapter four provides a brief method section. An in-depth explanation of methods used can be seen in each studies' chapters.
- Chapter five (study one) provides insights in terms of actual delivery approaches, how schemes are implemented and evaluated.
- Chapter six (study two) examines whether ERSs are associated with providing change within PA levels of participants. This chapter examines key data from the NRD including IPAQ.

- Chapter seven (study three) examines the patients' characteristics which could potentially predict the likelihood of dropout from an ERS in the UK. This chapter examines key demographics, referral pathways, and IPAQ data from the NRD.
- Chapter eight evaluates the key findings from this thesis, its limitations, and key recommendations for future research and practice.

1.4 My position relative to the research conducted

Before my position as a PhD research student, I had spent several years working and coordinating exercise referral schemes. The PhD was of interest to me as I have always wanted to help develop better ERSs. To begin with, I had a bias towards these schemes due to seeing the benefits to patients first hand. When I started my PhD and reviewed the literature, it was clear that ERSs were often seen as ineffective and there was a great deal of heterogeneity within the results of the research. With this, I wanted to improve the evidence base and explore the effectiveness of ERSs in more detail. During the time that the PhD was advertised, a new national database was created, the National Referral Database, which hadn't been analysed previously. This was a fantastic opportunity to see what was actually happening with ERSs at present with recent data from schemes across the UK.

I believe that having prior knowledge and experience of working within ERSs has been beneficial for this thesis, as I understand how ERSs work and where they sit within public health interventions. With this, there was bias towards the benefits of schemes, but over the past three years, I have developed skills to become an independent researcher which I believe will shine through this thesis.

The work within this thesis is my own, and I was given the freedom to decide what studies I wanted to conduct using the database. Although the data was secondary data and collected by ReferAll, the line of studies conducted within this thesis were my decision. The database contains a wealth of data, so deciding on the line of studies was based on the literature review in chapter three. I was given full control of the data exported from the database, which included cleaning the data and preparing the data for analysis. My position in relation to the research was that of a PhD researcher, given control over what was analysed and how, and the design of the line of studies presented in the following chapters.

Chapter 2:

Literature Review

Chapter 2: Literature Review

The purpose of this chapter is to examine the literature, providing a broad overview of physical activity and physical inactivity in the UK, then a more detailed exploration of exercise referral schemes. This chapter is divided into 6 sections. The first section (2.1) describes physical activity, in terms of what it is, its prevalence and the benefits to patients. The second section (2.2) describes physical inactivity, in terms of what it is, its prevalence and issues it can cause individuals. The third section (2.3) describes specific long-term health conditions, those that patients may be referred with. The fourth section (2.4) explores in detail different aspects of exercise referral schemes. The fifth section (2.5) review the theory that underpins exercise referral. Section six (2.6) examines health care professionals' perceptions of the effectiveness of ERSs.

2.1 Physical activity

2.1.1 Definition of physical activity and exercise

Physical activity is widely known as an effective prevention and management tool for a wide range of chronic health conditions and NCDs (Pavey, et al. 2011; Pederson & Denollet 2003; Pederson & Saltin 2015). PA can be defined as, any bodily movement created by skeletal muscles that has a demand of energy expenditure (World Health Organization: WHO 2015, 2018); whereas exercise encompasses a succession of structured and repetitive physical activities, with the overall aim of maintaining or improving physical fitness (Caspersen, et al. 1985). Exercise falls within the broader umbrella of PA, and that physical fitness, though not necessarily an intended outcome of PA more broadly, may be an associated outcome. PA can be conducted in many ways, including unstructured activities as part of an individual's daily living, leisure activities or occupation, and without the desired goal of improving fitness. Improving health and fitness can be a by-product of these unstructured activities, although unstructured PA is decreasing within the modern era (Booth, et al. 2012). The PA recommendations for adults aged 19 to 64 years (UK Chief Medical Officer: CMO 2018, 2019; PHE 2017; WHO 2018), is to aim for at least 150 minutes of moderate intensity aerobic activity (such as brisk walking or cycling; typically, in bouts of 10 minutes or more) each week or 75 minutes of vigorous intensity activity (such as running). Adults should also conduct muscle strengthening activities at least 2 days a week, but according to a recent update to PA guidelines, it has been suggested that any strengthening activity is better than none (CMO 2019). Adults should also aim to minimise total time being sedentary (CMO 2018; PHE 2017; WHO 2018), and break up long periods of inactivity with light physical activity at least (CMO 2019).

A National Health Service (NHS) Digital health survey, found that 66% of men, and 58% of women aged 16+ years, met the above aerobic activity guidelines; however, only 31% of men and 23% of women aged 16+ years, met both aerobic and muscle-strengthening guidelines (NHS Statistics Team 2017).

2.1.2 Prevalence

Worldwide one in four adults do not meet the current global recommendations for PA, which suggest that adults should undertake 150 minutes of moderate-intensity activity per week, which equates to 600 MET/min/week (WHO 2018). Although there is a clear, causal relationship between accomplished PA and health outcomes (Department of Health 2011), physical inactivity is rising (WHO 2015, 2017). Approximately, 20 million adults in the UK are not physically active (BHF 2017a), a figure that has remained unchanged in recent years (Sport England 2018). Physical inactivity is a public health dilemma in that it increases the risk of NCDs, which include obesity, cardiovascular diseases (CVDs), diabetes, and premature death (BHF 2017b). Physical inactivity has reportedly increased globally, having serious consequences on health and wellbeing (Morgan, et al. 2016; PHE 2016a, 2016b; Sport England 2018).

2.1.3 Associated outcomes of physical activity

Meeting the recommended levels of moderate to vigorous PA (MVPA) are associated with having possible positive effects on numerous health outcomes including: the prevention and reduction in type 2 diabetes (Chodzko-Zajko, et al. 2009; Orozco, et al. 2008; Roumen, et al. 2009); improving cardiovascular (CV) health (Chodzko-Zajko, et al. 2009); reducing the risk of CVD (Hamer & Chida 2008); decreasing BP and resting heart rate (RHR) (Brukner, et al. 2005; Pederson & Saltin 2006, 2015); lessen the risk of many cancers including colon, breast, endometrium, and prostate cancers (Giovannucci, et al. 2005; Patel, et al. 2003); delay the onset of dementia (Livingston, et al. 2017); positive influences on mental health by reducing anxiety (Stonerock, et al. 2015), decreasing depression and depressive symptoms (Blumenthal, et al. 1990; Mammen & Faulkner 2013; Pavey, et al. 2011); improve overall mental health and mood (Schuch, et al. 2016); prevent the risk of falls (Sherrington, et al. 2008), and osteoporotic fractures (Moayyeri 2008); reduce BMI and waist circumference (Mustelin, et al. 2009); and reduce the risk of developing stroke in older adults (Goldstein, et al. 2006; Wannamethee & Shaper 2014).

A meta-analysis estimated that the risk reduction for strokes (all forms) was 11-15% for moderate PA (Wendel-Vos, et al. 2004); whilst a further meta-analysis estimated 19-22% for vigorous PA. This relationship was increased for men, and vigorous activity was protective among women (Diep, et al. 2010). For various health conditions, a network meta-analysis has showed exercise interventions can be similarly, or more effective, than drug treatments in secondary prevention (Naci & Ioannidis 2013). This is not intended to be an exhaustive review of PA and its association with health outcomes, but there is clearly a good deal of evidence that suggests that PA may be beneficial for a wide range of health outcomes. It is also important to note that most evidence for the benefits of exercise and PA do come from observational studies, and evidence is assorted between RCTs and systematic reviews (Nunan, et al. 2017).

At present, there is an epidemic of physical inactivity which is predicted to get worse if interventions are not designed accurately to target improvements of specific health conditions, and tackle the rise in physical inactivity and sedentary behaviours (PHE 2017).

2.2 Physical inactivity and sedentary behaviours

2.2.1 Definition of physical inactivity

Typically, most research uses the term physically inactive to describe an individual who is not meeting specified PA guidelines, and are not performing adequate amounts of MVPA (Tremblay, et al. 2017).

2.2.2 Prevalence

Globally, 28% of adults aged 18+ years are inefficiently physically active, not meeting the current national and global recommendations for PA, according to WHO (2018). Inactivity is the fourth leading risk factor for worldwide mortality (6% of deaths worldwide), behind high BP (13%), tobacco use (9%), and high blood glucose (6%: WHO 2010). It must be accredited that although physical inactivity is a separate risk factor, PA levels are a key factor in moderating any additional risk factors such as high BP and glucose levels (NICE 2014; WHO 2010).

Approximately, 30% (20 million) of adults in the UK are not physically active and are not meeting the recommended guidelines (BHF 2017b). If this level of physical inactivity continues, then by 2030, it has been suggested through a predictive model of PA engagement, that people in the UK will be 35% less active than at present (PHE 2017).

2.2.3 Associated outcomes of physical inactivity

Physical inactivity increases the risk of NCDs including obesity, CVD, diabetes and premature death (BHF 2017b); providing a dilemma for public health. These NCDs are also commonly known as lifestyle-related diseases, due to these conditions being caused by unhealthy lifestyle habits, whose occurrence is based on the daily habits and behaviours of individuals (Sharma & Majumdar 2009). With an increase in physical inactivity, this could potentially have a negative influence on the NHS, due to the risk of physical-inactivity related conditions rising; more individuals may require support or treatment from their GP, which could hypothetically, lead to

GPs spending more time with patients who have a health condition caused by physical inactivity. By emphasising the importance of prevention rather than treatment, could reduce the burden on GPs who spend more time with inactive patients. If GPs were to recommend referral to an ERS, then this may reduce or prevent specific lifestyle-related diseases in the first instance. However, research found that many health care professionals cited pressures on their time as a reason for not promoting PA with patients (Din, et al. 2015). Therefore, future guidelines may need to focus on how health care professionals integrate discussions about PA with patients within appointments.

2.2.4 Definition of sedentary behaviours

Sedentary behaviours are a risk factor for poor health; there is increasing, emerging evidence that suggests that people are showing many sedentary behaviours (van der Ploeg & Hillsdon 2017). Sedentary behaviours can be defined as any waking behaviour which is expressed by an energy expenditure of <1.5 metabolic equivalent (METs) while sitting or in a reclining/lying position (Gardner, et al. 2016; Pate, et al. 2008; Tremblay, et al. 2017). It is important to clarify that sedentary behaviours can be confused for physical inactivity, but they are two different constructs. Sedentary behaviours are low levels of activity, which can involve increased sitting time, whereas physical inactivity is defined as not meeting PA guidelines (van der Ploeg & Hillsdon 2017). A more practical example is: an individual may go to the gym every morning for one hour before work, where they conduct MVPA, making them physically active, and potentially meet current PA guidelines. This individual may then drive to work, and sit at a desk using a computer all day long without regularly moving; thus, making them sedentary. People can be both sedentary and physically active within their day. However, recent conflicting research has concluded that meeting sufficient levels of PA can essentially mitigate the negative effects of sedentary behaviours during other times of the day, such as when sitting (Stamatakis, et al. 2019). If so, then the potential of promoting regular PA could provide positive benefits to those who may be sedentary at other times during the day.

2.2.5 Sedentary lifestyles

Large proportions of the UK population are not meeting the recommended levels of PA, as previously noted, and, show increased sedentary behaviours which could lead to sedentary lifestyles (Howlett, et al. 2015; Sport England 2018). Possibly due to advancements in technology, there has been increases in sedentary behaviours; specific activities include watching television, using a computer, tablet or games console, and taking motorised transport (Griffiths 2010). Conducting sedentary behaviours can lead to an individual's life becoming predominantly sedentary.

2.2.6 Associated outcomes of sedentary behaviours

Sedentary lifestyles can have a negative impact on an individual's health. Sedentary behaviours are associated with lower cognitive performance (Gray, et al. 2015). In a systematic review, there was strong evidence to support the correlation between sedentary behaviours and all-cause mortality, fatal and non-fatal cardiovascular disease, type 2 diabetes and metabolic syndromes (De-Rezende, et al. 2014). Dunstan, et al. (2010) discovered that for each one-hour increase in watching television, this was associated with 11-18% increased risk of all-cause and

CVD mortality. With an increase in binge-watching boxsets and television programmes which are readily available on multiple electronic devices, evidence such as this should be more publically published, so individuals understand the negative effects of sitting down and watching television continuously for hours.

It has been suggested that there is also a dose-response association between sitting time and mortality (Katzmarzyk, et al. 2009). Sedentary behaviours within childhood can potentially expand into adolescence and adulthood (Biddle & Asare 2011). Children and young adults who have sedentary lifestyles, have an increased risk of being overweight or obese, have greater fat mass, and increased BMI (Salmon, et al. 2011). A systematic review of sedentary behaviours and health outcomes in children found that lower levels of sedentary behaviours were associated with favourable health outcomes (Tremblay, et al. 2011). Within the same review, it was found that two or more hours of watching television were associated with increased measures of body composition, decreased fitness, and reduced academic achievement. An issue relating to studies measuring sedentary behaviours is, that most studies use self-report measures which are prone to biases (Lubans, et al. 2011); this is a common issue in many studies which use self-report measures, which must be reviewed so that more reliable measures could potentially be used to provide more accuracy. A recent narrative review found that there are a variety of surveillance measures used to measure sedentary behaviours, and that there is a need to standardise existing measures, along with device-based measures (Strain, et al. 2019). Device-based measures, such as physical activity trackers, are more readily available, and can measure both PA and sedentary time; these could potentially be an objective and reliable way to measure sedentary behaviours and PA.

Older adults have been found to be the most sedentary segment of the population (Hardy, et al. 2013). However, the NHS Statistics Team (2017) found that adults aged 75+ years were more likely to be more active than other age groups; although there was no discussion of any sedentary behaviours they may have. It is possible for individuals to be physically active (such as going to the gym daily), but also show sedentary behaviours (sitting at home, at a desk or in an office); that's why it is important to distinguish between the two. However, this research is inconsistent with other evidence which suggests this age group to be the least active (BHFNC 2010).

2.3 Long term health conditions

There are many people in the UK with various long-term health conditions for which exercise and PA may be an appropriate treatment option. It's important to define the prevalence of specific health conditions, and to also provide some evidence of the effects PA have on these conditions. This is not an exhaustive review; however, it is important to highlight common health conditions in the UK, and the effects PA have on these conditions.

2.3.1 Cardiovascular conditions

Cardiovascular conditions are defined as disorders which affect the heart and/or blood vessels (NICE 2010). CV disorders affect approximately 5.9 million people within the UK, with healthcare costs estimated at £9 billion each year (BHF 2017b). CVD costs the UK economy an estimated £19 billion each year (BHF

2017b). CVD includes coronary heart disease (CHD), stroke, and peripheral arterial disease. CVD usually occurs due to the development of atheroma and thrombosis, which are blockages within the arteries; CVD can also be linked to heart failure, dementia and kidney disease (NICE 2010). CV disorders can have huge implications on the NHS; the cost of hypertension can be as high as £2,040 per person, with a heart attack costing the NHS £2,390 per incidence (BHF 2017b). It has been suggested that individuals with CV conditions are more likely to participate in exercise if they are actively referred to an accessible scheme, are educated individuals, married and possessed high self-efficacy (Jackson, et al. 2005).

2.3.2 Mental health conditions

Mental health (MH) conditions are on the rise; it is thought that a sixth of people in the UK have a mental health problem (Brown & Triggle 2018). MH conditions are one of the major causes of overall disease burden worldwide, with the most predominant MH condition being depression (Mental Health Foundation 2016). The cost to the economy is estimated £105 billion a year according to the NHS (The Mental Health Taskforce 2017). Individuals with mental health conditions are at an increased risk of physical health comorbidities and early death (Wheeler, et al. 2018). There are various mental health conditions; most commonly reported are anxiety, depression and stress (Mental Health Foundation 2018; Mind 2018; Sohrabi-Shiraz 2018). Being physically active, can improve mental health. Undertaking regular exercise has been encouraged for people with mental health conditions to increase optimal health outcomes (Raglin & Wilson 2018). Past research has found that psychological benefits of a single bout of exercise can last for 2-4 hours before mood state can gradually return (Raglin 1997). PA and regular exercise has been proven to reduce depressive symptoms in various studies (Blumenthal, et al. 1999; Carney 1987; Dunn, et al. 2005; NICE 2009; North, et al. 1990). Exercise dose for people with depression was examined; participants were assigned to a 12-week programme of minimal activity (placebo) or one of four aerobic PA programmes that varied in energy expenditure (Dunn, et al. 2005); it was reported that there was a significant reduction in depression for the participants in the aerobic programmes.

2.3.3 Musculoskeletal conditions

Musculoskeletal (MSK) conditions, which includes orthopaedic disorders, is a broad term which covers over 200 various conditions affecting the muscles, joints and skeleton (Arthritis Research UK 2012). MSK conditions affect approximately 23 million people in the UK, with over 30 million work days lost each year as a result (Arthritis Research UK 2017). MSK conditions are the primary cause of work disability and sickness from work, and productivity loss across the European Union (EU: Bevan 2015; Rasotto, et al. 2015). One in two adults will develop knee osteoarthritis symptoms at some point during their lives, with one in four adults developing hip osteoarthritis symptoms by the age of 85 (Arthritis Foundation 2018). Rheumatoid arthritis which is also an autoimmune disease, is a common issue affecting over 400,000 people in the UK, making joints inflamed, painful and stiff (NHS 2019b).

Individuals suffering with MSK conditions can benefit from being physically active. One study reported reduced pain symptoms in wrists, elbows, neck and shoulders after participating within a tailored exercise intervention (Rasotto, et al.

2015). This could imply that creating a tailored exercise prescription based upon past evidence, could potentially provide reductions in MSK pain. Exercise, along with advice on how to stay active can be beneficial in the prevention and treatment of MSK conditions (Krismer 2007).

2.3.4 Metabolic conditions

There are various metabolic conditions, with obesity and type 2 diabetes being very common lifestyle-related conditions in the UK. In a 2016 survey, it was found that a total of 61.4% of adults in England were either overweight or obese (Baker 2018). This breaks down to 26.2% of adults being obese, and 35.2% of adults being overweight. Obesity is one of the leading risk factors for premature deaths, and various chronic health conditions that reduce quality of life (Ross & Janssen 2018). Obesity is an increasing epidemic in the UK (PHE 2014b). Obesity is an ongoing cycle which can begin during childhood, due to reduced PA levels and increased intake of junk foods, leading to weight gain (Dixon, et al. 2007). Childhood obesity has an associated link with an increased risk of premature death and disability in adulthood (Dietz 1998; Must, et al. 1992).

In 2018, obesity levels were highest among people aged 45-74 years old (Baker 2018). From a House of Commons briefing paper, it was reported that obesity levels have increased from 15% to 26% since 1993 (Baker 2018). Obesity can cause many health conditions including asthma (Egan, et al. 2013), obstructive sleep apnoea (Narang & Matthews 2012), MSK pain (Paulis, et al. 2013), type 2 diabetes (Thee, et al. 2013), and CV diseases (Lavie, et al. 2009). The cause of obesity can be due to bad lifestyle choices and behaviours, being physically inactive, eating unhealthily (increased intake of junk food), and being sedentary (Dixon, et al. 2007).

Approximately 90% of people in the UK with diabetes specifically have type 2 diabetes (Diabetes UK 2018). Diabetes affects various organs and bodily functions. Diabetes can cause multiple health issues including heart disease, nerve damage, renal failure, blindness and stroke (Bouchard, et al. 2018). Diabetes is where the body cannot control it's amount of blood glucose due to insufficient insulin production, or insufficient reaction from the body's organs to circulate insulin. Research has provided support for the benefits of PA on conditions such as diabetes (Bouchard, et al. 2018). Thompson, et al. (2008) found that in men with pre-diabetes and diabetes, having higher levels of cardiorespiratory fitness was associated with decreased risks of mortality (linked with cancer).

2.4 Exercise referral schemes

In acknowledgement to the physical inactivity burden, there have been various population-wide programmes implemented in the UK (NICE 2012); in addition to this, customised attempts to manage physical inactivity on an individual level led to the increase of exercise referral schemes. ERSs are one way of increasing PA levels, reducing sedentary lifestyles, and reducing the negative effects of long-term health conditions and lifestyle-related conditions; although, few studies have rigorously reported on changes in PA from exercise referral participation; thus, being a gap in the literature which is required to examine the effectiveness of ERSs.

ERSs are intended as individual level interventions, rather than a population based intervention. ERSs are intended to be individualised for each patient referred, but it shouldn't be implied that all schemes offer this individualisation. ERSs have their place within public health, however, due to limited evidence, they are not seen as effective, and many schemes have lost funding to allow patients to attend free of charge, or at most, at a subsidised cost (NICE 2014). Without any updates to current guidelines, there is uncertainty relating to the design and implementation of schemes, which means commissioners and scheme coordinators are potentially implementing ineffective schemes. If schemes are awarded funding for patients to participate free of charge, without an effectively designed scheme in place, participation rates could decrease or effectiveness on health outcomes may not be visible, which would then lead to funding cuts and potentially lack of use of schemes.

At present, there are economic implications of ill-health which are causing concerns for health professionals (Kim 2019), therefore the evidence-base for real world interventions such as ERSs needs to be more sufficient evidence to support or disapprove the benefits of ERSs to the public's health and reducing any burden on the economy and health systems.

ERSs are typically a treatment to specific heath conditions or physical inactivity; however, viewing ERSs as a potential prevention tool may reduce any burden on the NHS. With better design, ERSs could aid the NHS's long term plan (NHS 2019), which suggests that patients should self-manage their health conditions. ERSs bay be able to support this, by providing patients with 'teachable moments' which could act as a facilitator for change (Epiphaniou & Ogden 2010;

Rosenstock 1974), and initiate self-management of health through PA. ERSs are typically aligned with lifestyle determinants, as these determinants have a strong impact on an individual's health and wellbeing. ERSs aim to improve an individual's lifestyle by introducing them to PA (NICE 2014), which theoretically, should encourage them to continue being physically active within their daily life as well as in exercise settings.

2.4.1. Definition of exercise referral schemes

There are multiple ways to define exercise on referral. An earlier definition of exercise referral is a process "*whereby a health professional directs an individual to a service offering an assessment of need, development of a tailored physical activity programme, monitoring of progress and a follow-up. They involve participation by several professionals and may require the individual to go to an exercise facility such as a leisure centre*" (NICE 2006). This provides a description of the process of an ERS which is still referred to today, thirteen years later. There hasn't been much in the way of change to the process which will be discussed in section 2.4.3.

ERSs are clearly a low/moderate risk provision which is aligned with a prevention model; it excludes unstable or high-risk patients who may be better suited to other exercise rehabilitation pathways (Henderson, et al. 2017). ERSs aim to provide an exercise prescription in a supervised environment (such as a gym), with added social support which should in theory, encourage long term PA and prevention of specific health and lifestyle-related conditions (NICE 2014). Although providers intend to offer patients with an individual, personalised prescription of exercise, there is a lack of evidence for the effectiveness of evidence-based prescriptions of exercise, designed specifically for all health conditions. Therefore, it is highly unlikely that the exercise prescriptions given at present, are having the optimal effect on health and PA outcomes, due to the lack of evidence to support them.

2.4.2 History of exercise referral schemes

ERSs were created in the early 1990s (Department of Health 2001), with the aim to reduce physical inactivity within specific populations referred for the management and treatment of specific health conditions (Fox, et al. 1997; Pavey, et al. 2011), as briefly mentioned in chapter 1, section 1.1. Primary care is the most common setting to promote PA through ERSs (Fox, et al. 1997), with an aim of providing ERSs within the local community with easy access. The Royal College of General Practitioners praises Dr. Derek Browne, for being the first GP to promote exercise prescriptions in the UK (Labour Research Department 2004). It could be suggested that individuals could just meet with a personal trainer or exercise provider, or go to an exercise class to increase PA levels instead of exercise referral, but usually, the individuals for which schemes are intended for, are typically inactive and may or may not be seeking to change (NICE 2014). Previous research suggested that inactive individuals, even if they report being healthy, should be the target audience for exercise interventions as these individuals are at risk of developing ill health without long-term change (Howlett, et al. 2019). Therefore, it could be argued that ERSs should align within a prevention model, rather than treatment.

The first ever national ERS review was authorised in 1994, which found that schemes were becoming widespread across England, with approximately 173 schemes employed (Biddle, et al. 1994). Pavey, et al. (2011) suggested that there were more than 600 schemes in operation across the UK in 2011; however, there was no evidence to support where this figure came from. To date, there has been a lack of recording of the exact number of schemes throughout the UK, therefore, the true number of schemes is unknown.

To begin with, there were two types of scheme; firstly, practice-managed schemes within GP surgeries; and secondly, leisure centre-based schemes, where referrals are sent directly to leisure centres, and exercise professionals are responsible for the design and implementation of an exercise prescription. It was found that the leisure centre-based schemes were most popular and successful in encouraging individuals to become more physically active and improve health outcomes (Biddle & Mutrie 2007; Fox, et al. 1997).

Over the past two decades, there has been growth in the quantity of schemes across the UK (Pavey, et al. 2011); although, as mentioned, there has been a lack of mapping of these schemes. Upon the expansion of ERSs in the early 1990s, other countries adopted similar models shortly after. Portugal, Netherlands, Spain, Germany, Switzerland and Belgium all adopted similar schemes which incorporated the aims as UK schemes (Arsenijevic & Groot 2017; Martin, et al. 2014). In recent years, Ireland developed their first national exercise referral framework to support such schemes in their country (Woods, et al. 2016). Although, there has been continual interest across many countries, there are still many questions regarding the effectiveness of exercise referral (Campbell, et al. 2015; Pavey, et al. 2011).

2.4.3 Exercise referral guidelines

2.4.3.1 PH54 Physical activity: exercise referral schemes

Several policies, guidelines and toolkits have been published over recent years which attempt to inform exercise providers on how to design and implement schemes in the UK. The most common and recent guidelines are the NICE, PH54: Physical Activity: Exercise Referral Schemes (NICE 2014, 2018). It is unknown whether exercise providers use these guidelines to support the delivery and implementation of schemes. It should be noted that these guidelines are purely guidelines, and are not enforced in any way.

These guidelines were designed to provide exercise providers, policy makers and commissioners with the evidence and support for the design, implementation and evaluation of schemes. However, these guidelines are broad and lack clarity for specific subpopulations and tailored exercise prescriptions (Oliver, et al. 2016; Shore, et al. 2019), especially in terms of the types, mode, intensity, frequency of exercise, length of schemes, and preferred measures of PA and specific health outcomes. Research should focus on providing insights of how schemes are delivered at present as this will fill the gap within the literature.

It could be argued that these guidelines are broad for a reason. Either previous research recommendations haven’t been met, or the evidence-base for the use of schemes hasn’t expanded. It could be argued that broad guidelines allow for exercise providers to develop schemes accordingly, which could lead to the development of a successful and effective scheme which could be replicated. With this in mind, examining best practice (incorporating the type, mode, intensity and frequency of exercise) within ERSs across the UK should be reviewed, however, with a lack of schemes mapped and compared, knowing which schemes are successful is unclear.

Within the national guidelines (NICE 2014; 2018), there are several research recommendations, which include examining the effectiveness of different types of ERS (including schemes characteristics, setting, intensity, duration, techniques used and populations) and factors which encourage uptake and adherence (reviewing the design, content, delivery and choice of activity). However, it is important to observe how schemes are currently being delivered, with a view of reviewing their effectiveness. Within the guidelines, effectiveness hasn't been defined. Again, this is vague, but potentially allows researchers to explore various aspects of effectiveness. If these research recommendations are met and the current state of exercise referral is explored, in theory, potential recommendations could be made to improve national guidelines based on new research and current practice.

The aims of this thesis assist with the research recommendations (NICE 2014); this thesis intends to provide insights into current practice by reviewing characteristics of schemes and examining the effectiveness of ERSs on PA levels. It is important to integrate these recommendations into a line of studies which could provide insightful information with an aim of informing future research and guidelines.

Although the guidelines can be updated, it is vitally important to ensure that exercise referral specialists have the correct additional training (accurate data collection, standardised evaluation methods, fidelity checks and implementing effective prescriptions), so that they can encourage long term behaviour change, increase PA and maximise health benefits, all whilst reducing the risk of drop out. With updated evidence, guidelines could provide schemes with clear direction, including the appropriate approaches to delivery, provide awareness of key characteristics of patients who are likely to drop out and advice on how to achieve optimal results within a prescription.

As well as discussing most recent exercise referral guidance, it is important to discuss previous guidance which may have contributed to the development of NICE guidelines (2014, 2018), starting with most recent.

2.4.3.2 BHFNC exercise referral toolkit

The toolkit designed by the British Heart Foundation National Centre (BHFNC 2010) was created to provide an optional practical guide for commissioners and scheme coordinators on the delivery and evaluation of ERSs across the UK (including health professionals, exercise professionals and researchers). The overall aim was to provide exercise professionals with a practical guide focusing on the delivery and evaluation of ERSs. This guidance addressed any issues from previous policies (NICE 2006) which were expressed by exercise specialists, with a focus of providing support on how to implement NICE guidance locally within schemes.

These guidelines suggest that ERSs usually take place in a leisure facility, and last 10-16 weeks for a subsidised cost. Within a mapping exercise, it was found that typical length of schemes in England, Scotland and Northern Ireland were 12 weeks (BHFNC 2010). This toolkit provides vital evidence for 150 schemes, which provided recommendations for future practice. Results found that various delivery methods were employed across schemes; operational structures differed (schemes operating over several sites); and standards varied scheme to scheme. Typical prescriptions were 12 weeks in length, consisted of gym based sessions, and were conducted predominately in a local authority leisure facility. This mapping exercise uncovered that there were significantly smaller number of schemes, compared to previous estimations (Pavey, et al. 2011). This exercise was a snapshot of the nature and extent of ERSs in England, Scotland and Northern Ireland during 2006-2008. This snapshot of schemes is over 10 years old, therefore, there requires an update to this mapping exercise providing details on key characteristics of schemes.

Historically, evaluation of exercise programmes was not reported, but within a short amount of time there was a considerable increase in evaluation of sport, PA and exercise programmes (Varney, et al. 2018). However, these guidelines do suggest that most ERSs in the UK carry out limited evaluation; historically, evaluation was not conducted (Varney, et al. 2018). This gives little scope for comparison between schemes, which may be due to the varied measures used to evaluate outcomes. Improving evaluation is key, by providing more vigorous evaluations across schemes, however, little advice is given within the toolkit on how to achieve this.

2.4.3.3 Rapid review of exercise referral schemes to promote activity in adults

An earlier review of ERSs was conducted and published by NICE in 2006. This review was for primary care professionals, policy makers, commissioners and exercise referral specialists. It was specifically aimed at those who commissioned, developed, managed and delivered schemes across the UK (NICE 2006). The guidelines suggest that ERSs should consist of an assessment by a primary care professional to determine if someone is inactive (and possibly not meeting the recommended levels for PA); provide a referral to a local scheme; conduct an assessment to determine the content of the prescription; and an opportunity to participate in an exercise prescription. The guidelines were not developed to include the management or rehabilitation of cardiac and pulmonary conditions. The guidelines do not contain in-depth information about what the key characteristics of schemes should be, therefore lacking information which may be vital for setting up an effective scheme.

Some key recommendations for future research included examining the effectiveness of ERSs in people with multiple health conditions; the effects of ERSs in people with mental health conditions; the effectiveness of ERSs in providing increases in PA; guidance about different types and models of ERS, and for whom they are most effective; and how to encourage participation, and prevent or reduce risk of dropout.

2.4.3.4 National Quality Assurance Framework

The first policy which was published back in 2001, with the aim to improve the quality of ERSs, was the National Quality Assurance Framework (NQAF:

Department of Health 2001). The main purpose of this policy was to provide guidance on exercise referral systems, with a focus on improving exercise referral standards among schemes, and assist with the development of new schemes. The report set out quality standards which schemes should adhere to, including how to evaluate schemes. Since then, there has been many more developments in policies to guide ERSs across UK; these developments include:

- Register of Exercise Professionals (REPs) and recognised categories of registration for fitness professionals (2002).
- Review of existing evidence by NICE: A rapid review of exercise referral schemes to promote activity in adults (2006).
- Clarification issues by Department of Health (2007).
- Best practice guide (National Exercise Referral Scheme 2010).
- The British Heart Foundation National Centre for Physical Activity and Health toolkit (BHFNC Toolkit 2010).
- Improved referral pathways between referrers and schemes.
- Development of the physical activity: exercise referral schemes [PH54] by NICE (2014).
- Recent consultation from NICE: 2018 surveillance of physical activity: exercise referral schemes (NICE 2018).

The following sections will provide an overview of the referral process. Different aspects of ERSs will be discussed which are important to the design and implementation of schemes.

2.4.4 The exercise referral process

2.4.4.1 The typical process

Even though models may vary, referrals are typically made by primary care health professionals (such as GPs, nurses, condition-specific specialists). The typical exercise referral process can be seen in figure 1, which has been developed to provide a representation of the typical process. There are set inclusion (appendix 4) and exclusion criteria (appendix 5), and complete contraindications (appendix 6) that the health care professional should adhere to when referring a patient to an ERS, which can be found within the NICE guidelines (NICE 2014). However, these guidelines, as discussed in the previous section, are broad, so it is difficult to suggest whether it really is important or not for providers to follow them.

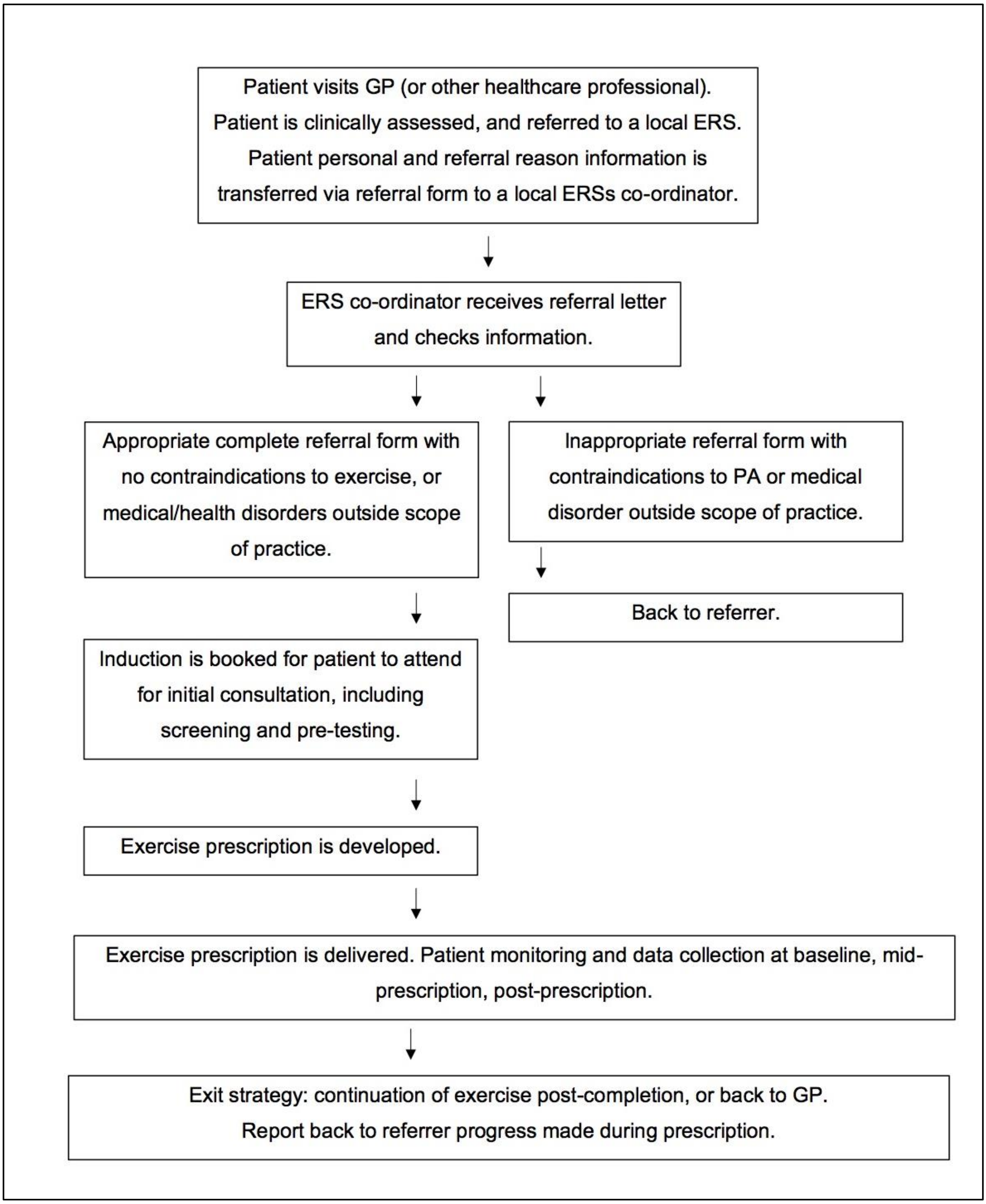


Figure 1. The Exercise Referral Process.

For those who do meet the inclusion criteria, ERSs provide patients with an opportunity to engage in a structured prescription of exercise within a leisure environment. The referral form from primary care is sent to third-party service providers (such as exercise referral specialists), usually situated in leisure centres, gyms, community centres/halls and other leisure facilities. Most referrals are sent electronically, but some are still posted to exercise providers.

2.4.4.2 Outcome measures used within exercise referral

A typical referral process would operate following the process in figure 1. There are several measures used throughout the process. Once receiving the referral form from the health care professional, the exercise referral specialist would contact the patient to book an induction meeting at the leisure facility. During this induction, the patient would typically undergo a series of screening and pre-testing to determine a baseline. The BHFNC exercise referral toolkit suggests that exercise referral specialists should measure BP, BMI and waist circumference, along with other relevant measures that are 'appropriate to the client' (BHFNC 2010).

2.4.4.2.1 Physical activity readiness questionnaire

Typically, the patient would complete a self-report PA readiness questionnaire (PAR-Q: see appendix 7: Cardinal, et al. 1996), which states whether they are ready to participate within an exercise prescription (however, not all exercise referral specialists may use this questionnaire or any questionnaire of this kind).

2.4.4.2.2 Informed consent and medical history

During the initial consultation, the patient must provide informed consent to participate within an ERS. The patient must also provide a full medical history, which includes a list of health conditions, injuries and illnesses, along with a list of any medication they are currently taking.

The following measures are usually taken at baseline and completion.

2.4.4.2.3 Blood pressure

Usually, blood pressure is one of the baseline measures used, and then repeated upon completion. Systolic blood pressure (SBP) is known as the highest level of BP; when the heart beats and contracts to pump blood away from the heart and through the arteries. Diastolic blood pressure (DBP) is the lowest level of BP, when the heart relaxes between beats, and blood is pumped back towards the heart (BHF 2019). Normal BP is below 120/80 mmHg; 120 represents the SBP, and 80 represents the DBP (American Heart Association 2017; BHF 2019). BP is typically measured by exercise referral specialists using an electronic BP monitor, also known as an electronic sphygmomanometer; this is connected to an inflatable cuff which is wrapped around a patient's upper arm. According to BHF (2019) BP is categorised as the following:

- Low BP: SBP <90mmHg, DBP <60 mmHg.
- Normal BP: SBP <140mmHg, DBP, <90 mmHg.
- High BP: SBP between 140 – 190 mmHg, DBP between 90 – 110 mmHg.
- Severe hypertension (severe high BP): SBP >180mmHg, DBP >110mmHg.

2.4.4.2.4 Body weight

The patients' body weight is typically measured by standing on electronic scales which measures weight in kilograms (kg).

2.4.4.2.5 Body mass index

BMI is used to assess weight in relative to height, and is calculated by dividing body weight (kg) by height (metres) squared ($kg.m^{-2}$; American College of Sports Medicine 2013). Although BMI does not distinguish between bone, muscle mass and body fat. Categories of BMI (American College of Sports Medicine 2013) can be seen in table 1.

Table 1. Classification of body mass index.

Categories	**BMI ($kg.m^{-2}$)**
Underweight	<18.5
Normal	18.5-24.9
Overweight	25.0-29.9
Obese (class 1)	30.0-34.9
Obese (class 2)	35.0-39.9
Obese (class 3)	>40

2.4.4.2.6 International Physical Activity Questionnaire

The International Physical Activity Questionnaire (IPAQ) is a questionnaire which measures self-reported PA. IPAQ-short form contains 7 open-ended items surrounding the patients' last 7-day recall of PA (see appendix 3). Items are structured to provide scoring on walking, moderate-intensity, vigorous-intensity activity, and sitting. The IPAQ assesses PA undertaken across a comprehensive set of domains which include: leisure time PA, work-related PA, transport-related PA, domestic and gardening activities. An example item from the scale is: *during the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast cycling?* This questionnaire was designed for observational research, and its test-retest reliability indicated good stability and high reliability (α <.80), along with concurrent validity (Craig, et al. 2003; Lee, et al. 2011).

There are two types of scoring within the IPAQ. The continuous data is MET-minutes. Due to the non-normal distribution of energy expenditure in participants, it has been suggested that continuous indicators to be presented as median MET-minutes. One measure of volume of PA can be computed by weighting each type of activity by its energy requirements defined as METS. A metabolic equivalent of task (MET) is the ratio of the rate of energy expended during an activity to the rate of energy expended at rest (Nelson, et al. 2007). A MET is a unit of energy expenditure and by calculating MET-minutes, can track the amount of PA an individual is doing per week (Ainsworth, et al. 2011). MET-minute is equivalent to kilocalories for a person of 60 kilograms.

There are three categorical levels of PA scoring to classify populations through the IPAQ: ‘low’, ‘moderate’ and ‘high’. Criteria set for each of the levels consider each question asked on the IPAQ form (Craig, et al. 2003). The ‘high’ category describes high levels of PA participation; either >1500 MET-minutes per week (consisting of vigorous activity on at least 3 days), or >3000 MET-minutes per week (consisting of any combination of activities across 7 days). This provides a higher threshold of measures of total PA, and is useful to examine population variation. The ‘moderate’ category defines an individual as participating in some activity, more than those in the ‘low’ category (600 to 1499 MET-minutes per week). Those in the ‘low’ category do up to at least half an hour moderate-intensity PA most days (0 to 599 MET-minutes per week). Individuals in the ‘low’ category are not meeting any criteria from the ‘high’ or ‘moderate’ categories, and are not participating in any regular PA.

Undertaking regular PA is the key concept in national and global PA guidelines (CMO 2018, 2019; NICE 2014, 2018; Pate, et al. 1995; PHE 2017). The IPAQ analysis algorithms include both total volume and number of days or sessions an individual undertakes, which can review whether regular PA is apparent.

2.4.4.3 Schemes’ characteristics

Upon completion of the screening and pre-testing, the exercise referral specialist then designs a prescription to suit the patient’s requirements. However, understanding how this is done hasn’t been reviewed extensively. Potentially, exercise referral specialists would base the prescription on referral reason, current health conditions and personal preference to exercise, however this is still unknown.

Schemes tend to last for twelve weeks (Pavey, et al. 2011; Rowley, et al. 2018; Woods, et al. 2016), however there is flexibility in length, with other schemes lasting anywhere between 10-16 weeks (BHFNC 2010). Patients normally attend hourly sessions on a weekly basis (Pavey, et al. 2012; Stathi, et al. 2004). Usually, patients attend sessions within a leisure environment such as a gym or fitness studio, however, more recently, different methods of exercise are being used (Pavey, et al. 2012; Queen, et al. 2015; Stathi, et al. 2004; Tobi, et al. 2012). Some schemes are offered at a subsidised cost (Morgan, et al. 2016; Tobi, et al. 2012), but this depends on funding, otherwise the patient would be expected to pay for each session they attend according to the prices charged by the leisure facility.

2.4.4.4 Schemes' variations

The process described in chapter 2, section 2.4.4.1, is how a typical ERS would operate; however, it should be noted that not all will do so, nor is there accepted evidence-based standards that suggest they should follow this process. Due to the lack of clarity from current exercise referral guidelines, schemes may implement schemes that differ from others. Due to no standardised implementation process, there are variations in measures, processes and schemes; the heterogeneity of schemes and data collection varies greatly (Shore, et al. 2019), which could potentially impact the effectiveness of schemes.

2.4.4.5 The National Referall Database

Current exercise referral guidelines do not provide support on how to collect and store exercise referral data; this again may vary by scheme. Up until 2016, there was no national database where data could be stored and used for research. The NRD was designed to provide a platform for exercise referral specialists to upload exercise referral data, based upon the data captured using the ReferAll system. The database is currently used by ReferAll customers who pay a fee to use the database. At present ReferAll has approximately 120,000 patients (from approximately 69 schemes, as of September 2019) in the system, but the NRD has not been updated with all those as of yet. The NRD provides data from exercise referral providers which could support a large-scale review of ERSs, which has never been done before. Further details of the NRD and the cut of data used within this thesis can be seen in chapter 4, section 4.2.

This database will be examined within this thesis to provide insights into current practice. This could potentially provide insights into the key characteristics that make up schemes, which could inform researchers and practitioners of whats going on within ERSs at present. There is a lack of evidence of how exercise referral specialists collect and store data across the UK, however, there has been no evidence of a national database previously, which could potentially provide a platform for all schemes to utilise.

The typical ERS process has been discussed, now it is important to discuss the qualifications required to be an exercise referral specialist.

2.4.5 Exercise referral qualifications

Exercise providers who work within schemes, should have a minimum qualification, Level 3 exercise referral specialist qualification. This qualification provides training on how to design and develop an ERS. The qualification is made up of an anatomy and physiology theory assessment, exercise referral theory assessment, completion of a case study and an exercise referral practical assessment. The modules include professional practice (how to design a scheme, code of ethics, patient selection and monitoring and evaluation), understanding of health conditions patients are referred with (consisting of a wide range of conditions: CV, MSK, MH and metabolic), initial consultation and screening (assessment measures), changing behaviour, barriers to participation (models of behaviour change), exercise counselling and communication, and planning, delivering and evaluating programmes (Rackley 2013).

During the training, the trainee acquires the knowledge of various health conditions which patients may be referred with (including specific signs and symptoms, pathophysiology, risk factors, medical intervention, side effects, lifestyle interventions, benefits of exercise, exercise considerations, risks and restrictions). This module is brief but covers approximately 15 health conditions over 3-4 weekends (along with long distance learning). Through practical elements, limited information on the types/modes of exercise to use with specific populations is given; however, there isn’t sufficient evidence to provide an optimal programme of exercise suited for each health condition, which requires further research.

The training covers the development of exercise prescriptions, using various training principles (taken from Level 3 personal training- a pre-requisite to this qualification). Trainees are encouraged to monitor patients on a regular basis, encouraging patients to keep a weekly self-report training diary. There is a lack of information provided on specific measures which should be reviewed, apart from resting BP, BMI, waist circumference, and measures relevant to the client (BHFNC 2010). This qualification is specifically designed for specialists in the UK and is approved by Register of Exercise Professionals (Rackley 2013). Some exercise referral specialists may have further qualifications, but the minimum requirement to work within exercise referral is Level 3 exercise referral specialist qualification.

The next section will explain various aspects of ERSs which are important to the design and implementation of schemes; these include length of schemes and activities offered on ERSs.

2.4.6 Length of schemes

There is a lack of clarity over the optimal length of scheme which provides effective change in PA and health outcomes. Length of schemes vary, but typically last between 8-12 weeks (BHFNC 2010; Pavey, et al. 2011; Webb, et al. 2016; Woods, et al. 2016), with some schemes continuing for up to 26 weeks (James, et al .2009; Tobi, et al. 2012). However, length of scheme is not clearly defined within guidelines (NICE 2014, 2018), so exercise referral specialists may opt for a different length of scheme.

When deciding on length of scheme, there are many variables an exercise referral specialist must consider, including:

- Potential funding to cover the length of scheme
- Current demand for the scheme
- Exercise referral specialists' capacity
- Locations' capacity
- Cost of participation (sometimes this is subsidised, but not always) for the patient.

The lack of clarity of the most beneficial length of scheme provides issues when examining schemes on a national level. Providing support for scheme's effectiveness and cost-effectiveness has been an issue due to the heterogeneity within schemes. Although, it does provide researchers with the opportunity to examine various lengths of schemes upon health and PA outcomes.

One length of scheme will not suit all patients. It could be that schemes need to be adaptable depending on the health condition a patient is referred with. For example, for individuals referred with a cardiovascular condition, an 8-week prescription provided them with significant decreases in BP (Webb, et al. 2016). Whereas patients referred with MH conditions, did not see statistically significant improvements in physiological and psychological outcomes within 8 weeks (Chalder, et al. 2012). There needs to be a degree of flexibility within length of schemes depending on the health condition referred with, however, a standardised approach to delivery is required, allowing for all schemes to adjust length dependant on the condition referred with.

Longer length schemes are associated with improved health outcomes (Mills, et al. 2013; Tobi, et al. 2012), and offer the patient an opportunity to gain long-term benefits of exercise (Gallegos-Carrillo, et al. 2014; Hanson, et al. 2013; James, et al. 2009; Mills, et al. 2013; Rowley, et al. 2018; Tobi, et al. 2012). However, it could be argued that this is due to the prolonged length of time spent exercising. One aim of exercise referral is to promote regular exercise and increase PA levels. ERSs provide patients with an introduction to becoming physically active (BHFNC 2010), which could be supported by regular follow ups post-completion (3 months, 6 months, and 12 months later). Therefore, encouraging longer length schemes may be ineffective, as they can be time consuming for the exercise specialists, and daunting for inactive individuals who are new to exercising. Ideally, exercise referral should encourage patients to undertake regular exercise as part of their everyday life, along with improving/self-managing their health conditions. There are many factors which must be considered when deciding upon a suitable length for schemes.

This is a complex issue, but if all these factors could be reviewed, updated evidence could provide the ideal solution to developing an appropriate length to suit each patient, whether that's on an individual basis or an overall length for a scheme.

There are gaps within the literature at present that review common scheme lengths. The BHFNC reported that the common length was 12 weeks, however, this was over 10 years ago. Therefore, it is important to re-examine this to see if length has changed.

2.4.7 Type and mode of exercise

Schemes can offer a variety of activity, all varying in type and mode of exercise. The evidence base of these varied activities and participation rates are mixed (Duda, et al. 2014; Rowley, et al. 2018). Within one trial, when comparing three exercise referral interventions (exercise class, advice only condition, and instructor-led walking group), results showed that the walking group was more cost-effective and increased PA levels, compared to usual care for elderly women (Gusi, et al. 2008). Walking groups are a cost-effective method due to the lack of equipment required to carry out this task.

Some research examines sole modes of exercise, rather than comparing various modes. Littlecott, et al. (2014) examined aerobic exercise as a sole mode of exercise within exercise referral, with participants referred with CV and MH conditions. Results showed that there were improvements in adherence to exercise; however, this study used measures to examine psychological outcomes, rather than physiological outcomes relating to the health condition referred with. Also, those who participated within the aerobic-only prescription may not have made the physiological gains that they could potentially have made from resistance exercises. Prescriptions that are aerobic-only, may be less efficacious than combining with resistance exercises. Aerobic exercise alone can present many issues including reductions and loss of lean body mass, and any associated loss in resting metabolic rate per decade associated with normal ageing (Westcott, et al. 2009). Resistance exercises have plenty of benefits which can be coupled up with aerobic training (Phillips 2007; Shaw and Shaw 2005). At present, the most reported types of exercise offered within ERSs across the UK are:

- Instructor-led aerobic group exercise classes (Din, et al. 2015; Hanson, et al. 2013; Mills et al. 2013; Moore, et al. 2011).
- Gym-based, individual exercise sessions and group sessions (Anokye, et al. 2011; Duda, et al. 2014; Eynon, et al. 2016; Littlecott, et al. 2014; Livingston, et al. 2015; Murphy, et al. 2012; Queen, et al. 2015; Rouse, et al. 2011; Tobi, et al. 2012).
- Swimming sessions (Eynon, et al. 2016; Mills, et al. 2013; Tobi, et al. 2012).
- Walking groups (Tobi, et al. 2012).
- Home exercise sessions (Livingston, et al. 2015).

These have all been reviewed on an individual basis, but not within any comparative trials. Some of these types of exercise may be more, or less effective than others. These sessions are likely to differ in intensity, frequency and duration, along with the effort patients put into each session, which may translate into differences or not, in the effectiveness of the session. It could be argued that individual preference should also be taken into consideration when producing an exercise prescription (Coll-Planas, et al. 2019; Hanson, et al. 2013; Rouse, et al. 2011; Stathi, et al. 2004).

Previous research specifically examining patients referred with cardiovascular conditions, found that incorporating both resistance and aerobic exercises into one prescription can improve cardiovascular health (Meka, et al. 2008; Schjerve, et al. 2008); this is supported by further research conducted by Webb, et al. (2016) who observed an associated reduction in both systolic and diastolic BP, compared to a community-based exercise class and a continuously monitored exercise programme. However, further research is required to review specific changes in PA compared to baseline and health outcomes, in further detail.

NICE guidelines (2014, 2018) do not provide specific information on the key characteristics of schemes (most suitable type, mode, intensity, effort, load, frequency and duration of exercise), leaving exercise referral specialists to find other resources to aid the design and implementation of schemes. Therefore, research that reviews key characteristics is required to observe how schemes are designed and implemented within the UK.

At present, exercise referral specialists do not have sufficient guidelines of the best combinations of specific types, mode, intensity, frequency and durations of exercise, suitable to increase PA and improve health outcomes within exercise referral settings, for a variety of subpopulations. Guidelines do not provide sufficient information, due to the complexity of the task and the lack of evidence to support the specific prescriptions. Thus, being a huge gap within exercise referral literature.

2.4.8 Reasons for referral

There are various reasons for referral. NICE (2014) recommend set target populations which health care professionals should adhere to when referring individuals. However, there is a lack of clarity of the exact health condition categories for which people are referred. According to these guidelines, individuals have been collated into groups, when clarifying who would benefit from exercise on referral (NICE 2014, 2018). The categories are:

- Sedentary/inactive individuals who are otherwise healthy.
- Sedentary/inactive adults with an existing health condition or factors that put them at risk of ill-health.
- Ongoing management and rehabilitation of specific health conditions, including coronary heath disease, stroke, chronic obstructive pulmonary disease.

These categories do not specify the actual health conditions patients are referred with, therefore, health care professionals must decide themselves whether a patient would benefit from an exercise prescription. Along with the categories above, there are also sets of inclusion and exclusion criteria (and contraindications) which were discussed previously in section 2.4.4 (also, see appendices 2, 3 and 4). Each patient should meet this criterion before beginning an exercise prescription. It is vital for referring health care professionals to follow these guidelines to ensure the safety of patients, however, there is no legal requirement for health care professionals to follow these guidelines. The decision to refer a patient usually lies with the health care professional.

Patients are referred for various reasons, sometimes with more than one reason. ERSs have been successful for patients referred from specific health condition pathways such as cardiac rehabilitation (Dugdill, et al. 2005; Hanson, et al. 2013). Referrals of patients to ERSs with various health conditions have been observed on smaller scales, however there are gaps within the literature that review patients' referral reasons on a larger scale.

There is a lack of evidence to support tailored exercise prescriptions designed to suit a wide range of health conditions patients are referred with. There is a lack of evidence reviewing how exercise referral specialists tailor prescriptions to suit each patient they have contact with. Some of the health conditions patients are referred with can be seen in section 2.3, and more detailed review of referral reasons will be discussed in chapter 3. Exercise referral must be adapted to be as effective as possible for each patient referred. An aim for researchers who are trying to support the development of updated NICE guidelines is to, develop a set of exercise prescriptions which cover a wide range of health conditions, which provide the right level of exercise suited to the patient's characteristics, which provide the optimal health and PA outcomes. To begin with, it is important to understand what schemes are doing at present, before making suggestions which may already be implemented within schemes.

2.4.9 Adherence to exercise referral schemes

2.4.9.1 Definition of adherence

Reviewing adherence is arguably a vital area of interest for further development by exercise referral policy makers and commissioners. Adherence is defined in many ways, such as where participants who initially take part, continue to participate, typically until completion, or even post-completion (Pavey, et al. 2012); or to the extent which an individual's behaviour resembles the agreed referral (Slade, et al. 2016b). Adhering to schemes can depend on many factors (Leijon, et al. 2011), including:

- Length of the prescription.
- Duration and frequency of exercise sessions.
- Patients availability.
- Activities available through exercise referral.
- Patients' preference to exercise.
- Patients' motivation levels to change behaviour.

2.4.9.2 Differences between adherence and attendance

For the purpose of this thesis, it is important to distinguish between adherence and attendance. Typically, adherence is often measured by attendance, due to adherence being referred to as the percentage of sessions attended (Arsenijevic & Groot 2017; Pavey, et al. 2012; Shore, et al. 2019). Attendance alone does not indicate the effort and intensity level of the patient's activity, which would display whether the patient is benefiting from the exercise prescribed. Therefore, the association between adherence and attendance may be misleading when reviewing changes in outcomes. A recent systematic review found that there was a lack of reporting of adherence (Shore, et al. 2019); details of the exercise prescription and adherence were lacking. This is similar to results found within a systematic review (Gidlow, et al. 2005), which also found poor reporting of attendance and inadequate participant profiling. Various methods to measure adherence have been utilised; most commonly, attendance, both self-reported, and reported by the exercise provider (Arsenijevic & Groot 2017; Gidlow, et al. 2005; Pavey, et al. 2012; Shore, et al. 2019). There is a requirement for a valid and reliable measure to draw valid conclusions on adherence within ERSs (Slade, et al. 2016b); however, the feasibility may be low due to the complexity of adherence, and finding an appropriate measure that observes the effort patients put into the exercise activity, and whether they adhere to every session prescribed accurately.

2.4.9.3 Definition of dropout

Dropout is a negative impact on the effectiveness of exercise referral, where the patient is not-attending the prescribed sessions (Beedie, et al. 2016). Dropout is where an individual uptake in an activity and begins to adhere, but then decides to not continue until the end of the programme, failing to complete. Dropout is usually measured by exercise referral specialists recording when the patient does not attend. However, there is no clear protocol exercise referral specialists should follow to record and deal with dropout.

2.4.9.4 Factors affecting adherence

Adherence can depend on various complex factors. There are a multitude of factors which must be considered when reviewing adherence. Patients' characteristics play an important part in whether they will adhere or not. Patients who were seeking the referred and were actively referred, married, educated, and retained high levels of self-efficacy, were more likely to adhere to the exercise prescription (Conn, et al. 2002; Jackson, et al. 2005). Being actively referred would suggest that the patient wants to participate in an exercise prescription, rather than being advised to do it. In this case, it could be suggested that adherence may be influenced by the reason for why they are referred, rather than the scheme itself. Being married may provide motivation to participate, as there is support from a partner which has been found to increase motivation to adhere to exercise (Lord & Green 1995).

Morgan, et al. (2016) systematically reviewed adherence to exercise referral, and what commissioners needed to know about adherence. This systematic review assessed participants' views from 33 UK studies. Key facilitators of adherence were support from family, the exercise referral specialist and other attendees. Having the opportunity to pursue exercise post-scheme completion was an important facilitator to adherence (Crone 2002; Murphy, et al. 2012; Schmidt, et al. 2008; Wiles, et al. 2008). Timing of sessions was an important factor of adherence. Sessions were required to be convenient and not clash with other commitments such as work and childcare (Beers 2006; Hardcastle 2002; Mills, et al. 2008). Having the option of various activities were another facilitator, along with personalised sessions within a safe environment unaffected by the weather (Mills, et al. 2008; Stathi, et al. 2004; Wormald & Ingle 2004). Key barriers to attending included the cost of each of sessions, the location, dislike of the music played in the facility, and, the inconvenient timing of sessions (Beers 2006; Crone 2002; Hardcastle 2002; Mills, et al. 2008). These reviews provide important insights into key facilitators and barriers of adherence, although patients' characteristics were not examined. There may be an array of patients' characteristics which could compliment this research and provide further insights to predict the likelihood of dropout and completion.

Adherence increases in correlation with increasing age of the patient (Morgan, et al. 2016). Long-term adherence was the primary outcome of this study, similar to a study by Tobi, et al. (2012). It should not be presumed that factors that affect short-term adherence, also affect longer length schemes, therefore, this is an issue which has been addressed within this study. It was identified that older patients were more likely to adhere to longer-term schemes, as they were less time-constrained, valued social interaction and could incorporate exercise into lifestyles. One characteristic which was not included within this study was marital status; being married is more likely to increase and maintain adherence to exercise referral, due to the support given from the partner (Lord & Green 1995). PA levels were not reported at baseline and completion, so it is unknown whether PA levels changed. A major limitation of dropout which is not always reported upon, is whether the reasons for dropout were to continue with self-directed exercise. Exploring the reasons for dropout is important, to find out why a patient stops exercising or is it to continue further exercise through another mode.

Qualitative research examining the subjective experiences of exercise referral adherers (Eynon, et al. 2016), found that changes in motivation from extrinsic to intrinsic were common to participants who adhered. This could be due to the observed benefits participants were seeing within their own health outcomes and improved physical fitness. It was discovered that intrinsic motivation did not occur instantly to most participants, but rather after participants began to understand the value of exercise. Exercise identity was another common theme, suggesting participants showed increased self-efficacy within exercise settings and with the equipment used, along with increased self-esteem and self-regulatory strategies. If participants missed a session, they would try to rearrange, so they would not miss out on the benefits of participation. This research provides insights which are typically missed within quantitative research.

2.4.9.5 Uptake and adherence

Patients must uptake in an activity before they adhere to it. There is limited reflection of uptake and adherence of ERSs (Morgan 2005). This may be due to the extensive heterogeneity across exercise referral studies, and is typically not controlled for. Pavey, et al. (2012) conducted a systematic review which examined levels and predictors of exercise referral uptake and adherence. It was suggested that the effectiveness of exercise referral is manipulated by uptake and adherence, suggesting that identification of factors which influence uptake and adherence is required. A systematic approach was taken reviewing articles and found twenty-one studies which met inclusion criteria (Pavey, et al. 2012). Results found an extensive range of uptake (28-100%) and adherence (12-93%); there is variation in both uptake and adherence rates, which was related to the lack of standardised definitions, and the heterogeneity between the different methods of defining both uptake and adherence across studies. It was also found that schemes that offered less sessions, presented higher adherence rates (75-100%) than those with more sessions (Pavey, et al. 2012). This could be due to the commitment required to attend fewer sessions, compared to schemes with more sessions.

A more recent systematic review reported uptake ranging from 35% to 81% (Shore, et al. 2019), slightly less variation than Pavey, et al. (2012) found. Females and older adults were more likely to uptake. Attendance ranged from 12% to 49%, again the range was less than that previously reported (Pavey, et al. 2012). Shore, et al. (2019) found an elevated degree of statistical heterogeneity in levels of uptake and adherence across studies. This could be attributable to the various methods of referral, and the number of sessions offered, which was not controlled for. Referral by letter showed lower uptake than face-to-face consultations with a GP. There was no evidence of whether the patients' referrals were self-directed or advised upon by a health care professional; this could cause implications as people may act differently depending on who advised them or not, to participate within an exercise prescription.

2.4.9.6 Dropout

There are many factors that can affect dropout. Older adults who were unconscious of their cholesterol levels, assumed their health condition was uncontrollable, and were unemployed, were found to dropout (Cooper, et al. 1999). This research was conducted with patients referred with CV conditions and didn't involve other subpopulations. If a larger and varied sample were examined, results would vary.

Previous research predicting the likelihood of dropout found that specific health issues may be predictors of dropout (Kelly, et al. 2016; Leijon, et al. 2011). Sickness and pain were common reasons for non-adhering, causing dropout before completion (Leijon, et al. 2011). This provides support for the likelihood of dropout relating to health conditions and some patients' characteristics. With research of this kind, and future research examining key characteristics, this evidence needs to be translated into practice; providing key characteristics of patients who are predicted to dropout. At present, there is minimal research reviewing key patients' characteristics to predict dropout within a large dataset. Research examining dropout previously, have analysed small cohorts of patients (*n*=6894, Kelly, et al. 2016; Leijon, et al. 2011; *n*=1358; *n*=701, Tobi, et al. 2012), or the focus in studies being adherence rather than dropout (Crone, et al. 2008; Gidlow, et al. 2005; Hanson, et al. 2013; James, et al. 2009; Tobi, et al. 2012). It is important to review a larger cohort of participants to examine which patients' characteristics are key predictors of both dropout and completion; thus, then can be compared to the results from these smaller studies to see if there are any similarities in results.

2.5 Theory that underpins exercise referral

Public health interventions are typically based on theory. However, not all ERSs are grounded by theory. Due to the flexibility within exercise referral guidelines and lack of details of how schemes should be designed and implemented, some schemes implement a theoretical framework based on the self-determination theory (SDT; Deci & Ryan 1985). Typically, ERSs should be designed to increase the likelihood of long term behaviour change; through participation and completion of an exercise prescription, sedentary and physically inactive individuals become more physically active. PA is a multi-faceted behaviour predisposed to demographic, environmental, biological, cognitive, sociocultural, emotional factors (Bauman, et al. 2002). Consequently, individuals must face various barriers in both the adoption and maintenance of regular PA. Researchers have not overcome the most significant barriers to adherence, reflecting on intervention fidelity challenges, and decreased personalisation of exercise prescriptions when applied in group PA classes (Pavey, et al. 2012). Reflecting on national ERS guidelines, there is a lack of support for the use of behaviour change techniques (BCTs) or theory that underpins an ERS.

Along with the lack of information about BCTs within national guidelines, there is limited application of BCTs within ERSs which needs improving (Duda, et al. 2014; Howlett, et al. 2019). ERSs provide an ideal setting for ‘teachable moments’ which would act as a facilitator for behaviour change (Epiphaniou & Ogden 2010; Rosenstock 1964). Due to a lack of clarification of the use of specific techniques within the national guidelines, the use of BCTs within schemes is sporadic. A frequently used BCT is goal setting and use of social support (Howlett, et al. 2019); other BCTs which can be implemented within ERSs include diary keeping, action planning, motivational interviewing and problem solving, but there is a lack of evidence reviewing BCTs used on a national level. Previous research has found that there has been a lack of fidelity checks within PA interventions (Shore, et al. 2019), and that further development of fidelity checks is required to improve the standard of BCTs used within PA interventions (Howlett, et al. 2019).

More recently, behavioural science provides more insight into the development of interventions. Behavioural science focuses on the requirement to draw important distinctions between initial behaviour change and maintenance (Howlett, et al. 2019), which is reportedly harder to achieve (Kwasnicka, et al. 2016). Public Heath England published a strategy which recognises the importance of using behavioural science to address public health challenges (*Improving people's health: Applying behavioural and social sciences to improve population health and wellbeing in England*; Public Health England 2018b). This strategy acknowledges the need to use behavioural science in the development of an intervention, which was not used in the development of ERSs previously. When designing future ERSs, combining the Behaviour Change Taxonomy v1 (Michie, et al. 2012), COM-B model (capability, opportunity and motivation which affects behaviour) and the behaviour change wheel (Michie, et al. 2011; 2014) could improve the design, review and replication of schemes. By reviewing BCTs included within schemes, and the capability, opportunity, motivation of patients who are referred (including the intervention functions and policy categories), could improve the overall design, fidelity and replication of schemes. Unfortunately, there is limited evidence examining behavioural science used within ERSs. By examining elements of ERSs individually using behavioural science, small changes to each element could be made (changing length of scheme, training to exercise providers, exercise environment), which could support the redesign of ERSs completely.

However, some ERSs are grounded in some theory, the self-determination theory, but there is limited evidence to support its use within ERSs (Littlecott, et al. 2012). However, there is an abundance of evidence to support the use of SDT and PA/exercise behaviour change within exercise settings (Teixeira, et al. 2012). Research has suggested that SDT is an appropriate framework for reviewing the adherence and dropout in exercise perspectives (Frederick and Ryan 1995). This theory differentiates between three types of behavioral regulation with degrees of motivation; intrinsic, extrinsic and amotivation. An individual's intrinsic motivation may be due to a recent health scare, wanting to improve their fitness, see the improvement or rehabilitation of a health condition (Duda, et al. 2014). This can be seen as a relevant theory to base the development and design of a scheme upon, however not all schemes may embed theory within the design of a scheme. Duda, et al. (2014) compared a SDT-based ERS, with a standard ERS. Results showed that having SDT embedded within an exercise referral, increased self-reported MVPA by an extra nine minutes per week, compared to a standard ERS; however, was this really a meaningful change? Although changes was observed, nine minutes may not provide reason to suggest that this change was meaningful. There were no objective measures of PA within this study, which may provide a limitation due to biases of self-report as previously discussed. Another researcher examined a SDT-based ERS which found that those who scored high on the Hospital Anxiety and Depression Scale (HADS), had high scores for PA intentions (Rouse, et al. 2011), which could suggest that imbedding a psychological theory within an ERS, may increase PA intentions, which could potentially lead to increase PA, as long as there is no intention-action gap.

Although there is this wealth of literature to support the use of theory, there is research that also opposes against the purportedly greater effects of theory based interventions. Research has found that the effect sizes seen in PA interventions are meditated by current theory, but the effects tend to be very small (Rhodes, et al. 2020); this research also found that no one theory appears to be crucial for mediated effect compared to any other. Dalgetty, et al. (2019) found within a systematic review examining RCTs of behaviour change interventions, the use of theory was not associated with increased effectiveness. However, the same systematic review found that interventions based on SDT were associated with greater effectiveness for PA outcomes. Hagger & Weed (2019) suggests that theory based interventions are effective in change behaviour in real world contexts, however there needs to be more evidence on how to best implement them, and increased fidelity of interventions is required (Rhodes, et al. 2020).

When reviewing key characteristics of schemes, it is vital that theory is embedded within each, to influence the success of these theoretical mechanisms. Specific characteristics which could influence an individual's behaviour include length of schemes, environment in which the prescription is performed and training of exercise providers. Characteristics of schemes can influence whether an individual participates until completion. For example, longer length schemes could put individuals off, whereas shorter schemes may seem more appealing. The type of activity conducted or the environment the prescription is conducted in could also influence whether an individual completes their prescription.

2.6 Health care professionals' perceptions

At present, there is limited evidence examining health care professional's views of exercise referral. Even if the evidence base expanded, and guidelines were updated, if the referring health care professional does not believe in referring patients to exercise, then schemes will be under-utilised. Patients can be referred by a health care professional, or some schemes may have the option of self-referral.

The referrer's perceptions of exercise referral can play an important role in the patients' uptake and adherence to a scheme. A systematic review examining ERSs success in increasing PA levels of sedentary adults with long-term health conditions, found that success was sometimes reliant on the referrer's perceptions of the effectiveness of schemes (Williams, et al. 2007). Even though PA is beneficial for the prevention and management of many health conditions (Pavey, et al. 2011; Pederson & Denollet 2003; Pederson & Saltin 2015), some health care professionals may prefer to prescribe medication or refer the patient to see a specialist within a hospital setting. With the benefits of exercise and PA widely known, access to schemes still seems to be limited, with health care professionals lacking in awareness of exercise referral (Wormald & Ingle 2004). Wormald and Ingle (2004) displayed that schemes were beneficial in encouraging patients to take up long-term, unsupervised exercise to improve health outcomes. However, first impressions of the scheme made by the referring health care professional were critical in aiding adherence.

Health care professionals have been perceived to be receptive towards exercise referral. However, in Wales, when promoting a trial of ERSs throughout the country, it was comprehended as a challenge to promote exercise referral to newly employed health care professionals and referring GPs (Murphy, et al. 2010). This was partially due to professionals not completely understanding the process of exercise referral, and not knowing all the potential health gains which could be achieved through participation. For each referring GP surgery, referral rates varied, and was found that patients were influenced by GP's perceptions of the efficiency of schemes. GPs have great influence over the patient's decisions, with some patients who prefer a GP that acts as an authoritarian doctor (Byrne & Long 1976). Authoritarian doctors are both patient and doctor centered. If they believe that schemes are effective in improving health, then the patient will listen to the GP and are more likely to adhere. However, when it comes to referring patients to exercise referral, a patient centered approach may work best for improving health holistically, whilst having a joint agreement between GP and patient. By having this agreement, it may improve adherence to the scheme, due to the joint decision.

Some GPs have a biomedical traditional approach to care and believe that treating illness with medication is more effective than holistic methods (Roter 2000). However, with the new NHS long-term plan, there is an emphasis on using other methods to manage and treat health conditions. It is becoming more common for GPs to use wider holistic approaches to improve health with input from the patient (Alsonso 2004).

Researchers found that promotion of exercise and PA by GPs was not seen as priority during routine consultations (Darzi 2008; Graham, et al. 2005). With the recent NHS long-term plan (NHS 2019a), there is now more emphasis on using holistic methods to promote self-care management. Exercise referral is one way that could promote self-care management through exercise. Promoting this idea with referring health care professionals, may persuade them to refer more patients to exercise, which could potentially help towards reducing the burden on the NHS.

When a GP or health care professional endorsed exercise referral as being successful in managing, and improving health conditions, referral rates increased (Jackson, et al. 2005). Numerous long-term health conditions are diagnosed, monitored and treated by GPs and primary care health professionals; however, it has been discovered that 54% of patients found that their GP did not provide any guidance on exercise and diet (Darzi 2008). Research found that GPs were positive towards exercise, but presented low levels of confidence in prescribing or referring patients to exercise (Stanton, et al. 2015). This can implicate schemes, impacting referral rates. This could result in a number of issues including low uptake, low adherence, cuts to funded schemes, and under-utilised schemes. Low referral rates due to a GP's lack of confidence in prescribing exercise, may be due to a lack of understanding of the referral process. If GPs were made aware, and more involved in the exercise referral process, then this could initiate a better understanding of the schemes' benefits for patients and GP contact time.

Chapter 3:

Systematic Review -

The effects of exercise referral schemes within the UK in patients with cardiovascular, mental health, and musculoskeletal conditions

Chapter 3: Systematic Review- The effects of exercise referral schemes within the UK in patients with cardiovascular, mental health, and musculoskeletal conditions.

Presented in this chapter is a systematic review of the literature exploring the effects of exercise referral in those with cardiovascular, mental health and musculoskeletal conditions. The aim of this systematic review is to provide an update to the last major systematic review by Pavey, et al. (2011).

3.1 Introduction

3.1.1 Physical activity and exercise

As discussed in chapter 2, section 2.1, frequent PA and exercise are both acknowledged to be effective in the prevention, management and treatment of many chronic health conditions (Blumenthal, et al. 1999; Pavey, et al. 2011; Pederson & Denellet 2003; Pederson & Saltin 2015). PA has previously been described in section 2.1, as any bodily movement which is created by skeletal muscles that demands energy expenditure (WHO 2015, 2018). Whereas, exercise comprises of a succession of structured and repetitive physical activities, with the aim of maintaining or improving physical fitness (Caspersen, et al. 1985).

Issues relating to physical inactivity levels in the UK have been discussed within chapter 2, section 2.2. There has been a decrease in population PA levels, which has generated severe consequences for the population's health, resulting in an epidemic of NCDs (Pederson & Saltin 2015; PHE 2016b). There is now an international, escalating importance to promote healthier lifestyles and increased PA

(Ekelund, et al. 2016; Wanless 2004). The use of exercise referral may be one way to promote increased PA, and reduce physical inactivity in the UK.

3.1.2 Exercise referral schemes

As discussed in chapter 2, section 2.4, using exercise for the management and treatment of many chronic health conditions can be built into public health pathways via ERSs. A detailed description of ERSs and the exercise referral process have been provided in chapter 2, section 2.4.4. As discussed in chapter 2, section 2.5, the referring health care professional may not completely understand the benefits of referring patients to exercise, or understand the referral process, therefore, making schemes under-utilised.

Compared to other clinical exercise interventions, exercise referral operates differently, typically commissioned in non-clinical environments. For patients who have difficulties accessing hospitals or other clinical environments, these schemes can be advantageous due to their locality within the community. By making schemes widely available in the leisure environment, this could offer an alternative, and appealing choice to patients who may not live near a hospital. However, this may be disadvantageous to some, due to schemes often delivered in a leisure centre or gym environment, which were previously discovered as a barrier to adherence (Morgan, et al. 2016). For patients who have never used a gym previously, or for those who have had negative experiences within a gym environment, the thought of being referred to an ERS may be daunting. It is important to reduce any stigma relating to these negative opinions, so that patients do not feel intimidated by such an environment. It is important for the referring health care professionals to dispel any negative judgements on the environment, and to promote the individualised benefits of participation the patient will profit from. As previously mentioned in chapter 2, section 2.5, the health care professional can influence whether a patient enrols onto an exercise referral, therefore promoting the schemes is essential in primary care.

As previously discussed in chapter 2, section 2.4.4, exercise referrals' intended aims include increasing PA levels which can potentially produce positive impacts on health outcomes (NICE 2014, 2018). PA levels are measured differently from scheme to scheme. Within current guidelines (NICE 2014, 2018), there are no specific measures which are encouraged. There are many ways PA can be measured and recorded, with heterogeneity across schemes (Shore, et al. 2019). If guidelines were to provide support for specific measures, and how to collect data correctly, then a more standardised approach may be seen across schemes.

3.1.3 Length of schemes

Schemes habitually last 10-12 weeks within England and Ireland (Pavey, et al. 2011; Woods, et al. 2016). Within Wales, the National Exercise Referral Programme lasts 16 weeks, which has showed to be more cost-effective than schemes that conclude prior to this (Edwards, et al. 2013). NICE (2014, 2018) do not currently provide enough support or evidence to recommend a specific length of scheme. Without this support, exercise providers and commissioners could be implementing ineffective schemes due to the wrong length.

3.1.4 Type and mode of exercise

Evidence is typically mixed regarding the types of activities offered with schemes, and participation rates (Duda, et al. 2014). Quite often, one-to-one supervised, gym based exercise sessions, incorporating cardiovascular and resistance exercise are the common options (BHFNC 2010; Pavey, et al. 2011). Other activities include walking groups, group aerobic classes, chair based exercise and swimming (Pavey, et al. 2011). Within current guidelines (NICE 2014, 2018), there are no recommendations for the type/mode of exercise which should be encouraged. Therefore, future research should examine current approaches, then explore different types/modes of exercise which are effective for various subpopulations.

3.1.5 Reasons for referral

There are many reasons for referral. Health conditions can be categorised according to the ICD-10 Version: 2010 (Jette, et al. 2010), which include cardiovascular, metabolic, respiratory, musculoskeletal, mental health, digestive and behavioural disorders/conditions. A description of specific health conditions which will be highlighted throughout this thesis can be seen in chapter 2, section 2.3.

ERSs are often recommended for various health conditions including CV, MH, MSK conditions. Despite different aetiologies, symptoms and co-morbidities of these conditions, the effectiveness of ERSs have often been judged based upon their overall impact in populations undertaking them, as opposed to their effectiveness of those with specific conditions, or upon specific health outcomes (Pavey, et al. 2011). As such, there is a need to examine the effectiveness of ERSs in this regard.

Reviewing the effectiveness of ERSs in patients with specific health conditions and the outcomes from participation, could inform guidelines on the management and treatment of specific health conditions.

At present, the NHS is under pressure (Personal Social Services Research Unit 2017), and there is a real need for change within the organisation, which is supported by the newly published long-term plan (NHS 2019a). Referral of more patients into ERSs may have the potential to reduce this burden. The economic burden of specific health conditions and prevalence can be seen in chapter 2, section 2.3.

As noted, a lack of PA increases the risk of NCDs (BHF 2017a; PHE 2016). For many of those conditions, patients will often visit their GP as a first point of contact. If exercise can be used as a management and treatment tool to improve health conditions, then this could potentially impact GP visits and reduce them over time. It costs the NHS £242 per hour of patient contact (Personal Social Services Research Unit 2017); to put a patient through a 12-week exercise referral, costs approximately £225, less than one hour of patient contact. If ERSs are found to be effective in improving health outcomes, then the NHS could theoretically reduce money spent on GP contact time with patients and invest funds into referring patients to ERSs.

3.1.6 Health and physical activity outcome measures

At present, there is a lack of consistency in measures used to document health and PA outcomes. Current guidelines do not provide any support for specific measures. Without a recommended list of measures for specialists to use, dependant on what they measure, exercise referral specialists may not be measuring outcomes accurately. For example, there is a lack of standardisation for PA measures; by providing a standardised approach to measuring PA could be benefitical for the translation of evidence and replication of studies (Howlett, et al. 2019). With a lack of consistent measures, evidence to support ERSs is lacking greatly. By testing and analysing a set of measures for ERSs to implement, could provide more consistency in the data collected. However, this could may be difficult and time consuming, due to analysing all measures available (for PA and specific health outcomes), but would provide valuable results which could encourage the use of a toolkit of measures. Research should also review specific types/modes of exercise used across the UK; there is a lack of evidence observing current and best practice.

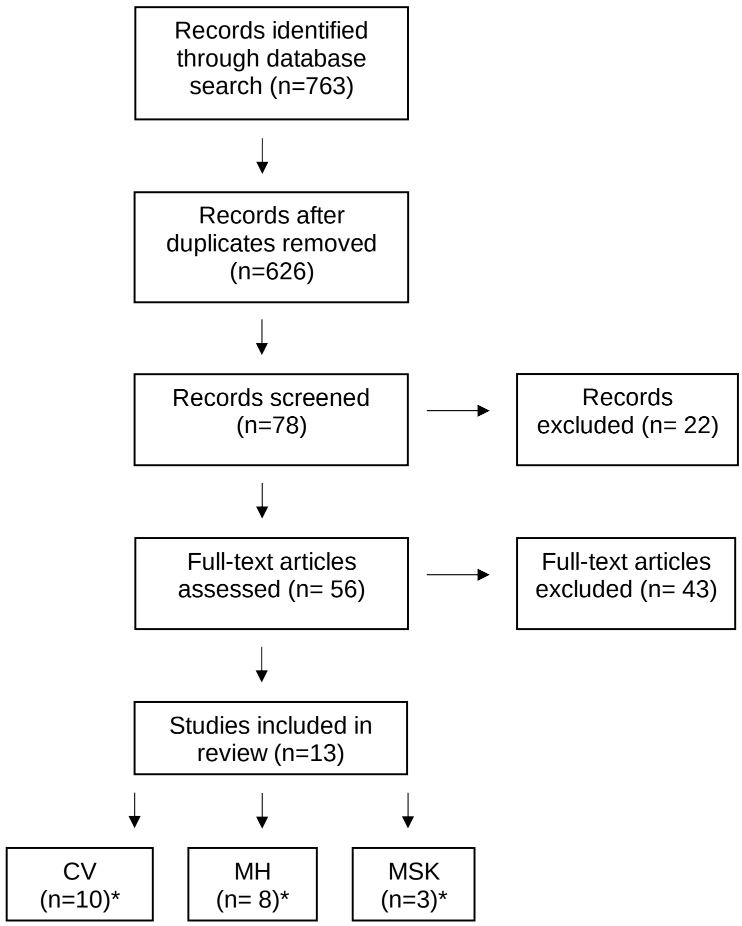
3.1.7 Current literature

There has been an amalgamation of reviews of ERSs published, with a focus on various constructs of the effectiveness of ERSs (Arsenijevic & Groot 2017; Gidlow, et al. 2005; Morgan 2005; Morgan, et al. 2016; Pavey, et al. 2011, 2012; Williams, et al. 2007). This body of work provides evidence that ERSs are thought of as an important method to increase PA, and reduce negative impacts of health conditions (Jones, et al. 2005). However, NICE (2014, 2018) have suggested that due to the varying nature of schemes, it is difficult to differentiate between effectiveness and acceptability of different types of schemes. The evidence to support the effectiveness of exercise referral is lacking due to inconsistencies within schemes, outcome measures, and comparability (NICE 2014, 2018). NICE suggested that this lack of evidence is a critical point for consideration, as there has been a lack of progress within research to increase the evidence base.

It has been suggested that exercise referral stakeholders, have conflicting and inconsistent views on the evidence which can influence funding opportunities (Henderson, et al. 2017; NICE 2014, 2018). A previous systematic review of the effects of exercise referral on PA and health outcomes, found that there was still uncertainty as to their effectiveness (Pavey, et al. 2011). Pavey et al. suggested that further research to separately report outcomes, and review health condition-specific populations. The current systematic review aims to meet these suggestions, with an update of research since 2011, to aid the advancements of NICE policy recommendations. Thus, the main aim of this systematic review is to examine the effects of ERSs in those with CV, MH, and MSK conditions within the UK.

3.2 Methods

This systematic review follows the guidelines set out by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, et al. 2015; PRISMA 2015). A PRISMA flow diagram can be seen in figure 2. Due to a lack of data available from each individual study, a meta-analysis was not deemed appropriate. Due to the range of outcomes considered from each of the studies, it was not appropriate to conduct a meta-analysis, therefore a systematic search and narrative synthesis of the studies' findings was used. Authors of each paper were contacted, however there was either a lack of response or authors were unable to provide the data. Therefore, a systematic review was conducted on the data which was available due to time constraints.



**Articles from the total article selection (n=14) are duplicated into more than one category due to the paper reviewing more than one disorder, e.g. CV and MH disorders).*

Figure 2: PRISMA flowchart detailing flow of studies through the review.

3.2.1 Search Strategy

This systematic review was based on a literature search in each of the following databases: Locate, PubMed, Scopus and Pro Quest: Public Health. To maximise the specificity, initial searches used "*exercise referral schemes*" and "*adherence*", along with sub-group specific words ("*cardiovascular*", "*mental health*", "*depression*", "*anxiety*", "*musculoskeletal*"). A title and abstract search was conducted primarily, with restrictions on publication dates (post January 2011 due to a previous systematic review (Pavey, et al. 2011) examining both CV and MH conditions sub-groups, and an open search for MSK conditions due to lack of research included in that review within this group; cut-off date December 2017). During the primary search of title and abstract, irrelevant titles and abstracts were ruled out. Articles reviewed ERSs specifically in the UK and were UK-based studies, due to the potential impact of this review influencing UK ERS policies and guidelines. During the next stage, remaining titles and abstracts were screened. During the final stage, full abstracts categorised as potentially eligible for inclusion were screened. Risk of bias criteria came from previous instruments which assessed the quality or risk of bias, which reduced any bias (Cochran, et al. 1954; Higgins, et al. 2011; Khan, et al. 2001; The Cochrane Collaboration 2011). ROBIS tool was used to assess the risk of bias within the systematic review (Whiting, et al. 2016); the interpretation of findings address all the concerns identified in domains 1 to 4 of the tool; the studies identified and their relevance to the research was appropriately considered; the reviewers involved avoided emphasizing results based on statistical significance.

The search strategy detected initially 763 potentially relevant articles within the literature search. In total, 137 duplicates were removed. From this, 78 articles were then screened due to their titles and abstracts being relevant, with then a further 64 excluded for not meeting inclusion criteria. A total of 56 articles were selected for further analysis by reading each full text. Of those, 13 studies were selected for inclusion (figure 2: flow of studies through search and screening).

3.2.2 Inclusion criteria

Papers which were included met the following conditions: (a) one of the main aims being prevention, observation, or decrease of ill-health (including (1) CV conditions, (2) MH conditions, and (3) MSK conditions); (b) participants were over the age of sixteen; (c) health conditions and their outcomes were reviewed; and, (d) UK based-ERSs, due to the potential of this study possibly influencing UK exercise referral policy. Studies were included regardless of the study design, as the primary aim was to provide an updated review of the ERS to inform policy and guidelines; (e) articles dated post-January 2011-December 2017.

3.2.3 Exclusion criteria

Papers were excluded if: (a) articles were not published in a peer-reviewed journal (annual reports, editorials, systematic reviews/meta-analyses, opinions and studies available only as abstracts were also excluded); (b) if participants were below the age of sixteen, as guidelines states patients referred must be over 16 years to participate within exercise referral (NICE 2014) and, (c) articles dated before January 2011.

3.3 Results

3.3.1 Characteristics of studies and results

Below, in tables 2-4, the characteristics and results from each of the studies are described and explained for CV, MH, and MSK conditions.

Table 2. Articles selected for review of ERS effects on (1) CV conditions.

Study	Design	Comparison	Time points	N, age (mean, SD)	Conditions	Length weeks	Prescription	Measures	Effect	Outcomes
Anokye, et al. 2011	Decision analytic model, Quantitative	Retrospective	Completion	*n*=701 40-60 years Mean age= 50 SD=n/a	**Cardiovascular** Mental health	12	Gym based, 2x weekly	QLAY	⇑ 51-88% cost-effective	ERS is associated with **modest increase in lifetime costs and benefits.** Cost-effectiveness of ERS is highly sensitive to small changes in the effectiveness. ERS cost is subject to **significant uncertainty** mainly due to limitations in clinical effectiveness evidence base.
Duda, et al. 2014	RCT, Quantitative	ERS SDT (*n*=184) vs. Standard ERS (*n*= 163)	Baseline 3 months 6 months	*n*=347 30-65+ Mean= n/a SD=n/a	**Cardiovascular** Mental health	10-12	Gym based, 2x weekly	7D PAR BP (mmHg) BMI (kg/m_2) Weight (kg) HADS anxiety HADS depression	$⇑_a$ 120 *** $⇔_a$ $⇓_a$ -0.24* $⇓_a$ -0.77* $⇓_a$ -0.24 $⇓_a$-0.47*	**Standard ERS:** No sig. changes in BP, but **reductions in weight and BMI** (reduced sig. at 6 months compared to baseline). 3 months' follow-up: **increase of 187 minutes** (from baseline) in self-reported moderate/vigorous PA. 6 months' follow-up**:** **increase of 120 minutes**. Sig. reduction in HADS depression scores, no sig. diff. in anxiety. **SDT-ERS**: 3 months' follow-up: **increase of 196 minutes** in self-reported moderate/vigorous PA compared to baseline. Sig. improvements in HADS anxiety and depression scores. 6 months' follow-up: No sig. diff. from baseline to 6 months' in BP, BMI or weight. **increase of 114 minutes** in self-reported moderate/vigorous PA. Sig reduction in HADs anxiety and depression.
Edwards, et al. 2013	RCT, Quantitative	Between time points	Baseline 6 months 12 months	*n*= 798 16+ years Mean= n/a SD= n/a	**Cardiovascular** Mental health	16	Gym based & exercise classes, 1-2 x weekly	EQ-5D Adherence	$⇑_a$ $⇑_a$	Participants with **risk of CHD**, were **more likely to adhere to the full programme** than those with mental health disorders/combination of mental health and risk of CHD. Those **living in areas of high deprivation were more likely to complete** the programme. Results of cost-effectiveness analyses suggest **NERS is cost saving** in fully adherent participants. Adherence at 16 weeks was 62%.
Hanson, et al. 2013	Observational cohort study, Quantitative	Between time points	Baseline 12 weeks Completion	*n*=2233 Mean=53 SD=15.9	**Cardiovascular**	24	Gym based sessions, 2x weekly	GLTEQ Adherence	$⇑_a$*** $⇑_a$***	ERS was **more successful for over 55s**, and **less successful for obese** participants. **Completers increased PA at 24 weeks**. Leisure site attended was a significant predictor of uptake and length of engagement. Uptake n=181, 12-week adherence n=968, 24-week adherence n=777.
Littlecott, et al. 2014	RCT, Quantitative	Between time points and ERS vs. usual care	Baseline 6 months 12 months	*n*= 2160 16-88 years Mean= n/a SD= n/a	**Cardiovascular** Mental health	16	Group aerobic sessions, 2x weekly	Adherence BREQ	$⇑_a$, $⇓_b$ $⇑_a$	**Improved adherence and improved psychosocial outcomes**. Significant intervention effects were found for autonomous motivation and social support for exercise at 6 months. No intervention effect was observed for self-efficacy. Greatest improvements in

										autonomous motivation observed among patients who were least active at baseline. **Individuals with CHD risk** in the control group **participated in more PA per week** than those in the intervention group with CHD risk factors.
Mills, et al. 2013	Observational cohort study, Mixed method	Prediction of completion	Baseline	*n*= 1315 31-68 years Mean=54 SD 12.4	**Cardiovascular**	26	Group, 1-to-1, gym, studio, swimming, 1-2 x weekly	BP (mmHg) Body mass (kg) Adherence	$\Downarrow_{a}$ 1.87*** $\Downarrow_{a}$ 3.541*** $\Uparrow_{a}$	**Increased confidence and self-esteem**. Link between age and attendance. **Increased age, increased likelihood of adherence**. 57% completed scheme, 33% achieved weight loss, 49% reduced BP. **Those with CVD, more likely to attend and adhere,** compared to pulmonary disorders.
Murphy, et al. 2012	RCT, Quantitative	ERS vs. usual care	12 months	*n*=2160 16-88 years Mean=52 SD=14.7	**Cardiovascular (*n*=1559)** Mental Health (*n*=522)	16	1-to-1, aerobic and resistance, 1-2 x weekly	7D PAR Adherence HADS depression HADS anxiety	$\Uparrow_{b}$ 1.19* $\Uparrow_{a,b}$ 1.46* $\Downarrow_{a}$ -0.71* $\Downarrow_{a}$ -0.54	**Increase PA observed** among those randomised to ERS intervention compared to usual care, and those referred with **CHD only**. For those referred for MH alone, or in combination with CHD, there were sig. lower levels of anxiety/depression, but no effect on PA.
Rouse, et al. 2011	Exploratory, Quantitative	SDT theory based programme	Baseline	*n*=347 Mean=50.4 SD=13.51	**Cardiovascular** Mental Health	12	Gym based sessions, 1x weekly	IOCQ BREQ-2 SVS HADS	$\Uparrow_{a}$ $\Uparrow_{a}$ 0.24 ** $\Uparrow_{a}$ 0.17 * $\Downarrow_{a}$ **	**Autonomy support increased intrinsic motivation**. Autonomous motivation was positively associated with vitality and PA intentions. Those who **scored high on HADS, had high scores for PA intentions**. Regression analyses revealed that the effects of autonomy support on mental health and PA intentions differed as a function of who provided the support (offspring, partner or physician), with the offspring having the weakest effects. Autonomy support and more autonomous regulations led to positive mental health outcomes.
Tobi, et al. 2012	Retrospective, Quantitative	Adherers vs. non-adherers	13 weeks Completion	*n*= 701 Mean age =46.4 SD=13.85	**Cardiovascular (*n*=111)** Musculoskeletal (orthopaedic *n*=164) Mental health (*n*=141) *Respiratory (n=34)* *Other (n=23)* *Metabolic (n=228)*	20-26	1-to-1, aerobic and resistance, 1-2 x weekly	Adherence (DV) BMI (kg/m_2) BP (mmHg)	$\Uparrow_{b}$ ** - -	**Longer term schemes increased adherence**. Longer-term adherence was found for increasing age and medical condition. **For every 10-year increase in age, the odds of people continuing exercise increased by 21.8%.** Participants referred with metabolic conditions were more likely to adhere than those with orthopaedic, CV and other disorders. **Longer-term schemes offer the opportunity to maintain adherence to exercise.**
Webb, et al. 2016	Evaluation, Quantitative	NERS vs. community-based exercise vs. continuously monitored exercise programme	Baseline Completion	*n*=107 Mean=44.6 SD=11.4	**Cardiovascular**	8	Group exercise sessions, 2x weekly	IPAQ (min/week) BMI (kg/m_2) Systolic BP (mmHg) Diastolic BP (mmHg) Adherence	$\Uparrow_{a,b}$ 540*** $\Downarrow_{a,b}$ 0.4+0.1** $\Downarrow_{a,b}$ -6.1+2.6* $\Downarrow_{a}$ -0.6+1.8	CV health benefits were observed in all three interventions. **CV health benefits achieved in laboratory based studies were achieved in ERS settings**. BMI had bigger reductions in NERS compared to the other two conditions. **Systolic BP and Diastolic BP were also reduced more in NERS** compared to the other two conditions.

									⇑b *	

CVD cardiovascular disease, CHD coronary heart disease, QALY quality adjusted life-year, 7D PAR 7-day physical activity recall scale, IPAQ international physical activity questionnaire, BMI body mass index, BP blood pressure, HADS hospital anxiety and depression scale, EQ-5D EuroQol 5 dimension, GLTEQ Godin leisure-time exercise questionnaire, BREQ-behavioural regulation in exercise questionnaire, SVS subjective vitality scale, IOCQ important other climate questionnaire.

⇓= reductions in scores, ⇑ = increase in scores, ⇔ no change.

a all comparisons are with baseline value -not available in the results

b all comparisons are with control ***p<0.001, ** p<0.01, * p<0.0

3.3.2 Results for CV conditions' sub group

All ten articles collected quantitative data. Four randomised controlled trials (RCTs) were included in the review for CV conditions. One RCT compared standard ERS to a self-determination theory (SDT)-based ERS (Duda, et al. 2014), two RCTs compared ERSs to usual care (Littlecott, et al. 2014; Murphy, et al. 2012), and one compared to baseline (Edwards, et al. 2013). A retrospective study reviewed the costs and benefits associated with ERS (Anokye, et al. 2011). Another study compared the characteristics of adherers and non-adherers (Tobi, et al. 2012). One observational cohort study (Hanson, et al. 2013) reviewed outcomes between time points: baseline, six months, and twelve months, whilst another examined the success of ERS to predict completion (Mills, et al. 2013). Another study used an exploratory approach to review the role of autonomy support upon entering ERSs (Rouse, et al. 2011). Whilst a final paper conducted an evaluation of ERSs compared to community-based exercise and a continuously-monitored exercise programme (Webb, et al. 2016).

3.3.2.1 CV condition-related outcomes

Four studies contained participants with coronary heart disease (CHD) or who were at increased CHD risk (Edwards, et al. 2013; Duda, et al. 2014; Littlecott, et al. 2014; Murphy, et al. 2012); six studies with CV disease or at increased risk of CV disease (Hanson, et al. 2013; Mills, et al. 2013; Rouse, et al. 2011; Tobi, et al. 2012; Webb, et al. 2016); and one study included participants with hypertension (Anokye, et al. 2011). Even though various designs were employed, BMI (kg/m_2) and body mass decreased (Duda, et al. 2014; Mills, et al. 2013; Webb, et al. 2016), with one study showing a significant difference of $0.24kg/m_2$ (p<0.05) compared to baseline

(Duda, et al. 2014). Webb, et al. (2016) found reductions in BMI compared to baseline and control. Mills, et al. (2013) did not report on BMI, but did report on body mass, finding significant reductions in body mass (p<0.001) compared to baseline, with 33.3% of participants achieving weight loss.

Both systolic and diastolic blood pressure was recorded in four studies (Duda, et al. 2014; Mills, et al. 2013; Tobi, et al. 2012; Webb, et al. 2016). Mills, et al. (2013) found significant reductions in BP compared to baseline (p<0.001), with 49% of participants reducing BP. Webb, et al. (2016) reported significant reductions in systolic BP and diastolic BP. Tobi, et al. (2012) did not report on BP findings. BP was not reduced, compared to baseline within one study (Duda, et al. 2014).

BMI was also reported to have significantly reduced at 6 months, compared to baseline, however clinically, this reduction was only small (Duda, et al. 2014).

3.3.2.2 Physical activity outcomes

Compared to baseline, two of the four RCTs showed increased 7-day physical activity recall (7D PAR) scores (Duda, et al. 2014; Murphy, et al. 2012), with two of these studies reporting significant increases (p<0.001). One study showed a significant increase (p<0.05) compared to control (Murphy, et al. 2012). Murphy, et al. (2012) found significant increase in 7D PAR compared to usual care. More standard ERSs compared to a SDT-based ERS found that both schemes significantly improved self-reported PA, with no significant difference between the two conditions (Duda, et al. 2014).

3.3.2.3 Adherence

Seven out of ten studies recorded PA adherence (defined as the number of participants who attended the whole exercise prescription) to the exercise referral programme. Compared to baseline, adherence to PA prescribed increased in every study. Hanson, et al. (2013) reported significant differences (p<0.001) along with Murphy, et al. (2012) and Webb, et al. (2016) showing significant differences (p<0.05), and Tobi, et al. (2012) also having a significant difference (p<0.01). Littlecott, et al. (2014) found increased adherence to the prescription compared to baseline, but not compared to usual care.

3.3.2.4 Duration and mode/type of exercise

Scheme's duration was either 8-12 weeks (Anokye, et al. 2011; Duda, et al. 2014; Rouse, et al. 2011; Webb, et al. 2016), 16 weeks (Edwards, et al. 2013; Littlecott, et al. 2014; Murphy, et al. 2012) or 20-26 weeks (Hanson, et al. 2013; Mills, et al. 2013; Tobi, et al. 2012), consisting of a prescription of 1-2 exercise sessions per week. Nine studies utilised one-to-one gym based PA as their main mode of exercise, consisting of both cardiovascular and resistance exercise. Two studies utilised group based aerobic exercise sessions (Mills, et al. 2013; Webb, et al. 2016), along with other forms of PA including swimming and exercise based in a studio setting (Mills, et al. 2013).

Table 3. Articles selected for review of ERS effects on (2) MH conditions.

Study	Design	Comparison	Time points	N, age (mean, SD)	Conditions	Length (weeks)	Prescription	Measures	Effect	Outcomes
Anokye, et al. 2011	Decision analytic model, Quantitative	Retrospective	Completion	*n*=701 40-60 years Mean age= 50 SD=n/a	**Mental health** Cardiovascular	12	Gym based, 2x weekly	QLAY	$\Uparrow$ 51-88% cost-effective	ERS is associated with **modest increase in lifetime costs and benefits.** Cost-effectiveness of ERS is highly sensitive to small changes in the effectiveness. ERS cost is subject to **significant uncertainty** mainly due to limitations in clinical effectiveness evidence base.
Chalder, et al. 2012	RCT, Quantitative	ERS vs. usual care	Baseline 4 months 8 months 12 months	*n*= 361 18-69 years Mean=40.9 SD=12.5	**Mental health**	8	Group aerobic classes, 1-4x weekly	BDI 7D PAR	$\Downarrow_{a,\,b}$ -0.54 p=0.68 $\Uparrow_{a,\,b}$ p=0.08	**Increased PA, improved mood**. **No reduction in antidepressant** use in ERS group. A mean 7.2 (SD 4.1) sessions was completed. **More people reported increased PA at the follow up in ERS,** than those in usual care.
Duda, et al. 2014	RCT, Quantitative	ERS SDT (*n*=184) vs. Standard ERS (*n*= 163)	Baseline 3 months 6 months	*n*=347 30-65+ Mean= n/a SD=n/a	**Mental health** Cardiovascular	10-12	Gym based, 2x weekly	7D PAR BP (mmHg) BMI (kg/m^2) Weight (kg) HADS anxiety HADS depression	$\Uparrow_{a}$ 120 *** $\Leftrightarrow_{a}$ $\Downarrow_{a}$ -0.24* $\Downarrow_{a}$ -0.77* $\Downarrow_{a}$ -0.24 $\Downarrow_{a}$-0.47*	**Standard ERS:** No sig. changes in BP, but **reductions in weight and BMI** (reduced sig. at 6 months compared to baseline). 3 months' follow-up: **increase of 187 minutes** (from baseline) in self-reported moderate/vigorous PA. 6 months' follow-up**: increase of 120 minutes**. Sig. reduction in HADS depression scores, no sig. diff. in anxiety. **SDT-ERS**: 3 months' follow-up: **increase of 196 minutes** in self-reported moderate/vigorous PA compared to baseline. Sig. improvements in HADS anxiety and depression scores. 6 months' follow-up: No sig. diff. from baseline to 6 months' in BP, BMI or weight. **increase of 114 minutes** in self-reported moderate/vigorous PA. Sig reduction in HADs anxiety and depression.
Edwards, et al. 2013	RCT, Quantitative	Between time points	Baseline 6 months 12 months	*n*= 798 16+ years Mean= n/a SD= n/a	**Mental health** Cardiovascular	16	Gym based & exercise classes, 1-2 x weekly	EQ-5D Adherence	$\Uparrow_{a}$ $\Uparrow_{a}$	Participants with **risk of CHD**, were **more likely to adhere to the full programme** than those with mental health conditions/combination of mental health and risk of CHD. Those **living in areas of high deprivation were more likely to complete** the programme. Results of cost-effectiveness analyses suggest **NERS is cost saving** in fully adherent participants. Adherence at 16 weeks was 62%.
Littlecott, et al. 2014	RCT, Quantitative	ERS (*n*=1080) vs. control (*n*=1080)	Baseline 6 months 12 months	*n*= 2160 16-88 years Mean= n/a	**Mental health** Cardiovascular	16	Group aerobic sessions, 2x weekly	Adherence BREQ	$\Uparrow_{a}$, $\Downarrow_{b}$ $\Uparrow_{a}$	**Improved adherence and improved psychosocial outcomes**. Significant intervention effects were found for autonomous motivation and social support for exercise at 6

				SD= n/a						months. No intervention effect was observed for self-efficacy. Greatest improvements in autonomous motivation observed among patients who were least active at baseline. **Individuals with CHD risk** in the control group **participated in more PA per week** than those in the intervention group with CHD risk factors.
Murphy, et al. 2012	RCT, Quantitative	ERS vs. usual care	12 months	*n*=2160 16-88 years Mean=52 SD=14.7	**Mental Health (*n*=522)** Cardiovascular (*n*=1559)	16	1-to-1, aerobic and resistance, 1-2 x weekly	7D PAR Adherence HADS depression HADS anxiety	⇑$_b$ 1.19* ⇑$_{a,\ b}$ 1.46* ⇓$_a$ -0.71* ⇓$_a$ -0.54	**Increase PA observed** among those randomised to ERS intervention compared to usual care, and those referred with **CHD only**. For those referred for MH alone, or in combination with CHD, there were sig. lower levels of anxiety/depression, but no effect on PA.
Rouse, et al. 2011	Exploratory, Quantitative	SDT theory based programme	Baseline	*n*=347 Mean=50.4 SD=13.51	**Mental Health** Cardiovascular	12	Gym based sessions, 1x weekly	IOCQ BREQ-2 SVS HADS	⇑$_a$ ⇑$_a$ 0.24 ** ⇑$_a$ 0.17 * ⇓$_a$ **	**Autonomy support increased intrinsic motivation**. Autonomous motivation was positively associated with vitality and PA intentions. Those who **scored high on HADS, had high scores for PA intentions**. Regression analyses revealed that the effects of autonomy support on mental health and PA intentions differed as a function of who provided the support (offspring, partner or physician), with the offspring having the weakest effects. Autonomy support and more autonomous regulations led to positive mental health outcomes.
Tobi, et al. 2012	Retrospective, Quantitative	Adherers vs. non-adherers	13 weeks Completion	*n*= 701 Mean=46.4 SD= 13.85	**Mental health (*n*=141)** Musculoskeletal /orthopaedic (*n*=164) Cardiovascular (*n*=111) *Respiratory (n=34)* *Other (n=23)* *Metabolic (n=228)*	20-26	1-to-1, aerobic and resistance, 1-2 x weekly	Adherence (DV) BMI (kg/m$_2$) BP (mmHg)	⇑$_b$ ** - -	**Longer term schemes increased adherence**. Longer-term adherence was found for increasing age and medical condition. **For every 10-year increase in age, the odds of people continuing exercise increased by 21.8%.** Participants referred with metabolic conditions were more likely to adhere than those with orthopaedic, CV and other disorders. **Longer-term schemes offer the opportunity to maintain adherence to exercise.**

CVD cardiovascular disease, CHD coronary heart disease, BDI Beck depression inventory, QALY quality adjusted life-year, 7D PAR 7-day physical activity recall scale, IPAQ international physical activity questionnaire, GPPAQ general practice physical activity questionnaire, BMI body mass index, BP blood pressure, HADS hospital anxiety and depression scale, EQ-5D EuroQol 5 dimension, GLTEQ Godin leisure-time exercise questionnaire, BREQ-behavioural regulation in exercise questionnaire, SVS subjective vitality scale, IOCQ important other climate questionnaire.
⇓= reductions in scores, ⇑ = increase in scores, ⇔ no change.
$_a$ all comparisons are with baseline value
$_b$ all comparisons are with control
-not available in the results
***p<0.001, ** p<0.01, * p<0.05

3.4.3 Results for MH conditions' sub-group

Five of the eight studies were RCTs (Chalder, et al. 2012; Duda, et al. 2014; Edwards, et al. 2013; Littlecott, et al. 2014; Murphy, et al. 2012). Three of these compared ERS to usual care (Chalder, et al. 2012; Littlecott, et al. 2014; Murphy, et al. 2012), one compared ERSs to a SDT-based ERS (Duda, et al. 2014), or between time points (Edwards, et al. 2013). A further study used a SDT theory-based exploratory design (Rouse, et al. 2011). A retrospective study compared adheres to non-adheres (Tobi, et al. 2012).

Anokye, et al. (2011) reviewed the cost-effectiveness of ERSs overall. It was found that ERSs were linked to a slower increase in lifetime costs and benefits. ERSs were found to be 51-88% cost-effective. However, this was not only related to mental health, but generic ERSs.

3.4.3.1 MH condition-related outcomes

Seven studies conducted research on patients diagnosed with either mild or moderate depression, anxiety or stress (Anokye, et al. 2011; Chalder, et al. 2012; Duda, et al. 2014; Edwards, et al. 2013; Littlecott, et al. 2014; Murphy, et al. 2012; Rouse, et al. 2011), with one study not providing a detailed description of the mental health condition patients were referred with (Tobi, et al. 2012).

Various psychosocial and psychological measures were employed, with the Hospital Anxiety and Depression Scale (HADS) being the most common. HADS anxiety and depression were both decreased compared to baseline (Duda, et al. 2014; Murphy, et al. 2012). HADS depression showed lower scores compared to

HADS anxiety, with clinically significant differences between changes (*p*<0.05: Duda, et al. 2014; Murphy, et al. 2012). Chalder, et al. (2012) reported decreases in scores on the Beck Depression Inventory and reduced depression, compared to both baseline and control. Behavioural Regulation in Exercise Questionnaire (BREQ) scores also increased compared to baseline suggesting an increase in motivation; with one study showing significant increase in results at completion (*p*<0.01). Subjective Vitality Scale (SVS) scores also showing significant increases at completion (*p*<0.05: Rouse, et al. 2011), suggesting positive changes in vitality with the individual being full of energy and alert (Bostic, et al. 2000).

3.4.3.2 Physical activity outcomes

7D-PAR scores reported increases in PA at completion compared to baseline (Littlecott, et al. 2012; Duda, et al. 2014), and compared to control (Chalder, et al. 2012; Murphy, et al. 2012). Significant increases (*p*<0.001, *p*<0.05) were found in three of these studies (Chalder, et al. 2012; Duda, et al. 2014; Murphy, et al. 2012). Chalder, et al. (2012) found some differences in reported PA at a four month follow up (adjusted odds 1.58, 0.94 to 2.66; *p*=0.0.8) compared to baseline. Duda, et al. (2014) found that at the three month follow up, participants reported an increase of 187 minutes (95%CI= 131 to 243) in PA per week, which is more than the recommended guidelines of a minimum of 150 minutes per week (WHO 2018).

3.4.3.3 Duration and mode/type of exercise

Scheme's duration was either 8 weeks (Chalder, et al. 2012), 10-12 weeks (Anokye, et al. 2011; Duda, et al. 2014; Rouse, et al. 2011), 16 weeks (Edwards, et al. 2013; Littlecott, et al. 2014; Murphy, et al. 2012) or 20-26 weeks long (Tobi, et al.

2012), prescribing 1-2 exercise sessions weekly. Seven schemes used one-to-one gym based exercise, consisting of both cardiovascular and resistance exercise. Two studies utilised group based aerobic exercise sessions (Mills, et al. 2013; Webb, et al. 2016), along with other forms of PA including swimming and exercise with a studio setting (Mills, et al. 2013).

Table 4. Articles selected for review of ERS effects on (3) MSK conditions.

Study	Design	Comparison	Time points	N, age (mean, SD)	Conditions	Length (weeks)	Prescription	Measures	Effect	Outcomes
Hillsdon, et al. 2002	RCT, Quantitative	ERS vs. no intervention	Baseline 12 months	*n*=1658 45-64 years Mean= n/a SD= n/a	**Musculoskeletal**	12	1-to-1 exercise sessions, weekly	Self-reported PA MLTAQ BMI (kg/m$_2$) Systolic BP (mmHg) Diastolic BP (mmHg)	⇑ 124, p=0.39 ⇑ ⇓ p=0.86 ⇓ p=0.81 ⇓**	Intention to treat analysis revealed **no significant differences in PA between groups**. **Community-based PA ERS have some impact on reducing sedentary behaviour** in the short-term, but unlikely to be sustained and lead to benefits in terms of health.
James, et al 2009	Observational cohort study Quantitative	Population based analysis	Completion	*n*=1315 Under 50=539 Over 50=776 Mean=n/a SD=n/a	**Musculoskeletal**	26	1-to-1 and group exercise sessions	BMI (kg/m$_2$) BP(mmHg)	⇓1.292 p=0.043 ⇓*	Completers demonstrated an **increased likelihood of reduced BP**. Participants who achieved a reduction in body mass had an increased likelihood of achieving reduced BP. **Completion is associated with reduced body mass and BP.**
Tobi, et al. 2012	Retrospective, Quantitative	Adherers vs. non-adherers	13 weeks Completion	*n*= 701 Mean= 46.4 SD= 13.85	**Musculoskeletal/ orthopaedic (*n*=164)** Cardiovascular (*n*=111) Mental health (*n*=141) *Respiratory (n=34)* *Other (n=23)* *Metabolic (n=228)*	20-26	1-to-1, aerobic and resistance, 1-2 x weekly	Adherence (DV) BMI (kg/m$_2$) BP (mmHg)	⇑$_b$ ** - -	**Longer term schemes increased adherence**. Longer-term adherence was found for increasing age and medical condition. **For every 10-year increase in age, the odds of people continuing exercise increased by 21.8%.** Participants referred with metabolic conditions were more likely to adhere than those with orthopaedic, CV and other disorders. **Longer-term schemes offer the opportunity to maintain adherence to exercise.**

CVD cardiovascular disease, CHD coronary heart disease, IMD index of multiple deprivation, MLTAQ Minnesota leisure time activity questionnaire, 7D PAR 7-day physical activity recall scale, BMI body mass index, BP blood pressure, HADS hospital anxiety and depression scale, EQ-5D EuroQol 5 dimension, GLTEQ Godin leisure-time exercise questionnaire, BREQ-behavioural regulation in exercise questionnaire, SVS subjective vitality scale, IOCQ important other climate questionnaire.
⇓= reductions in scores, ⇑ = increase in scores, ⇔ no change.
[a] all comparisons are with baseline value
[b] all comparisons are with control
-not available in the results
***p<0.001, ** p<0.01, * p<0.05

3.4.4 Results for MSK conditions' sub-group

Research reviewing MSK conditions is extremely limited. Within a complete search, only three articles showed relevance of reviewing MSK conditions, which included arthritis, back pain, osteoporosis, fibromyalgia and other bone and musculoskeletal conditions (Tobi, et al. 2012). MSK measures were not used. Hillsdon, et al. (2002) and Tobi, et al. (2012) did not clarify the types of MSK conditions participants were referred with. All three studies facilitated different designs which included a RCT (Hillsdon, et al. 2002), an observational cohort study (James, et al. 2009), and a retrospective design (Tobi, et al. 2012).

3.4.4.1 MSK condition-related outcomes

While these papers include participants referred with MSK conditions, uptake was low, and no MSK condition-specific measures were used.

3.4.4.2 Physical activity outcomes

Adherence to longer length schemes was better than shorter length schemes (Tobi, et al. 2012). When reported, using an objective measure of adherence which assessed session attendance, rather than a subjective self-reported PA questionnaire, longer schemes showed a significant difference in adherence (defined as the number of participants who attended the whole prescription) to PA (Tobi, et al. 2012). It was also suggested in the same study that, for every 10-year increase in age, odds of exercise continuation increased by 21.8%, meaning that participants were 21.8% more likely to adhere to longer-term exercise.

3.4.4.3 Duration and mode/type of exercise

One study's length was 12 weeks (Hillsdon, et al. 2002), with two studies of 20-26 weeks in length (James, et al. 2009; Tobi, et al. 2012). They all utilised one-to-one cardiovascular and resistance exercise, within a prescription of 1-2 sessions weekly, over either 12 (Hillsdon, et al. 2002), 20-26 (Tobi, et al. 2012), or 26 (James, et al. 2009) weeks. Additionally, one study also incorporated group exercise sessions, alongside the one-to-one sessions (James, et al. 2009).

3.5 Discussion

3.5.1 Summary of findings

The aim of this systematic review was to examine the effects of ERSs within three populations: patients referred with CV, MH, and MSK conditions. Length of schemes, and mode and type of exercise were reviewed within each sub-group, due to inconsistencies in the literature (NICE 2014, 2018; Pavey, et al. 2011). At present, there is a lack of evidence that supports a specific length of scheme, particularly in respect to improving adherence to the exercise prescription. Evidence suggests schemes do not tailor the mode and type of exercise based on referral reason. The evidence to support the effects of ERSs within sub-populations, in relation to adherence and improving health outcomes is poor (Duda, et al. 2014; Parretti, et al. 2017; Pavey, et al. 2011). These two key variables will be discussed further in detail.

Schemes have evidenced the effectiveness in CV (Duda, et al. 2014; Tobi, et al. 2012; Webb, et al. 2016) and MH conditions (Duda, et al. 2014; Murphy, et al. 2012), but evidence is lacking in MSK conditions; this may be due to national guidelines providing a lack of guidance of how to measure health condition-specific outcomes. Dependant on the health condition, there should be a menu of measures to determine condition-specific outcomes; however, at present, there is not. Duration and type and mode of exercise within ERSs were elements to consider in terms of their impact on health and PA outcomes. Overall, ERSs resulted in significant reductions in BP (Hillsdon, et al. 2002; James, et al. 2009; Mills, et al. 2013; Webb, et al. 2016) and BMI (Duda, et al. 2014; Hillsdon, et al. 2002; James, et al. 2009; Webb, et al. 2016), and increased adherence to the exercise prescription over the length of scheme (Edwards, et al. 2013; Hanson, et al. 2013; Hillsdon, et al. 2002; Littlecott, et al. 2014; Murphy, et al. 2012; Tobi, et al. 2012). Self-reported PA levels also increased (Duda, et al. 2014; Hanson, et al. 2013; Hillsdon, et al. 2002; Murphy, et al. 2012). Prior to this review, a previous systematic review suggested that there was a need for separately reporting health outcomes relating to referral reason (Pavey, et al. 2011). Within this systematic review, the health condition sub-groups were individually analysed to review any health condition-specific outcomes, of those which were available.

Within the CV condition sub-group, not all studies reported a condition-specific measure (Anokye, et al. 2011; Edwards, et al. 2013; Hanson, et al. 2013; Littlecott, et al. 2014; Murphy, et al. 2012; Rouse, et al. 2011). To get a true representation of any improvements made, there needs to be specific measures made available. However, this provides a gap within the literature at present. This may be due to the practicality of measuring conditions by specific measures which may not be feasible. Of those who did report CV-specific measures, they all showed improvements, including improvements in BP and BMI (Duda, et al. 2014; Mills, et al. 2013; Webb, et al. 2016).

Patients referred with MH conditions, responded positively to either gym-based exercise sessions or group aerobic exercise sessions. Health condition-specific measures such as HADS, showed that exercise referral significantly, and clinically reduced anxiety and depression scores (Duda, et al. 2014; Murphy, et al. 2012). These were self-reported measures of anxiety and depression, therefore caution of over- or under-estimation is required. Other measures were also reported, but some patients may be referred due to more than on health condition or reason (NICE 2014), which can be observed in the articles reviewed in tables 2-4.

There is limited research of MSK conditions and the effects of ERSs on condition-specific outcomes. There are no direct measures used to evaluate the effects of ERSs in MSK conditions. Measures which review pain may provide insight to whether the health condition is improving due to the exercise prescription. If this was utilised, then it would be expected, or hoped, that pain would reduce over the lifetime of the referral. Other measures can include range of movement and functional measures. If there were improvements in range of movement and functional movement, then it could be suggested that the prescription improved the condition. Using measures such as Lower Extremity Functional Scale, Lower Limb Functional Index (Shultz, et al. 2013), McGill Pain Questionnaire (Melzack, et al. 1975), or the Visual Analogue Scale (Litcher-Kelly 2007), could be potential tools which could more accurately measure pain or exertion related to specific MSK conditions. At present, one in five people consult a GP about MSK pain each year; support and treatment for MSK chronic pain account for approximately 4.6 million appointments per year (Belsey 2002). There are over 200 different types of MSK conditions (Arthritis Research UK 2017), which may make it difficult for researchers to create valid and reliable measures for each of these conditions. If further research into the effectiveness of ERSs in MSK conditions was conducted, then exercise referral may show to be effective in reducing the need to see a GP due to the MSK condition. It may also increase self-care management of MSK conditions, which would support the NHS long-term plan (2019a).

3.5.2 Length of schemes

ERSs tend to conclude after a 10-12-week exercise prescription within England and Ireland (NICE 2014; Pavey, et al. 2011; Woods, et al. 2016), although longer length schemes offer more opportunity for patients to gain health benefits of long-term PA (Hanson, et al. 2013; James, et al. 2009; Tobi, et al. 2012). NICE (2014, 2018) do not provide support on length of scheme, as previously discussed. Research regarding longer length schemes is extremely limited. However, a previous study suggests that longer length schemes have been beneficial for patients with CV disease risk and MH conditions, increasing PA levels whilst also being cost-effective (Edwards, et al. 2013). Research based on schemes of 12-weeks, suggest that significant health outcomes and changes in PA do not occur (Pavey, et al. 2012). Many studies may have employed 12-week schemes due to the popularity of the length throughout the UK. However, a true representation of the number of schemes, and most common length is unavailable due to the lack of mapping and recording in recent years.

Shorter-length ERSs (8-10 weeks) did not produce the same outcomes as schemes of longer lengths. For example, a short length scheme (8 weeks) did not have statistically significant effects on physiological and psychosocial outcomes for individuals referred with MH conditions (Chalder, et al. 2012). However, Webb, et al. (2016) did find significant changes in BP, through an 8-week long scheme for participants referred with CV conditions. Although, longer length schemes may be associated with improved adherence (Mills, et al. 2013; Tobi, et al. 2012). Thus, it could be argued that shorter length schemes may have the potential to impact CV conditions, provide the patient with an introduction to long-term exercise behaviour, whilst being cost-effective due to the shorter length. Though, longer schemes may be required for MH conditions, as these patients may require a longer period of exercise to improve outcomes, and also improve adherence rates.

Past research has showed that exercise can have positive impacts on CV outcomes after only a couple of weeks of participating in 30 minutes of regular, vigorous exercise, per week (O'Keefe, et al. 2014). Further research supports that four weeks of aerobic and resistance exercise can improve BP, arterial stiffness and blood flow (Collier, et al. 2008; Halbert, et al. 1997). It has also been reported that diastolic and systolic BP can potentially be reduced after one exercise session, and remain low for up to 24 hours' post-exercise session; this is known as the post-exercise hypotensive response (Cardoso, et al. 2010; Pescatello, et al. 2004; Tang, et al. 2014). Thus, could support the use of 8-week schemes for patients with CV conditions, in the improvement of CV-specific health outcomes such as systolic and diastolic BP. This shows the complexity of the ideal length of scheme; the optimum length of scheme may vary dependant on the referral reason, amongst other factors also, therefore, creating a scheme of one fixed length may be unsuitable for all health conditions patients are referred with.

Mid length schemes (11-19 weeks) did show significant improvements in the health conditions examined. As previously mentioned, 12 weeks is a common length for schemes, with NICE suggesting further research into schemes of this length. Other clinical and traditional exercise programmes have been longer than 12 weeks (Edwards, et al. 2013; Strohle, et al. 2009; Taylor, et al. 1998; Zimmer, et al. 2016), and demonstrate greater efficacy in improving health conditions (Webb, et al. 2016). Increasing the length of exercise referral, may produce results more comparable with other exercise and PA interventions. However, initially, exercise referral should focus on introducing patients to exercise, with the aim of long-term exercise adherence post-scheme completion. Instead of focusing purely on length of scheme, consideration for the mode and type of exercise, could improve the effectiveness of exercise referral.

Duda, et al. (2014) found that there were no significant changes in BP for patients participating in schemes of 10-12 weeks in length. This may be due to other cofounding influences which may have affected BP, not allowing it to reduce in the short term, including medication (Lee, et al. 2006). Combinations of longer duration exercise interventions with medication may potentially provide a more stable, and positive effect on BP (Maruf, et al. 2013). Although, it should be noted that it could be due to the volume of exercise prescribed; the intensity of exercise may not have been sufficient to provide any improvements in health outcomes. There is a lack of evidence reviewing condition-specific outcomes of tailored exercise prescriptions, and reviewing the key characteristics of schemes in relation to this.

Studies reviewing schemes that are 12 weeks in length, found that compared to no intervention, self-reported PA did not differ (Hillsdon, et al. 2002). Again, reviewing exercise intensity and effort are essential to evaluate whether this is due to the intervention, the exercise prescribed, or the patients' effort during sessions. Fidelity checks should be conducted to ensure that the intervention is implemented correctly.

Longer-length schemes (20+ weeks) have also been associated with improving various health outcomes and aiding healthier behaviours (Hanson, et al. 2013; James, et al. 2009; Mills, et al. 2013). All longer-length schemes reviewed had positive impacts on health, reducing BP and BMI (Dugdill, et al. 2005), improving PA levels (Edwards, et al. 2013), and increasing adherence to the prescription (Hanson, et al. 2013; James, et al. 2009; Mills, et al. 2013; Tobi, et al. 2012). As previously stated, guidelines do not support any specific length. If guidelines were updated with evidence to support the effectiveness of specific lengths for specific health conditions, it could potentially result in more schemes delivering effective prescriptions, producing improved health outcomes as well as potential cost savings for the NHS (Edwards, et al. 2013). However, the cost-effectiveness of longer length schemes must be examined. If schemes are longer, this could potentially impact on exercise referral specialists' time.

Although there is a clear argument for longer exercise programmes resulting in improved outcomes, programmes need to be pragmatic and the overall aim of ERSs need to be considered. Whilst writing up this study for publication (Rowley, et al. 2018), the key idea was to explore longer length schemes in detail. However, since then and whilst writing up this thesis, thoughts have changed, with an emphasis on making schemes as efficient and effective as they can be. Although longer length schemes may be beneficial in improving PA and health outcomes, the feasibility of implementing longer length schemes may be problematic. At present the literature reviewing the effectiveness of schemes is lacking. If schemes were increased in length, and referrals did not adhere and dropped out, then the evidence to support the increase in length would be weak, making longer schemes ineffective. The emphasis should be placed on the fact that exercise referral aims to introduce inactive patients to PA, which could act as a catalyst to long-term behaviour change (BHFNC 2010), therefore longer length schemes would be redundant.

Current guidelines do not recommend the optimal length of scheme for changes in PA, or health outcomes. Instead, NICE guidelines provide recommendations for further research into the effectiveness of various lengths of schemes. By reviewing the evidence of the shortest length of scheme which provides the best health outcomes, may be more beneficial, and more cost-effective. Length of scheme may be health condition-specific; different referral reasons may require a different length of scheme to provide the optimal health and PA benefits.

3.5.3 Type and mode of exercise

The most common types of exercise employed within exercise referral were one-to-to one supervised gym based sessions, incorporating both resistance and cardiovascular exercise for all health conditions (Duda, et al. 2014; Edwards, et al. 2013; Hanson, et al. 2013; Murphy, et al. 2012; Rouse, et al. 2011; Tobi, et al. 2012). Patients referred with CV conditions, who incorporated both resistance and aerobic exercises into their prescription, found this was associated with greater improvements in CV health (Meka 2008; Schjerve, et al. 2008). This is in line with results found within studies included in this review (Duda, et al. 2014; Mills, et al. 2013; Webb, et al. 2016). This evidence supports the recommendations by WHO, suggesting that programmes should consist of a combination of both aerobic exercise and strengthening exercises (WHO 2018).

Patients with mental health conditions found exercise referral participation was associated with significant improvements, for those who incorporated both aerobic and resistance exercise (gym-based) within their prescription. Depression and anxiety scores showed improvements (Duda, et al. 2014; Edwards, et al. 2013; Murphy, et al. 2012; Rouse, et al. 2011; Tobi, et al. 2012), and PA levels increased. This could suggest that gym based sessions incorporating both aerobic and resistance exercise, are potentially suitable for improving MH conditions. A recent meta-analysis supports the use of resistance exercise in treatment of anxiety (Stonerock, et al. 2015), while previous reviews also supports the benefits of aerobic training (LeBouthillier & Asmundson 2017). Both are clearly effective, yet may exert specific effects upon MH outcomes. Thus, the combined approach, may be best suited for patients with MH conditions.

There is very limited research on the effects of exercise referral in patients with MSK conditions, therefore, the results and past literature are incomparable. Only three articles were relevant for this review (Hillsdon, et al. 2002; James, et al. 2009; Rouse, et al. 2011). All comprised of predominantly one-to-one exercise sessions, and all reported increases in adherence to the exercise prescribed.

Unfortunately, none of the studies included any outcomes related to MSK conditions, such as pain or disability. Considering that all studies utilised similar interventions, it is therefore difficult to discern specifically the comparative efficacy of different types of exercise referral for patients referred with MSK conditions. However, there is evidence to suggest that, similarly to other conditions, using both aerobic and resistance exercises are associated with improvements in MSK conditions, including osteoarthritis of the knee (Ettinger, et al. 1997); which is the most common type of osteoarthritis (Arthritis Foundation 2018). Due to the lack of detail concerning referral reason, there is limited evidence to suggest the most common type of MSK referral reason within exercise referral. Within guidelines (NICE 2014, 2018), there are no requirements for exercise referral specialists to measure pain. There may be issues in capturing this data due to the complexity of measuring pain, patients' perceptions of pain, and different types of pain related to specific conditions. With over 200 MSK conditions (Arthritis Research UK 2017), having a condition-specific measure for each MSK condition is not be feasible.

Aerobic exercise sessions were solely the mode of some schemes (Littlecott, et al. 2014; Chalder, et al. 2012). However, as discussed, exercise prescriptions that solely focus on aerobic exercise may be less efficacious as combined approaches. Resistance training exerts a wide range of benefits alongside aerobic training (Shaw & Shaw 2005; Phillips 2007). Additionally, aerobic exercise-only ERSs present its own issues such as lack of efficacy, as typically employed in reducing or stopping lean body mass loss, and associated loss in resting metabolic rate per decade, affiliated with normal ageing (Westcott, et al. 2009). Much of the research has focused upon the health benefits gained from aerobic training, having made this mode of exercise a primary focal point within PA guidelines (Phillips & Winett 2010). However, it has been argued that resistance training based interventions should have a greater emphasis in public health approaches (Steele, et al. 2017), along with PA recommendations (WHO 2018) stating that patients must complete a combination of both aerobic and resistance exercise training.

At present NICE guidelines (2014) do not advise on the type and mode of exercise that should be employed within ERS, which may be due to the complexity of the patients referred, and the exercise required to meet specific outcomes. Many studies within this review have showed that one-to-one gym based sessions, employing both aerobic and resistance exercises, are effective, and are seen to be most popular within the literature. However, the feasibility of one-to-one sessions in practice may be low. Some leisure environments may not have the capacity to deliver one-to-one sessions, only group sessions which may impact on participation. Tailoring the type and mode of exercise to be health condition-specific, could also influence adherence and outcomes. Delivering schemes with a variety of choices may not be feasible, and thus, being a reason for why guidelines may be broad, allowing schemes to deliver what they can. The evidence reviewed suggests that combining both aerobic and resistance exercises is effective across a range of health conditions and referral reasons. There are studies which suggest the benefits of exercise, however not always conducted in a real-world setting. Moving forward, it is important to review whether the literature relates to the real-world implementation of schemes across the UK.

3.5.4 Implications for future research and clinical practice

Exercise referral provides a suitable model to aid the delivery of exercise regularly, and provides the jump-start patients may need to get active. Yet, patients may feel that their health condition may stop them from exercising, or provides barriers to why they cannot exercise. There needs to be an emphasis, provided through exercise referral, that people need be physically active regularly, which would assist them with self-care management of their condition and improve their quality of life.

The typical length of schemes is 12 weeks long (BHFNC 2010; Pavey, et al. 2011). Research within this review have found that longer schemes (20 weeks+) may provide better effects on adherence and health outcomes (Hanson, et al. 2013; James, et al. 2009; Tobi, et al. 2012). This could suggest that longer schemes should be recommended. Indeed, as noted, longer schemes have also been shown to be cost effective for specific sub-populations (Edwards, et al. 2013). However, a concluding statement would suggest that shorter schemes lasting 8-12 weeks, may provide the optimum length for best health outcomes and changes in PA. ERSs provide patients with a platform to commence exercising to improve their health and PA outcomes; therefore, ERSs may not be best suited as a longer length. Longer length schemes may provide some cost-effectiveness in reducing condition-specific outcomes, but looking at the cost-effectiveness of implementing and running these schemes may not provide any savings. In practice, there needs to be a balance in saving money for those who commission schemes, and provide schemes that are beneficial to patients.

As discussed previously in chapter 3, section 3.5.2, shorter length schemes do provide improvements in health outcomes. If schemes were to offer follow up appointments post-scheme completion, then this may result in savings relating to the exercise referral specialist's capacity and time, and, provide a personal contact with the patient if they require support post-scheme completion.

A key challenge for future research is to identify ways to maximise uptake and improve adherence to exercise prescribed, up until completion across all schemes. Firstly, an updated study on the effects of exercise referral on changes in PA levels is required, reviewing the typical length of 12 weeks; this will be discussed further in chapter five.

At present, NICE (2014) have not set any guidelines of the type and mode of exercise, which is to be administered, let alone health condition-specific exercise guidelines. Broadly, the results of this review suggest that combined approaches of both cardiovascular and resistance exercises are effective across conditions. Yet there is little research directly comparing different approaches, or comparing generic interventions to those schemes with specific individualisation. By tailoring prescriptions to suit each patient, exercise referral could address some of the barriers which some patients report that stop them from adhering; these include unfamiliar environment, quality of interaction with exercise referral specialist, boredom, exercise preferences, poor record keeping, and clinical disorder (Morgan, et al. 2016).

Economic impact of ERSs was reported in one study (Anokye, et al. 2011).

Results show that for sedentary patients with CVD, and those with a MH conditions, the estimated cost per quality-adjusted life year (QALY) was £12,834 and £8,414 respectively. Benefits and incremental lifetime costs linked with ERSs were found to be sensitive to variations in the relative risk of ERSs costs and becoming physically active. ERSs are more expensive compared to usual care, due to the additional mean lifetime costs of £170 per individual, although, it is more effective in leading to a lifetime mean QALY gain of 0.008 per individual. Although schemes need to be cost-effective, future training for exercise referral specialists need to be adapted to improve exercise prescriptions and their effectiveness. This will make specialists more equipped to prescribe more accurate prescriptions that have great benefits on outcomes.

3.6 Conclusion

This chapter presents an updated overview of ERSs in the UK, and provides insights relating to three key conditions for which patients are referred with. It can be concluded that both short and longer length schemes may produce, or be associated, with more significant positive effects on health outcomes. These effects include reduced BP and BMI (James, et al. 2009; Mills, et al. 2013), improved PA levels (Hanson, et al. 2013), and increased adherence (Hanson, et al. 2013; James, et al. 2009; Mills, et al. 2013; Tobi, et al. 2012). This provides a basis for the line of studies within this thesis.

Following on from this chapter, the line of enquiry should begin with looking at what is happening within ERSs at present across the UK; this includes how schemes are designed, implemented and evaluated, with a focus on the type, mode, duration, frequency and intensity of exercise, and length of schemes that exercise referral specialists use within exercise prescriptions. By reviewing this in detail, it can be compared to the current guidance (BHFNC 2010; NICE 2014, 2018); see chapter five.

Chapter six will review whether the common length of 12 weeks is sufficient in providing changes in PA levels, as recommended by NICE (2014). This is also a recommendation of further research from this review, which suggests further research is required to examine the effectiveness of shorter schemes in providing changes in PA outcomes. The gap between research, policy, and practice needs to be bridged, and this thesis aims to provide support for this. Research of key patients' characteristics may provide evidence which could decrease dropout rates, and increase adherence until completion, thus, being reviewed in chapter seven.

Chapter 4:

Methods

Chapter 4: Methods

To begin with, this chapter considers my position as researcher and past experience within exercise referral. This chapter also contains an overview of the methods used within this thesis. The data used within this thesis is from secondary sources and have been provided by ReferAll, through the National Referral Database.

4.1 Objectivity and position as a researcher

As noted in the introduction, prior to starting this PhD, I was involved within exercise referral schemes since 2008. I have witnessed first-hand the benefits of exercise referral for patients, and started this PhD with a bias towards the benefits of these schemes. Something which I had to develop was my position as an independent researcher, and move away from being an exercise referral specialist. To begin with, I believe I may have been biased towards the benefits of schemes and wanted to provide evidence for the effectiveness of schemes; but whilst completing a systematic review of the literature, I began to realise that the evidence was weak and does not support the effectiveness of schemes. I decided to step away from working as an exercise referral specialist, so that I could focus on developing as an independent researcher. Over the past three years, I have learnt to become more independent, and my objectivity has altered. Although, I have seen the benefits of schemes for patients, this does not mean that they are beneficial for all, and the evidence does not support schemes' effectiveness. My position as a researcher has changed, and I view the literature and evidence more objectively rather than with a subjective view.

4.2 Epistemological approach

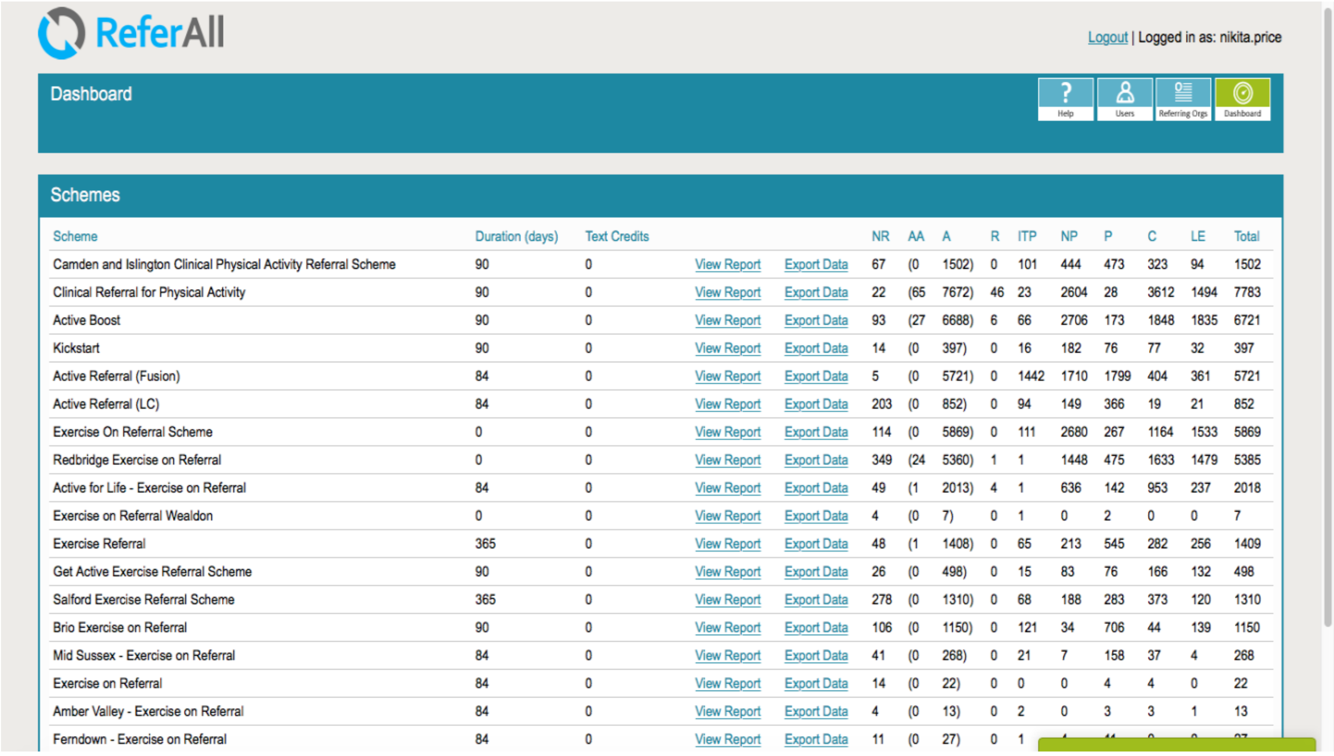
An ontological position was taken when conducting the research within this thesis. Ontology in research is defined as “the science or study of being” (Blaikie 2010). The research adopts a subjectivism view; this view “perceives that social phenomena are created from the perceptions and consequent actions of those social actors concerned with their existence” (Bryman 2012). This research adopts this view due to the exploration of ERSs and their effects on specific variables. This approach allows the researcher to perceive how things are in reality, how exercise referral schemes perceived in the real world, away from the literature. There is a lack of knowledge of schemes in the UK right now, not knowing what they consist of or how they are ran on the ground, compared to how the literature perceives them. This thesis also includes an interpretivism approach, due to the research figuring out whether ERSs effect PA levels within study two. It could be argued that realism is present within the research conducted, due to studies having an objective view, existing independently of individuals thoughts or beliefs of schemes existence (Novikov & Novikov 2013). However, this subjective epistemology I began with, changed after developing a more objective epistemology as the PhD progressed.

4.3 Ethical approval

The Certificate of Ethical Approval (page 2) for this thesis was obtained from Coventry University in August 2017, reference number: P46119.

4.4 The National Referral Database

In 2014, NICE suggested the need for the development of an online tool to collect and collate local exercise referral data to inform future practice. ‘Big data’ analytics is a trend currently within healthcare, with the ability to provide guidance for decision making for commissioners (Steele, et al. 2019). Utilising health-based databases for scientific research can provide policy makers and commissioners with the evidence to support or disregard specific interventions. Through the collaboration between ukactive, ReferAll, the National Centre for Sport and Exercise Medicine in Sheffield, and Coventry University, a national database was created to collect data from across the UK, which could be analysed in greater depths to work towards research recommendations from NICE. Figure 3 is a screen shot of the referral system used by ReferAll. The NRD has the potential to become a ‘big data’ analytic, which could potentially transform the way policy, commissioning and delivery is conducted within exercise referral (Raghupathi & Raghupathi 2013). The NRD is the largest database within the UK, and has the potential to facilitate large scale evaluation of ERSs, presenting as the largest longitudinal study which could potentially support recommendations from NICE. The database is a potentially valuable resource for the research community, as well as commissioners, policy makers and practitioners, which hopefully will provide a better understanding of ERSs and could potentially inform public health policy and practice.



Scheme	Duration (days)	Text Credits			NR	AA	A	R	ITP	NP	P	C	LE	Total
Camden and Islington Clinical Physical Activity Referral Scheme	90	0	View Report	Export Data	67	(0	1502)	0	101	444	473	323	94	1502
Clinical Referral for Physical Activity	90	0	View Report	Export Data	22	(65	7672)	46	23	2604	28	3612	1494	7783
Active Boost	90	0	View Report	Export Data	93	(27	6688)	6	66	2706	173	1848	1835	6721
Kickstart	90	0	View Report	Export Data	14	(0	397)	0	16	182	76	77	32	397
Active Referral (Fusion)	84	0	View Report	Export Data	5	(0	5721)	0	1442	1710	1799	404	361	5721
Active Referral (LC)	84	0	View Report	Export Data	203	(0	852)	0	94	149	366	19	21	852
Exercise On Referral Scheme	0	0	View Report	Export Data	114	(0	5869)	0	111	2680	267	1164	1533	5869
Redbridge Exercise on Referral	0	0	View Report	Export Data	349	(24	5360)	1	1	1448	475	1633	1479	5385
Active for Life - Exercise on Referral	84	0	View Report	Export Data	49	(1	2013)	4	1	636	142	953	237	2018
Exercise on Referral Wealdon	0	0	View Report	Export Data	4	(0	7)	0	1	0	2	0	0	7
Exercise Referral	365	0	View Report	Export Data	48	(1	1408)	0	65	213	545	282	256	1409
Get Active Exercise Referral Scheme	90	0	View Report	Export Data	26	(0	498)	0	15	83	76	166	132	498
Salford Exercise Referral Scheme	365	0	View Report	Export Data	278	(0	1310)	0	68	188	283	373	120	1310
Brio Exercise on Referral	90	0	View Report	Export Data	106	(0	1150)	0	121	34	706	44	139	1150
Mid Sussex - Exercise on Referral	84	0	View Report	Export Data	41	(0	268)	0	21	7	158	37	4	268
Exercise on Referral	84	0	View Report	Export Data	14	(0	22)	0	0	0	4	4	0	22
Amber Valley - Exercise on Referral	84	0	View Report	Export Data	4	(0	13)	0	2	0	3	3	1	13
Ferndown - Exercise on Referral	84	0	View Report	Export Data	11	(0	27)	0	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 3. The National Referall Database.

ReferAll was founded in 2009 by software developer Mike Carey and public health specialist Stuart Stokes. The NRD is a platform which offers an online referral management system to allow exercise referral specialists to upload data from various schemes; these include smoking cessation, weight management, cardiac rehabilitation and exercise referral. ReferAll aim to provide a unified platform to push industry standards, communicate best practice, reduce inefficiencies, and demonstrate effective outcomes to support policy changes.

The NRD allows exercise referral specialists to upload standardised information they collect from ERSs to the largest exercise referral database in the UK. This data can be reviewed by providers themselves, ReferAll, ukactive, National Centre for Sport and Exercise Medicine in Sheffield, Coventry University, and other academics upon request. Information which is typically uploaded includes physiological measures such as BP, BMI, height, weight, any specific fitness tests conducted, length of scheme and prescription status (left early, completed, participating, not attended). Physiological measures and any other testing conducted, is typically pre-and post-completion (patients who left early will not complete post-completion testing). This data is then uploaded into the national database. However, it should be noted, that not all exercise referral specialists will upload all this data, which has led to missing data throughout the NRD.

The main purpose of the database is to provide a platform for exercise referral specialists to utilise a standard reporting system. By providing a platform which requires standardised information from schemes across the UK, may enhance data collection and increase the number participants within one database, providing more data for large-scale evaluations.

Exercise referral specialists uploaded data from participants throughout the UK. At present (September 2019), the ReferAll system has 69 ERSs within the database, however at the time of the data cut for this thesis in October 2017, there were 19 schemes with a total of 24086 participants, who consented to share their data for research purposes.

In regards to providing consent, participants consented to the collection of and sharing of data when entering the scheme, and then these schemes agreed to share that data for the purpose of research, via ReferAll. If a participant agreed to participate in a scheme and share their data, but later decided that they wanted their data to be removed from any future research, then this could technically be done.

However, it would be very difficult to identify them, and would require the exercise providers to provide the ID number of that participant to ReferAll, and then to researchers, so that their data can then be removed from any research conducted, and keep the participant anonymous throughout this process. Although, all the data provided for this research is anonymised anyway, and the data sharing falls within GDPR guidelines, which allows for the data to be used for research purposes and without any prior approval from HRA or RECs. Therefore, the NRD is a tool which should be utilised by many researchers to learn more about exercise referral, without breaching any confidentiality or GDPR guidelines, and provides large datasets which could provide beneficial for the future of ERS research in the UK.

The data was cut in October 2017; the reason for cutting the data at this time point, was due to the need to clean and analyse the data to provide the evidence required within this thesis. It was important to analyse the same dataset throughout this thesis, rather than export 3 separate data cuts, clean and analyse each set of data.

The data analysed within this thesis (studies two and three only) is secondary data, primarily collected by exercise providers who then uploaded data collected from participants enrolled onto an exercise referral scheme, onto the National Referall Database. This data was then exported by ReferAll, for use within this thesis. Analysing secondary data is becoming increasingly common in health service research, especially for analysing effectiveness of interventions (Cole, et al. 2017), with databases potentially containing a wealth of data which could influence research and policies (Hoffman, et al. 2008a). Using secondary data does have a variety of advantages including practicability, accessibility and cost-effectiveness (Asghari & Mahdavian 2013; Hoffman, et al. 2008b), which make these databases an important resource within population-based health research. However, the origin of secondary data does provide systematic limitations (Hoffman, et al. 2008b); interpreting secondary data can produce biased results (Williams 2010), however, efforts to reduce any bias towards the results were put into practice, with support from the supervisory team on how to reduce any bias, especially with my background as an exercise referral specialist.

Data collected within the database is limited, as not all schemes collected the same data, therefore leading to missing data. For example, referral reason was missing from the data export; when trying to locate referral reason, this was not possible due to the size of the data exported, and gaining access to the missing data. When approaching ReferAll for this data, they were unable to obtain this data from exercise providers. When approaching exercise providers directly, they either did not collect this data, or they did not have the time to process this data and input it into the National Referral Database. Thus, provided issues and limited data which could be analysed in this database.

4.5 Participants

Referrals to local ERSs throughout the UK were made between September 2011 and October 2017. Data were collected from 24086 exercise referral patients from 19 schemes across the UK. Age and gender of all participants can be seen below in section 4.5.1, table 5. Participants were patients referred to local ERSs by a health care professional (including GP, exercise specialist, physiotherapist and nurse: full list of referring professionals can be seen in chapter seven). Participants were referred by various health care professionals (including GP, nurse, physiotherapist, healthcare assistants; full list of referring professionals can be seen in chapter seven) to either aid the treatment or management of a specific health condition, and/or to increase PA levels. The various health conditions have been discussed in chapter 2, section 2.3.

According to the guidelines, patients should be referred if the health care professional deemed them as suitable to participate in an exercise prescription over a specific period, usually 12 weeks. Participants met the inclusion criteria which can be seen in appendix 4 (exclusion criteria: appendix 5; contraindications: appendix 6). However, knowing whether health care professionals are following these guidelines when referring patients to exercise referral is unknown. Fidelity checks are required to ensure that the guidelines are being followed by health care professionals, again, it is unknown whether these are carried out adequately.

The referral form completed by the health care professional is then sent to the exercise referral specialist, who would contact the patient to book an induction meeting (referral process can be seen in chapter 2, section 2.4.4: figure 1). During the initial induction meeting, the exercise referral specialist would explain the process of exercise referral to the patient, then if the patient consents to participating, they would then go through a standardised screening process and pre-testing assessments. Upon completion of the induction, the exercise referral specialist would develop an exercise prescription; the participant would then begin a prescription of exercise.

4.6 Measures

Baseline demographic data and IPAQ were collected from all participants who attended their first appointment at a local ERS. Other measures were collected within the database (including, BP, BMI, body weight), but for the purpose of this thesis, and to discuss what is being analysed within the next three chapters, only demographics, IPAQ and referrer types/organisations will be reviewed. All data were provided from ReferAll from the data which exercise referral specialists uploaded onto the NRD.

4.6.1 Demographics

Baseline demographic data (week one) were collected from all participants who attended an exercise referral at nineteen local schemes. This data included age, gender, ethnicity, disability, employment status and marital status. The baseline demographics are examined in study three (chapter seven) as potential predictors of dropout and completion.

4.6.2 International Physical Activity Questionnaire (IPAQ)

The IPAQ short form (appendix 3) was utilised to examine self-reported PA pre- and post- scheme to determine weekly PA, in MET-minutes per week (mm/pw). mm/pw self-reported PA pre-and post-scheme to examine change in PA levels. IPAQ short form contains seven open-ended items surrounding the participants' last 7-day recall of PA. Items were structured to provide scoring on walking, moderate-intensity, vigorous-intensity activity, and sitting. The IPAQ assesses PA undertaken across a comprehensive set of domains which include: leisure time PA, work-related

PA, transport-related PA, domestic and gardening activities. An example item from the scale is: *during the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast cycling?*

The IPAQ was designed for observational research and is valid with criterion validity Spearman's coefficient of 0.40 for total PA (Craig, et al. 2003). IPAQ is also a reliable questionnaire, with test-retest Spearman's reliability coefficient of 0.69 for all PA intensities (Craig, et al. 2003; Lee, et al. 2011).

There are two types of scoring within the IPAQ. The continuous data is MET-minutes. Due to the non-normal distribution of energy expenditure in participants, it has been suggested that continuous indicators to be presented as median MET-minutes. One measure of volume of PA can be computed by weighting each type of activity by its energy requirements defined as METS. A metabolic equivalent of task (MET) is the ratio of the rate of energy expended during an activity to the rate of energy expended at rest (Nelson, et al. 2007). A MET is a unit of energy expenditure and by calculating MET-minutes, can track the amount of PA an individual is doing per week (Ainsworth, et al. 2011). MET-minute is equivalent to kilocalories for a person of 60 kilograms.

There are three categorical levels of PA scoring to classify populations through the IPAQ: 'low', 'moderate' and 'high'. Criteria set for each of the levels consider each question asked on the IPAQ form (Craig, et al. 2003). The 'high' category describes high levels of PA participation; either >1500 MET-minutes per week (consisting of vigorous activity on at least 3 days), or >3000 MET-minutes per week (consisting of any combination of activities across 7 days). This provides a higher threshold of measures of total PA and is useful to examine population variation. The ‘moderate’ category defines an individual to be participating in some activity, more than those in the ‘low’ category (600 to 1499 MET-minutes per week). Those in the ‘low’ category do at least half an hour moderate-intensity PA most days (0 to 599 MET-minutes per week). Individuals in the ‘low’ category are not meeting any criteria from the high or moderate categories, and are not participating in any regular PA. Regular PA is a key concept included in public guidelines for PA (NICE 2014, 2018, Pate, et al. 1995), therefore within the IPAQ analysis algorithms, both total volume and number of days/sessions are both included.

The IPAQ characterizes itself to be the most feasible method for measuring PA levels of a cohort of exercise referral participants (van der Ploeg, et al. 2010). It should also be noted that there is the potential for either underestimation or overestimation of the amount of PA conducted when using the IPAQ, so caution is required when interpreting the results (Westerterp 2009). The IPAQ is a measure included in study two, examining PA levels upon completion (chapter six), and within study three (chapter seven) examining patients’ characteristics to predict dropout and completion.

4.6.3 Referrer organisation and referrer type

The referring organisation and referrer type were recorded at baseline (week one). The referring organisations were community, hospitals, medical centres, outreach centres, pharmacies and GP surgeries. The referring health care professionals included alcohol services, dietician, exercise specialist, GP, health care assistant, health improvement, nurse, occupational therapist, other, pharmacist, physiotherapist, podiatrist/chiropodist, psychologist/psychiatrist, self-referral, and specialist doctor. Referring organisations and referring health care professional were predetermined categories created by ReferAll, which meant that data input errors were minimized.

4.7 Data cleaning and management

All data were recorded and stored through ReferAll based in Worthing, UK. Permission to use the data was provided by ReferAll. All data were anonymised by ReferAll prior to the data export in October 2017. This data was exported into a Microsoft Excel spreadsheet, which was downloaded onto password protected laptop.

Due to the size of the database, and the fact that data was inputted manually by exercise referral specialists at the source of collection, data cleaning (Van den Broeck, et al. 2005) was conducted. The data cut exported in October 2017 contained 24086 participants. However, upon an examination of the data in the exported Excel spreadsheet, there were many data entry errors; some outcomes contained data outside of plausible ranges, based upon the measures and its unit of measurement. After cleaning of the data, there were 14 schemes consisting of 23782 participants (average age 51±5 years, 68% female). Table 5 consists of descriptive statistics for participants from the 14 schemes after cleaning.

Table 5. Descriptive statistics of participants' characteristics.

Scheme code	Age (Mean ± SD)	*N* (Female:Male:Transgender)
1	56±17	1264 (738:526:0)
2	48±12	3736 (2815:921:0)
3	49±13	2070 (1596:474:0)
4	51±15	3736 (2692:1044:0)
5	50±15	4574 (3012:1562:0)
6	45±11	325 (237:88:0)
7	48±12	1735 (1285:450:0)
8	56±14	1670 (993:677:0)
9	51±16	591 (413:177:1)
10	57±14	853 (469:384)
11	57±21	51 (26:25)
12	50±16	1628 (85:643)
13	52±17	450 (271:179)
14	59±15	1099 (680:419)
Total	**51±5**	**23782 (16212:7569:1)**

Key demographics including gender (female, male), ethnicity (White/White British, Asian/Asian British, Black/Black British, mixed, other), disability (blind/visual impairment, cognitive impairment, deaf/hearing impairment, not disabled, learning disability, long term health condition, mental health condition, other, prefer not to say) and employment (carer, employed full time, employed part time, other, permanently sick/disabled, retired, self-employed, student, unemployed, volunteer) were all collected using predetermined categories created by ReferAll, reducing data input errors. This data was still checked for clear errors such as incorrect spelling or missing characters.

There were also missing data for paired comparisons at either pre- or post-time points. Therefore, for example, only paired data were included within study two (chapter six; IPAQ (total MET-mins): standard cleaning and analysis procedures for the IPAQ were followed: Mean±SD 652±1600; range -13745 to 13086, *n* of participants=5246, *n* of schemes=12, missing data excluded includes *n*= 18840).

There were missing data throughout the data exported from the National Referral Database. Due to the size of the database, and that data was from a secondary source, it was not possible to pursue replacement data from each scheme. There were issues with gaining this data through ReferAll, which impacted on the data that was used within this thesis. This relates back to the issues of using secondary data (Hoffman, et al. 2008b), that gaining replacement data isn't as easy as collecting this data first hand, rather relying on other sources to gain this data. Due to time constraints and a lack of funding to improve the database, there was no options for including replacement data.

After this, ERS values were screened with respect to their range and upper and lower cut-offs used to exclude data based upon either previous reports including typical ranges for physiological variables, or the possible ranges for questionnaire-based data based upon the scoring systems used. Data editing was not performed as it was impossible to determine satisfactory rules to address the potential reasons for incorrect input values. IPAQ data were handled using the standard cleaning and analysis procedures, leaving 4672 participants with paired IPAQ data from 24086 for study two (see chapter 5, section 5.3).

4.8 Statistical analysis

The analysis used within each study is briefly discussed below. A more detailed explanation can be seen in each corresponding chapter. Each study used a different method, therefore, it makes sense to explain in detail within each chapter.

4.8.1 Study one

Study one (see chapter five) consists of an exploratory analysis to answer the research question: *What is currently happening within ERSs in terms of delivery approaches?* The purpose of this study is to observe what is currently happening within exercise referral practice. By simply observing and reviewing some of the characteristics of schemes will provide evidence which isn't usually collected by researchers or schemes. This research will provide an overview of schemes at present, and will set the scene for the rest of this thesis. Descriptive statistics were calculated and presented within this study.

4.8.2 Study two

Study two (see chapter six) consists of a two stage individual patient data meta-analysis to answer the research question: *Do exercise referral schemes provide change in physical activity levels in the UK?* Analysis for study two was performed using the 'metafor' package in R (version 3.5.0; R Core Development Team, https://www.r-project.org/). The reason for using this software for this study, was due to SPSS not permitting meta-analysis to be performed. Full detail of the analysis for study two can be seen in chapter 6, section 3.5.

Two stage individual patient data meta-analysis was performed on the both pre- ERS and change scores (post- minus pre-ERS scores) for MET-minutes, to determine PA before participation, and how large the changes were by completion. Stage one consisted of both pre-ERS and change scores, and their standard error which were derived for each scheme. The second stage involved performing a random effects meta-analysis. Further explanations of study two analysis can be seen in chapter six. The reason for conducting this analysis was due to the data that was available; data were exported from multiple schemes, and this needed to be accounted for. This analysis could produce results based on the whole body of data, considering the raw individual level data from each scheme. The meta-analysis summarises the evidence from multiple schemes to examine if ERSs are effective in changing PA levels.

4.8.3 Study three

Study three (see chapter seven) consists of a chi-squared (χ_2) analysis which was conducted to determine any differences in patients' characteristics. Binary logistic regression analysis was then conducted to investigate the ability of the independent variables which were measured at baseline to predict dropout or completion. Multiple regression models were used for each independent variable to determine which had a significant effect on dropout and completion. This was conducted to answer the research question: *What patients' characteristics predict the likelihood of dropout from exercise referral schemes?* Analyses for study three were performed using IBM SPSS Statistics version 25 for windows, http://www.ibm.com/analytics/us/en/spss/spss-statistics-version/). *Each chapter corresponding to the three studies within this thesis (study 1: chapter 5, study 2: chapter 6, study 3: chapter 7), will have more details of the methods used within each study.*

Chapter 5:

Study 1 -

Exploring the different delivery approaches currently used within exercise referral schemes.

Chapter 5: Exploring the different delivery approaches currently used within exercise referral schemes.

The first in a line of studies is presented within this chapter. The purpose of this chapter is to provide insights into what is actually happening with exercise referral schemes at present, in terms of delivery approaches. Currently, guidelines do not provide sufficient support on how to design, implement, and evaluate schemes. Also, there is a lack of evidence observing how schemes are constructed and whether it is coherent with the evidence base, therefore this research aims to narrow the research gap and provide insights to how schemes are currently approaching delivery of schemes and prescriptions.

5.1 Introduction

ERSs have been an under-utilised setting to promote prescriptions of exercise within clinical populations in non-clinical settings (Fox, et al. 1997; Hanson, et al. 2013; Williams, et al. 2007). ERSs allow patients who are medically referred with clinical health conditions to increase their PA levels in non-clinical environments such as leisure centres and gyms (Pavey, et al. 2012; Queen, et al. 2015; Stathi, et al. 2004; Tobi, et al. 2012).

The delivery models and standards within exercise referral have been reported as heterogeneous (Beck, et al. 2016; Oliver, et al. 2016). In the 1990s and early 2000s, prompt preliminary development saw various programmes delivered in an ‘off the shelf’ manner, which was usually copying former programmes, which lacked quality assurance, regulation and vigorous evaluation (Beedie, et al. 2016;

Crone & James 2016; Dugdill, et al. 2005). If an ERS lacks efficacy but is implemented correctly, it will ultimately still lack effectiveness (even if it may have high uptake and adherence). Schemes are required to be efficacious; schemes need to be implemented correctly so that their efficacy is maintained when implemented within an ecologically valid setting such as in a leisure environment (Beedie, et al. 2016). ERSs are an effort to translate efficacy into a model of implementation, targeting exercise interventions for specific populations. However, translating this into implementation may be an issue due to current reporting of intervention content being generally poor (Michie, et al. 2011; Shore, et al. 2019); this is linked to the diversity in terminology used and lack of replicability.

Insights into the inner workings of ERSs are required before encouraging any change in national guidelines. These insights could potentially provide a wealth of information relating to intervention content which isn't usually discussed within studies. This data could provide useful in acknowledging how schemes are primarily constructed, along with recognising common practice. At present, the research tends to show heterogeneity between scheme comparisons. This may be due to varied outcome measures being utilised, which can limit comparison of effectiveness (NICE 2006, 2014, 2018; Pavey, et al. 2011; Shore, et al. 2019). It is important to set the scene within the world of exercise referral, before aiming to change how schemes operate. Once this has been achieved, then developing a framework for schemes to follow may increase the standards within exercise referral and reduce any heterogeneity.

In 2010, BHFNC published a report which contained a mapping exercise of ERSs operating across England, Scotland and Northern Ireland between 2006-2008. Self-report questionnaires were sent to 198 schemes between September 2006 to February 2008, to gather information about schemes. In total, 126 schemes responded during the 18-month period. This mapping exercise uncovered that there were significantly smaller numbers of schemes, compared to previous estimations of 600 schemes nationally (Pavey, et al. 2011). It was found that some schemes operated over several sites, meaning that there may be more sites recorded than actual number of schemes. The survey captured insight into schemes' locations, responsibility of schemes, length of schemes (how long they've been in existence, rather than length of prescription), aims of schemes, qualifications, referral pathways, scheme completion rates and monitoring and evaluation. Characteristics of schemes were also collected, consisting of facilities and settings of schemes, activities, and length of referral.

Typical prescriptions were 12 weeks in length, consisted of gym based sessions, and were conducted predominately in a local authority leisure facility. Although there were many schemes included, this report is now outdated; there has been no update since. This mapping exercise did not consider some key schemes' characteristics such as length of prescription, use of motivational strategies, determining progression, use of non-exercise components, recording and monitoring adverse events, detailed descriptions of exercises and how prescriptions are designed and tailored. It is important to provide an update to this report, and provide further, updated insights which include reviewing some key characteristics of schemes which were missed in the BHFNC report (2010).

Current guidelines are weak due to limited evidence, as previously discussed. NICE guidelines (2014, 2018) are vague, not providing specific details of the most advantageous characteristics for schemes (duration, type, mode, intensity, effort and frequency of the exercise). There are no enforced regulations that schemes must follow which specify length and mode/type of exercise, meaning that outcomes and adherence rates vary by scheme (Shore, et al. 2019; Williams, et al. 2007). With this, there is also a lack of evidence observing schemes which would provide insights into how schemes are constructed and the delivery approaches utilised. To enable replication of successful schemes, those replicating the intervention would benefit from knowledge of factors such as mode, type, frequency and fidelity (Howlett, et al. 2019), therefore it is important for future studies to provide these details, as well as this study reviewing current practice.

5.2 Aim

The main outcome of this study is to provide insights into what is currently happening on the ground within ERSs. This will provide a basis for the rest of the thesis, by setting the scene within the world of exercise referral. There has been a lack of research examining current practice, therefore the purpose of this research is to explore the delivery approaches schemes are using at present. It is important to explore whether national guidelines (BHFNC 2010; NICE 2014; 2018) are being used or whether other guidelines which focus on exercise doses are helping with the delivery of exercise prescriptions (CMO 2018, 2019; Fisher, et al. 2011, 2017). Although this study does not provide a comprehensive mapping exercise similar to BHFNC (2010), it still provides relevant insights to what is currently happening, and hopes to explore further schemes' characteristics than in the previous mapping exercise.

By providing these insights at the beginning of the line of studies, the next study can then further explore whether ERSs have any effects on PA, and potential assumptions could be made based on the insights provided in this chapter. At present, national guidelines do not specify on the design of ERSs, therefore it is assumed that schemes are all designed differently. Studies evaluating ERSs also lack detail about the intervention and exercise prescribed (Shore, et al. 2019). By asking scheme coordinators how schemes are delivered and what they contain, will provide new evidence of current practice.

5.3 Methods

The study required exercise referral specialists who coordinated local schemes to complete an online questionnaire which was designed using the Consensus on Exercise Reporting Template (CERT: Slade, et al. 2016b), asking questions about the key scheme characteristics and delivery approaches. This study used an observational design reviewing current exercise referral practices. Ethics approval was provided by Coventry University (project code: P46119).

5.3.1 Participants

Data were collected from 29 schemes within England (n=28) and Scotland (n=1) between August - October 2018, and May - June 2019. Data were collected through a survey which was created and uploaded to online survey website Survey Monkey (https://www.surveymonkey.co.uk/r/NationalReferAllDatabase: appendix 8) by ukactive Research Institute. Table 6 provides details of the location of schemes, length of schemes and number of referrals. Figure 4 provides a geographical representation of the location of schemes.

Table 6. Schemes locations, length, and number of participants.

Scheme Number	Scheme Location	Length (weeks)	Number of referrals to date
1	Falkirk	24	3500
2	Wiltshire	12	8000
3	Canterbury	12	1444
4	Luton	12	1500
5	Test Valley	12	1600
6	Dorset	12	2441
7	Cheshire and Chester	12	6882
8	Essex	12	452
9	Broadbridge Heath	12	94
10	Essex & West Sussex	12	1000
11	Cheshire East	12	8300
12	Kingston Upon Thames	12	-
13	North Lincolnshire	10	-
14	Ferndown	12	359
15	Huntingdon, St.Neots, St.Ives	12	929
16	Leeds	12	528
17	Lewisham	12	3713
18	Tameside	52	4518
19	East Lindsey, Lincolnshire	12	630
20	Mid Sussex	12	-
21	Dorking, Surrey	12	550
22	Northumberland	12	-
23	Oldham	12	3750
24	Kirklees, Scotland	45	5468
25	Stockport	26	5161
26	Plymouth	6	300
27	Sheffield and Rotherham	12	-
28	Trafford, Manchester	8	3000
29	Wandsworth, London	12	9446

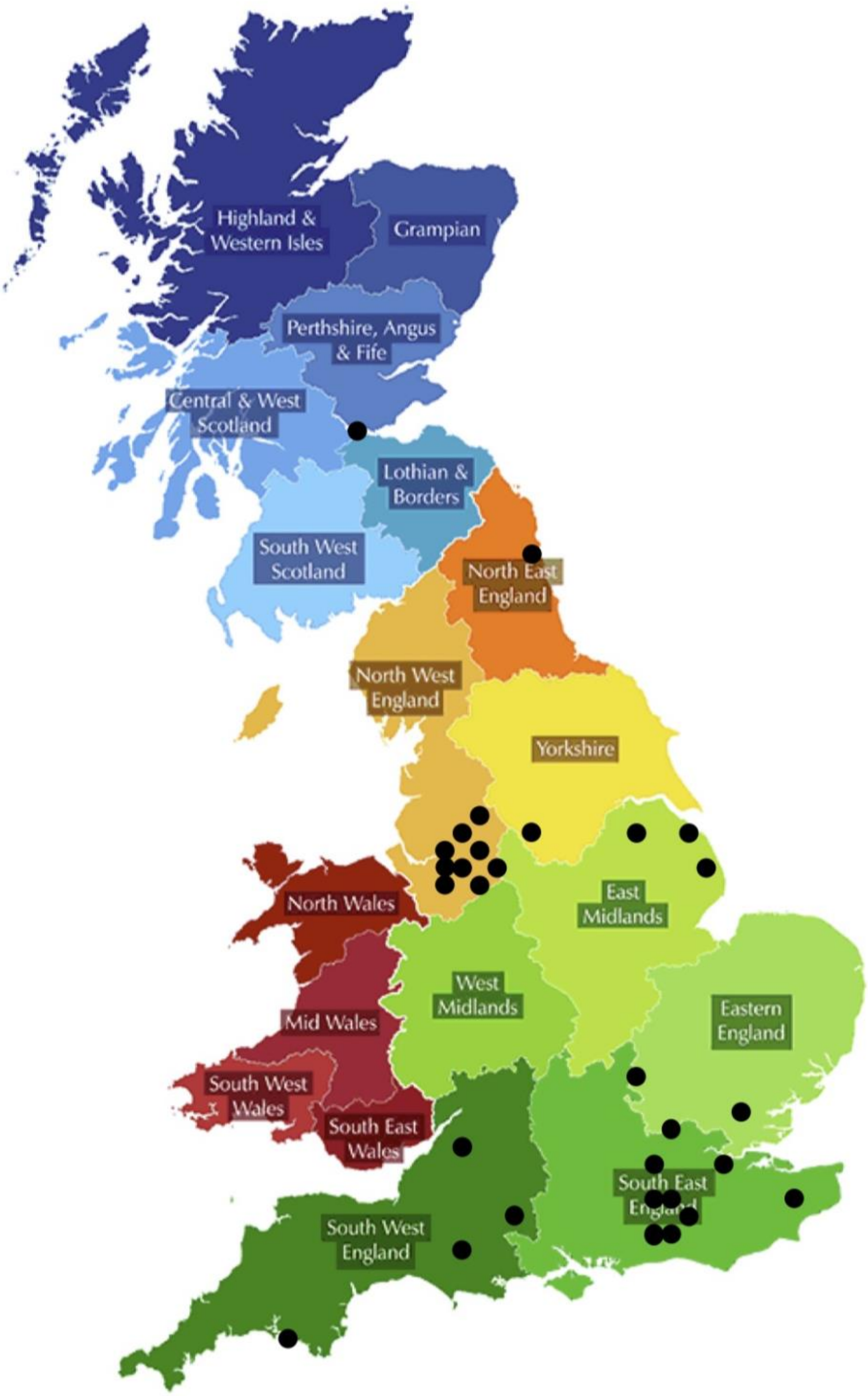


Figure 4. Geographical distribution of exercise referral schemes across England and Scotland.

5.3.2 Measures

Survey data were collected through online website Survey Monkey (https://www.surveymonkey.co.uk/r/NationalReferAllDatabase: see appendix 8 for the questionnaire). The survey was sent out via ukactive Research Institute to ukactive's and ReferAll's customers and contacts within the industry. ukactive also sent the survey out via Twitter, in the hope to capture more data from a wider audience across the UK. However, only exercise referral specialists who coordinated schemes from England (n=28) and Scotland (n=1) responded to the survey.

The survey was created based on the CERT, a 16-item checklist which was developed by an international panel of exercise experts to improve the reporting of exercise programmes (Slade, et al. 2016a). It reviews all evaluative study designs and contains seven categories: provider, materials, delivery, location, tailoring, dosage and compliance (Slade, et al. 2016b). The CERT was developed because of a lack of content recall being produced within trial descriptions. This checklist provides the minimum data set considered necessary when reporting exercise interventions. Within ERSs, there are no set checklists which exercise referral specialists are required to use. By designing a checklist guided by CERT principles, may allow for a deeper understanding of how schemes are currently being delivered.

The CERT can be used by a whole range of individuals including reviewers to assess the completeness of exercise programmes, to structure intervention reports and to facilitate the use of published information (Slade, et al. 2016b). CERT allows for detailed reporting of the delivery of exercise interventions for policy makers and practitioners (Shore, et al. 2019; Slade, et al. 2016b). If the CERT is used correctly to review current practice, it has the potential to influence the design and implementation of schemes, which in theory, could improve uptake, adherence and outcomes. CERT could additionally improve the evidence base for specific target populations of which exercise prescriptions provide optimal benefits, and are most advantageous.

5.3.3 Survey analysis

The data collected were used solely for observations and thus, descriptive statistics were calculated and reported. These insights offer an opportunity to observe how schemes are currently delivered, with the aim of reviewing common practice.

5.4 Results

5.4.1 Overview

These results provide insights to current practice within the exercise referral world. Although it was expected that schemes from across the UK would complete the survey, only 28 schemes in England, and one in Scotland completed the survey. It should be noted that the findings presented in this study should be interpreted with caution due to a number of limitations which will be discussed later in the chapter.

A total of 29 exercise referral specialists who coordinate schemes responded to the questionnaire. In total, schemes consisted of 73565 referrals to date, however, five schemes did not disclose the number of referrals within their schemes. The number of schemes who responded was a lot lower than those in the BHFNC mapping exercise (2010), but this was partly due to the limited time the questionnaire was accessible. BHFNC's questionnaire was live from September 2006 to February 2008 (total of 18 months) whereas this questionnaire was only live for five months. If this questionnaire was accessible for longer, then it would've been expected that more coordinators would have completed the survey.

5.4.2 Questionnaire responses

Table 6 in section 5.3.1, provides insights of the schemes' locations, lengths and number of referrals. Table 7 provides the number of responses and percentages to the questions asked, using the CERT guidelines about the key characteristics of schemes and current delivery approaches. Table 8 refers to the responses given to how the exercises are typically performed.

Table 7. Number of responses to the schemes' characteristics questionnaire.

Question		Number of responses
1	**Location (regional)**	
	North East England	1
	East Midlands	3
	Eastern England	2
	North West England	9
	Scotland	1
	South East England	9
	South West England	4
2	**Length of scheme (weeks)**	
	6	1
	8	1
	10	1
	12	22
	24	1
	26	1
	45	1
	52	1
3	**Mode of exercise**	
	Resistance	27
	Cardiovascular	29
	Free weights	27
	Balance/core	25

	No equipment Swimming pool Functional Rackets	22 3 4 1
4	**Qualifications exercise providers hold** None Level 2 gym instructor Level 3 personal trainer Level 3 exercise referral specialist Level 4 cardiac rehabilitation Level 4 obesity Level 4 back specialist HNC/HND in related subject Undergraduate degree in related subject Post graduate degree in related subject	 0 19 20 28 21 12 18 4 14 7
5	**How the exercise is performed** Individually unsupervised Individually but with supervision Group Combination of gym and home based exercise	 23 20 25 13
6	**Is adherence measured?** Yes No **Measuring adherence** Attendance (singing into leisure environment) Sign in and out of prescription with exercise provider recording attendance Self-report Completion questionnaire Other	 26 3 16 14 4 1 7
7	**Use any motivation strategies?** Yes No **Motivation strategies used** Goal setting Goal achievement Shared decision making Acknowledgment of success Graphic, visual, or verbal cues Diary keeping Motivational interviewing Preferred environments Problem solving advice Senior peer mentoring scheme Self-management Text messages and emails	 22 7 21 20 12 18 9 10 16 10 8 1 1 1
8	**Exercise prescribed in a progressive manner?** Yes	 21

	No	1
	Not answered	7
	Determining progression	
	Resistance exercises	
	Based upon rating of perceived effort	20
	Based upon number of reps (repetitions)/sets completed	22
	Based upon load used	11
	Combination of the above	3
	Cardiovascular exercises	
	Based upon rating of perceived effort	11
	Based upon heart rate	1
	Based upon duration completed	8
	Based upon speed/power/etc. used	2
	Combination of the above	5
	Other exercises	
	Based upon rating of perceived effort	8
	Based upon client feedback	9
	Based upon performance	13
9	**Exercises prescribed target**	
	Predominantly lower body	0
	Predominantly upper body	0
	A combination of both	1
	Depends on the individual	28
10	**Home programme components?**	
	Yes	15
	No	14
	Home programme components provided	
	A full programme to conduct at home	5
	A partial programme which can be conducted at home	9
	Advice on activities which can be done at home	13
	Advice on activities which can be done outside of the leisure environment, but not at home	14
11	**Non-exercise components included in addition to exercise prescription**	
	Meditation	2
	Cognitive behavioural therapy	2
	Massage	1
	Informational materials	13
	Fitness tracker	7
	None	13
	Nutritional advice	2
	Counselling services	2

12	**Adverse events during exercise record and monitored?** No Yes	 8 21
13	**Environment exercises are performed** Fitness gym Sports hall Studio Outside on grass Outside on a hard surface Spinning studio Community hall Swimming pool	 20 14 19 5 4 6 5 6
14	**Tailor each referral's prescription?** Yes, tailored to suit an individual and their condition referred for Yes, tailored to suit an individual's preferences to exercise No, use a generic programme which is used for every referral	 27 21 0
15	**Decision rules used to determine starting level for referrals entering the programme?** Yes No **Which decision rule do you use?** Conduct baseline fitness testing Use referral self-report Other Not answered	 16 13 7 2 7 13
16	**Exercise programs delivered and performed as planned?** Yes, exactly as planned No, they can be tailored each session No, depending on the how the individual is on the day of exercise	 0 4 25
17	**Measuring fidelity of exercise prescriptions** Staff observed Checklists to report Training records are kept Staff training Regular contact with the referral to see what they've been doing and how they are managing	 12 5 12 11 25

Table 8. Description of how exercises are typically performed.

Description of how exercises are typically performed for those included in your prescription for:	Average number	Range of answers
CARDIOVASCULAR exercises:		
Frequency (days per week)	2	1-3
Intensity (% heart rate, or perceived effort)	65	60-70[1]
Duration (mins per session)	35	10-60
RESISTANCE exercises:		
Frequency	2	2
Intensity (perceived effort)	65	55-75[2]
Load (i.e. weight)	62	55-70
Sets	2	1-10
Reps	7	3-15

5.5 Discussion

5.5.1 Overview

The main aim of this study was to observe the current practices within ERSs across the UK and provide insights to current delivery approaches used within schemes, due to a lack of previous literature reviewing current practices. The results presented are findings from 28 schemes across England and 1 scheme in Scotland (total n=29 schemes), consisting of 73565 referrals (five respondents did not disclose number of referrals). These results are purely observations of what schemes currently look like and how they are constructed based upon survey responses from scheme coordinators. It's been reported that there are inconsistences in the recording and reporting of current exercise referral practice (NICE 2014, 2018; Shore, et al. 2019). At present, reporting of intervention content in published evaluations is lacking detail required for replication (Dombrowski, et al. 2007; Howlett, et al. 2019; Shore, et al. 2019). Physical activity interventions are

1 Exercise providers may have misinterpreted this question regarding intensity for both cardiovascular and resistance exercises. Both 13% and 7% were reported, but they may have been giving the actual RPE ratings. Therefore, these responses were removed and averages were recalculated.

usually complex consisting of many interacting components which are not always reported (Craig, et al. 2008). Within the research available, trial/intervention descriptions (exercise prescription details) are often suboptimal, with unclear information of the content within effective programmes (Rowley, et al. 2018; Shore, et al. 2019; Slade, et al. 2016b). Similarly, there is a lack of this information within national guidelines (NICE 2014, 2018). It is important to understand and acknowledge the contents of ERSs before trying to change them. By reviewing these insights directly from schemes, it may provide new insights which provide greater details of current practice within local ERSs.

The following section will discuss the results from each question in more detail.

5.5.2 Length of schemes

In total, 22 schemes had a length of 12 weeks; length of schemes can be seen in table 7, section 2. Schemes length varied from 6-52 weeks. The common length of 12 weeks is the same as many reported lengths within studies (Rowley, et al. 2018). It has been conveyed that most ERSs tend to conclude after a 10–12-week prescription of exercise within England and Ireland (Pavey, et al. 2011; Woods, et al. 2016). BHFNC (2010) suggest that schemes should last for 10-16 weeks. Four schemes were of longer length, ranging from 24-52 weeks. It has been suggested that longer length schemes may provide participants with an opportunity to engage in exercise for longer, which could lead to longer term behaviour change and increased health benefits (Hanson, et al. 2013; James, et al. 2009; Tobi, et al. 2012). Adherence to longer length schemes has been associated with lowered CVD risk, and improved MH outcomes (Edwards, et al. 2013). Only three schemes reported shorter lengths (6, 8, and 10 weeks). Previous research concluded that shorter length schemes did not produce the same outcomes as longer length schemes (Rowley, et al. 2018). However, for patients referred to reduce BP, prescriptions lasting 8 weeks did provide them with significant changes in BP (Webb, et al. 2016). Exercise can impact CV outcomes positively in as little as 2 weeks of participating in 30 minutes of MVPA (O'Keefe, et al. 2014). Thus, it could be suggested that for specific health conditions, shorter length schemes may be suitable. Whereas longer length schemes may be required for other health conditions and may encourage sustained behaviour change.

Recommending follow-up appointments post-completion of shorter prescriptions may be required to reduce the need for longer length schemes. Exercise referral aims to increase PA, whilst offering patients an *introduction* to exercise, which should lead to long term behaviour change (BHFNC 2010). Follow-up appointments would review whether the patient has continued to participate in exercise upon completion, and still can provide additional support to continue exercising, whilst embedding behaviour change techniques within appointments between the patient and exercise specialist.

5.5.3 Mode of exercise

Exercise providers were asked, "*what type of exercise equipment is used?*". Table 7, section 3, provides a breakdown of the equipment exercise referral specialists use within their schemes. In total, all 29 schemes incorporated cardiovascular equipment within prescriptions, with 27 schemes using resistance equipment, and free weights within prescriptions. When asked what other equipment was used, one scheme used rackets (racket sports including badminton and tennis), three schemes used swimming pools, and four schemes used functional equipment. There is a wide variation in the mode of exercise, however, without a detailed description of the activities conducted on this equipment, assumptions cannot be made to whether it is effective.

Past research has found that incorporating both resistance and aerobic exercises into one programme, can improve cardiovascular health and PA outcomes (Meka, et al. 2008; Schjerve, et al. 2008). Current national guidelines suggest doing both aerobic and resistance training (CMO 2018, 2019). Prescriptions that are aerobic-only, may be less efficacious than combining it with resistance exercises. Aerobic exercise alone can present many issues which include reductions and loss of lean body mass, and any associated loss in resting metabolic rate per decade associated with normal ageing (Westcott, et al. 2009). Resistance exercises, in combination with aerobic training have shown to result in optimal outcomes (Phillips 2007; Saeidifard, et al. 2019; Shaw & Shaw 2005).

Current ERS guidelines (NICE 2014, 2018) do not offer any support on the mode of exercise which should be encouraged within prescriptions. Due to the lack of evidence to support modes of exercise within exercise referral, it is difficult to compare the results with the literature. It has been reported that there is a lack of description of the type and mode of exercise which is utilised within schemes and within studies (Pavey, et al. 2011; Shore, et al. 2019; Williams, et al. 2007). This study provides evidence of the varied modes of exercise used within exercise referral across England and Scotland, which was found to be lacking in other studies (Rowley, et al. 2018; Shore, et al. 2019).

Mode of exercise can influence long term behaviour change. If an individual has a preference to a specific mode of exercise, then this is more likely to be a facilitator to exercising long term (Morgan, et al. 2016). The same study also found that offering a range of different types of physical activities, and providing individualised programmes were seen to be facilitators of adherence.

5.5.4 Exercise referral qualifications

All coordinators were asked about the qualifications the exercise referral specialists have in relation to working within exercise referral (see table 7, section 4). A total of 28 schemes had exercise professionals working on schemes with the appropriate qualification, level 3 exercise referral specialist. According to the Department of Health's NQAF report (2001), the minimum level of qualification recommended for exercise professionals is the level 3 advanced instructor course, as mentioned. Typically, the pre-requisite to the level 3 exercise referral specialist course is either level 2 gym instructor, or level 3 personal trainer qualification (Wright Foundation 2019). However, only 19 schemes had professionals with level 2 gym instructor, and 20 schemes had exercise specialists with level 3 personal trainer qualifications. Nearly three quarters of schemes (n=21) had exercise referral specialists who had obtained the level 4 cardiac rehabilitation qualification, along with 12 schemes with specialists with level 4 obesity, and 18 schemes with level 4 back pain specialists. Four schemes had a specialist with HNC/HND in a relevant subject, with nearly half of schemes (n=14) with specialists who have obtained an undergraduate degree in a related subject, and seven schemes with specialists with a postgraduate degree, which is higher than the minimum required qualifications.

Without having properly qualified staff, patients may be prescribed the wrong exercise levels, duration and intensities, which may influence how effective the prescription is. Having specialists with further qualifications may provide added support for patients and provide them with more detailed support.

The support and supervision from exercise providers were seen as facilitators to adherence of an ERS, as the exercise provider was able to guide safe and efficient exercise, provide equipment, knowledge and motivation (Morgan, et al. 2016). Therefore, ensuring exercise providers have the relevant qualification is a vital facilitator to aid the adherence to schemes. In the longer term, it could affect behaviour change dependant on the relationship the patient has with the exercise specialist.

5.5.5 Performing the exercise prescription

There are various ways a patient can perform their prescription, this includes being supervised or unsupervised, in groups (such as exercise classes), or a combination of gym and home based exercises (see table 7, section 5). In total, 13 schemes used a mixture of methods, combining gym and home based exercises. Many schemes (n=23) allowed patients to exercise unsupervised, with 20 schemes supervising patients whilst exercising. In total, 25 schemes offered group exercise sessions to referrals.

A recent study examining the supervision of resistance training found that direct supervision is associated with significant improvements in strength and body composition outcomes (Mann, et al. 2018). This implies that providing patients with supervision throughout their prescription, may lead to greater improvements in outcomes compared to unsupervised sessions. A recent meta-analysis found that minimally supervised home-based resistance training for older adults, was an inexpensive and useful tool to preserve and enhance lower body muscle strength in older adults (Kis, et al. 2019). This suggests that offering home based exercise programmes may be effective for improving lower body muscle strength if adhered to. In unsupervised exercise prescriptions, poorer compliance to exercise was observed, compared to group exercise sessions which encouraged social interaction and lead to improved adherence (King, et al. 1990).

Whilst performing exercise prescriptions, having guided support and supervision from a qualified exercise provider was found to be a facilitator of adherence (Morgan, et al. 2016). Providing support may encourage the patient to participate, and could improve the chances of long term behaviour change if adherence to exercise is continued.

5.5.6 Measuring adherence

A total 26 schemes measured adherence (see table 7, section 6), with three schemes not recording adherence to the prescription. Adherence has been described as an indicator for intervention feasibility (Willinger, et al. 2019). Adherence was reported through various methods. Measuring adherence was reported by attendance (signing into the leisure environment) with 16 schemes using this method; followed by 14 schemes using a similar method of signing in and out of the prescription with the exercise provider. Self-report adherence was used within 4 schemes, with adherence being measured through the completion questionnaire at one scheme.

Previous research has found that reporting intervention content is generally poor, with great diversity in terminology (Howlett, et al. 2019; Shore, et al. 2019). Adherence and attendance are typically referred to as the same thing, with little advice in national guidelines on how they differ. Past research found that adherence is measured by attendance, due to adherence being referred to as the percentage of sessions attended (Arsenijevic & Groot 2017; Pavey, et al. 2012; Shore, et al. 2019). Attendance alone does not indicate the intensity level of the patient's activity, which would indicate whether patients are benefiting from the exercise prescribed. Therefore, this association between adherence and attendance may be misleading when reviewing changes in outcomes.

A recent systematic review found that there was a lack of detail relating to recording adherence (Shore, et al. 2019), which supports the findings in this study. Exercise referral specialists are not reporting adherence to the prescription accurately, but rather reporting attendance to the leisure facility without any indication of the patients' effort used to adhere to the prescription.

Various methods to measure adherence have been used in the past, commonly self-report (Arsenijevic & Groot 2017; Pavey, et al. 2012; Shore, et al. 2019). Again, this has its own issues, relying on the patient to record their adherence to the exercise, which they may mistake for attendance. A standardised approach to measuring adherence is required, dependant on modality, to draw valid conclusions on adherence within ERSs (Slade, et al. 2016b). Without supplying clear definitions and a standardised approach to measuring adherence, drawing clear conclusions about whether adherence to ERSs affect longer term behaviour change is not possible. Once clearer definitions have been reported, future work should emphasise on examining the longer term adherence to exercise, rather than adherence to the prescription; ERSs should only introduce patients to exercise, therefore, measuring adherence to the during and post-completion could provide evidence of behaviour change.

5.5.7 Use of motivational strategies

Three quarters of schemes (n=22) used additional motivational strategies to encourage adherence to exercise prescriptions (see table 7, section 7), with some schemes utilising more than one motivational technique. Most common motivational strategy used was goal setting (n=21 schemes). Goal setting is a common motivational strategy or behaviour change technique, used within exercise referral (Littlecott, et al. 2014; Mills, et al. 2013; Morgan, et al. 2016; Murphy, et al. 2012). Goal setting focuses on an individual’s attention to behaviour change (Locke & Latham 2002). Goal setting has been used within other exercise interventions to encourage behaviour change, and was found to be a popular BCT used within exercise settings (Michie, et al. 2011; Samdal, et al. 2017; Williams & French 2011). Goal setting has the potential to influence long term behaviour change (Michie, et al. 2011), but patients should be encouraged to set realistic and quantifiable goals regularly (Fabricatore 2007), which also increases self-efficacy (Bellentani, et al. 2008).

Goal achievement was also a popular technique (n=20 schemes) along with acknowledgement of success (n=18 schemes). Goal achievement is where an individual identifies and prioritises activities which can lead to achieving the goal; whereas, goal setting is a process where the individual identifies what they want to accomplish and establishes measurable goals (Locke & Latham 2002). Motivational interviewing is a common motivational technique used with ERSs (Murphy, et al. 2012), however, only half of schemes (n=16 schemes) used this technique. This may be due to the additional training exercise referral specialists require to conduct this technique. Motivational interviewing is commonly used as an approach to change behaviours, although fidelity of implementing this technique has been reported as poor (Moore, et al. 2012). This research suggested that effectiveness of exercise referral could be improved, if the use of BCTs was correctly implemented and regular fidelity checks were in place.

Diary keeping was another motivational strategy used within 10 schemes, which was also used to record adherence to exercise. Diary keeping allows the patient to record activities they conduct during their exercise prescription and daily lives. Although due to the nature of self-reporting, a previous study found that exercise adherence can be significantly overestimated when using a diary to record adherence, presenting questionable validity (Nicolson, et al. 2018).

5.5.8 Exercise progression

In total, 21 schemes prescribed exercise in a progressive manner. It should be noted that seven schemes did not answer this question (see table 7, section 8), however, some of the respondents may not have understood the question. There are consequences of not progressing an exercise prescription; a patient may begin to show improvement in fitness and health outcomes, but to maintain these improvements their prescription must be updated regularly to provide increased intensity and/or duration of the exercise, otherwise they will begin to plateau; they may show signs of a dramatic decrease in the noticeable results of the prescription (Dishman, et al. 1985).

Progression in resistance exercises is a dynamic process which requires evaluation of training progress and development of goals (Kraemer & Ratamess 2004). Progression of resistance exercises accommodates optimal muscular adaptive response (Peterson & Gordon 2011). When determining progression for resistance exercises, 22 schemes based this upon the number of reps and sets completed, with 20 schemes using rating of perceived effort, followed by 11 schemes basing it upon the load used. Only 3 schemes used a combination of perceived effort, number of reps and sets completed and load used. There is a lack of evidence reviewing the progression of resistance exercises within exercise referral at present.

Determining progression for cardiovascular exercises, 11 schemes based it upon the rate of perceived effort, 8 schemes based on duration completed, 2 schemes based it upon speed and power and one scheme on heart rate. Only 5 schemes used a combination of all the above.

Determining progression for other exercises, 13 schemes based this upon performance, 8 schemes based this upon perceived effort and 9 schemes based upon client feedback. Incomplete reporting of effective exercise interventions is an issue within ERSs at present. Schemes do not adequately report exercise prescriptions details and having access to this information is difficult (Slade, et al. 2018).

Monitoring participants' progress is advised within the BHFNC toolkit (BHFNC 2010). The toolkit suggests that the exercise referral specialist should monitor the patient's progress during each session to ensure safety. This toolkit suggests monitoring how the patient is coping with the exercise intensity, how they feel during the exercise and identify any change in response to the exercise. However, there are no specific details on ways to determine progression within an exercise prescription.

5.5.9 Targeting exercises

Exercise referral specialists were asked whether exercise prescriptions targeted either: predominantly lower body, predominantly upper body, a combination of both or depends on the individual (see table 7, section 9). A total of 28 schemes said it depended on the individual, however there was no detail on what factors it depended on. If patients are given the option to choose the exercise intensity, through automatic affective evaluations, when given the opportunity to decide on the intensity level, people usually choose the easier option (Bluemke, et al. 2010), which means they are not achieving the essential levels of stimulus.

Only one scheme used a combination lower and upper body exercises. Within NICE guidelines (2014, 2018), there is a lack of guidance relating to targeted exercises. Ideally, this should depend on the patient, taking into consideration their referral reason and preference to exercise; however, there is a lack of evidence reviewing this area within ERSs.

If patients when given the opportunity to decide on the intensity level usually choose the easier option (Bluemke, et al. 2010), then this won't be effective for changing long term behaviour. Schemes should implement fidelity checks to review whether the exercise is being conducted as prescribed.

5.5.10 Home programme components

Just over half of the schemes (n=15 schemes) used home programme components within exercise prescriptions, as well as exercise assisted by an exercise referral specialist within a leisure facility (see table 7, section 10). This comprised of 14 schemes that offered advice on specific activities which could be conducted outside of the leisure environment, but not within the household. A total of 13 schemes advised on activities which could be conducted at home. With 9 schemes offering a partial exercise programme to be conducted at home, along with only 5 schemes offering a full exercise programme to conduct at home.

Home exercise programmes should be offered to patients who participate in an ERS (BHFNC 2010). Home exercise prescriptions have been suggested to appear superior to centre-based programmes, in terms of adhering to the prescription of exercise (Ashworth, et al. 2005), however, it is dependent on the referral reason and what is being measured. Those referred with CV conditions found that centre-based programmes were superior to home programmes, for improving time and distance walked. Although home based programmes were found to have higher adherence rates than centre-based. By combining an exercise referral with both centre-based and home exercise programmes, may provide greater improvements in adherence to the overall prescription and enhance longer term behaviour change, but also provide greater health and PA improvements; this is something which requires further research.

5.5.11 Use of non-exercise components

Some schemes have non-exercise components within their exercise prescriptions (see table 7, section 11). Thirteen schemes reported not using any non-exercise components. Thirteen schemes used additional informational materials for patients to read. Only two schemes offered meditation, two schemes used cognitive behavioural therapy, two schemes used nutritional advice and two included counselling services; one scheme also offered massage. There is little advice within current guidelines (NICE 2014, 2018) and toolkits (BHFNC 2010) that offers support for non-exercise components within exercise referral.

Offering non-exercise components is not required, however, may benefit schemes to offer additional services which may be of interest to patients in order to promote longer term behaviour change and adherence to exercise. Meditation and exercise combined, especially mindfulness and exercise, has been suggested to improve mental health and adaptive responses to stress (Goldstein, et al. 2018). The use of internet-based cognitive behavioural therapy and exercise was successful in improving symptoms of depression, and more effective than treatment given by a GP (Hallgren, et al. 2015).

Informational materials could be adapted with the use of behavioural insights and behavioural economics to promote longer term exercising and change behaviours. Using tools such as EAST (Behavioural Insights Team 2012) and MINDSPACE (Behavioural Insights Team 2010), can enhance the design of informational materials to encourage behaviour change. Behavioural insights offer new solutions to policy problems. EAST (easy, attractive, simple, timely) framework is a simple way of applying behavioural insights to policy and documents for initiating behaviour change (Hallsworth, et al. 2016). MINDSPACE (messenger, incentives, norms, defaults, salience, priming, affect, commitments, ego) is a more in-depth framework which can also be used to adapt informational techniques. Using behavioural insights can reduce even small barriers to making a healthy behaviour more likely (Behavioural Insights Team 2012), therefore using this in the informational materials may encourage patients to change their lifestyles.

5.5.12 Recording and managing adverse effects

A total of 21 schemes recorded and monitored adverse events during exercise, with 8 schemes not recording or monitoring these events (see table 7, section 12). Many exercise referral studies do not report adverse events at all, whether there were, or were not, any. There is no way of understanding whether the lack of reporting is due to there not being any, or just that researchers do not record them within studies. CERT guidelines suggest that reporting adverse events is essential within exercise interventions (Slade, et al. 2016a). Clearly, this is not being acted upon by all schemes at present. It has been reported that ERSs require consistent recording and reporting, but it is not evident within the literature at present (Shore, et al. 2019).

5.5.13 Location of exercise

A wide range of exercise locations are offered within these schemes (see table 7, section 13). These vary from exercise outside on hard surfaces (4 schemes) or on grass (5 schemes), in community halls (5 schemes), spinning studios (6 schemes), swimming pools (6 schemes), sports halls (14 schemes), fitness studios (19 schemes) or fitness gyms (20 schemes).

In the previous mapping exercise (BHFNC 2010), it was found that leisure facilities were the most popular setting for delivering exercise referral. Within this review, it was also found that gym-based sessions, group exercise, swimming and walking were common activities. In the Moving Communities Active Leisure Trends Report for 2018 (ukactive 2018), it was found that over the past three years, 80% of all visits were made to three core activities: the gym, swimming, and group workouts. This correlates with the evidence found within this study, as fitness gyms were the most popular, followed by fitness studios, where group exercise sessions are typically performed. However, having prescriptions performed in a fitness gym can be intimidating for some patients, due to the dislike in the music, and, lack of understanding and confidence in operating the equipment (Morgan, et al. 2016), which can lead to potential dropout. The environment can play a potential role in changing behaviour. If the patient dislikes the environment then they may see this as a barrier to adhering to the prescription (Morgan, et al. 2016). Offering different options in terms of environment (gym, studio, outside) for the patient to choose from may enhance their decision to continue exercising, even after completion.

Having prescriptions which consist of outdoor activities, may prove to be popular with patients and exercise referral specialists, as they are convenient, safe and affordable (BHFNC 2010), dependant on the weather. Providing a prescription in a safe environment and which is affordable was seen as a facilitator for adherence (Morgan, et al. 2016). In a trial reviewing exercise intervention venues, outdoor activities such as walking and cycling were most popular (Vuori, et al. 2004). By having a wide range of locations on offer, and tailoring the prescription to include patient's preferences, adherence rates may improve which could lead to longer term behaviour change.

5.5.14 Tailored prescriptions

In total, 27 schemes tailored exercise prescriptions to suit the patient and health condition referred with (see table 7, section 14). A total of 21 schemes tailored the prescription to suit the patient's preferences to exercise. No schemes reported using a generic programme of exercise with all patients, which suggests that exercise referral specialists are tailoring exercise prescriptions to some extent. At present, studies are insufficiently recording the exercise prescribed, along with a lack of reporting of adherence (Shore, et al. 2019). Complex exercise intervention studies, should include detailed information of the exercise prescription, so that these interventions can be replicated (Howlett, et al. 2019), and assumptions can be made to whether schemes are tailoring prescriptions and how these are achieved.

At present, there is a gap within the literature reviewing sub-populations based on referral reasons, specific exercise prescriptions and their effectiveness. Further research is required to examine the type, mode, intensity, duration and frequency of exercise prescriptions to determine its effectiveness, and whether schemes tailor prescriptions sufficiently. Tailoring exercise prescriptions has been found to be a facilitator to adherence and could potentially affect longer term adherence to exercise (Morgan, et al. 2016), therefore it is important for specialists to tailor prescriptions, but further research is required to examine the effectiveness of tailored prescriptions.

5.5.15 Baseline fitness assessments

When a patient is referred, decision rules should be used to determine starting levels (see table 7, section 15). Baseline testing is encouraged to assess where the starting level is for the exercise prescription (Rackley 2013). If the prescription is too easy, then the patient will observe a lack of benefits from participating. If the prescription is too hard, then this may lead to a lack of effort put in by the patient, or even lead to dropout. It is important for the exercise referral specialist to pay attention to the patient's ability to conduct the right level of exercise and adjust it when, and where necessary. Only 7 schemes conducted baseline fitness testing; this is something that all schemes should be conducting (BHFNC 2010; Rackley 2013). Only 2 schemes reported using the patient's self-report to determine the exercise intensity. Nearly half of schemes (n=13) decided not to answer this question.

This is a key limitation of ERSs at present; without baseline testing, there is nothing to compare the post-completion results to, not knowing whether the patient has improved their PA levels and health outcomes upon completion. For the purpose of research and understanding whether a patient has benefited from the prescription, it is vital for exercise referral specialists to conduct baseline assessments. Thus, should be made clear within national guidelines, making it compulsory for schemes to collect standardised data pre-and post-completion.

5.5.16 Planned delivery and performance

No schemes reported that prescriptions are delivered as planned (see table 7, section 16). In total, 25 schemes reported that programme delivery depended on how the patient felt on the day of exercise, with 4 schemes reporting that prescriptions could be tailored each session. Although this allows for consideration for how the patient feels on the day of exercise, this could lead to diverting from the original prescription, resulting in a lack of developments in health and PA outcomes, and can potentially affect longer term behaviour change. It is important for patients to follow the exercise as prescribed, if they want to achieve the desired improvements. If they do not, and opt for an easier intensity or shorter length of time, then they will not see the benefits, making the prescription seem ineffective. Automatic affective evaluations (dual processes) play an important role in how an individual decides on what level of exercise intensity they conduct (Bluemke, et al. 2010). When given the opportunity to make the decision for themselves, people will often opt for the easier and more enjoyable option, which, in the case of exercise, means that they are not achieving the requisite levels of stimulus. Especially for the populations who were previously reported as sedentary at baseline. This is a key area which requires further research to observe how regularly people divert from their original prescription and opt for an easier alternative; thus, could have major implications on the effectiveness of exercise referral.

5.5.17 Programme fidelity

Fidelity is rarely reported within ERSs and related studies (Pavey, et al. 2011; Shore, et al. 2019; Williams, et al. 2007), and when reported, it is low compromising the effectiveness of ERSs (Campbell, et al. 2015). It is important to check the fidelity of an intervention, to ensure that it is being implemented correctly, and that the right procedures are in place. In total, 25 schemes kept regular contact with the referral to see what they've been doing (see table 7, section 17); with 12 schemes observing staff, and kept training records; 11 schemes offered staff training; only 5 schemes reported specific checklists. Within current training, there is a lack of guidance on fidelity which should be reviewed (Rackley 2013). By making sure that exercise referral specialists are implementing prescriptions correctly, would then support the effectiveness of schemes more accurately. Fidelity checks may also check whether the prescription has been designed to encourage behaviour change.

5.5.18 Descriptions of exercises performed

Table 8 provides insights into the details of how exercises are typically performed. On average, cardiovascular exercises are conducted two times a week (reportedly ranged from 1-3 days per week). Current guidelines suggest doing 150 minutes of moderate intensity activity per week (CMO 2019; WHO 2018) – one approach is to do 30 minutes 5 days a week (CMO 2018). Exercise intensity was reported as 52% on average (heart rate or perceived effort; ranges from 13-70%, recorded by exercise providers). The recommended target heart rate is 50-70% intensity (American Heart Association 2019). However, within the current UK PA guidelines, there are no mention of intensity (CMO 2018, 2019). Duration of a cardiovascular based session is typically 35 minutes (reported range from 10-60 minutes); this, does meet one of the suggestions of exercising for at least 30 minutes in one session (CMO 2018). If patients are only conducting aerobic exercise 35 minutes, twice a week, then they are not meeting the current PA recommendations of 150 minutes of moderate intensity per week (CMO 2018, 2019; PHE 2017; WHO 2018).

For resistance exercises, these were typically conducted two times a week, with an intensity of 43% (perceived effort reportedly ranged from 7-60%). The load was reported at 36% (weight reportedly ranged from 0-70%). On average patients would conduct 2 sets (ranging from 1-10 sets) of 7 reps (ranging from 3-15 reps). Reviewing PA recommendations, patients conducting muscle strengthening exercises twice a week, should be meeting the current recommendations (CMO 2018, 2019; PHE 2017; WHO 2018). More detailed information of each individual activity being conducted is required, to make an informed decision on whether patients are meeting recommended levels adequately. This detail may provide evidence which would support findings that resistance exercises should be conducted twice a week, but focusing on major muscle groups in the upper and lower body, and should be repeated until failure (Murphy, et al. 2018).

5.5.19 Summary

These results provide insights to key characteristics of schemes which are not usually reported within studies. This information provides a preliminary mapping of schemes across England and Scotland. From reviewing the data collected within this study, it can be seen why schemes are not particularly effective in improving health and wellbeing outcomes (Wade, et al. 2019), due to the average intensities for the exercise sessions conducted within the prescription. Also, by allowing exercise referral specialists to adapt each session depending on how the patient is feeling, the effectiveness of the prescription is compromised. There needs to be a larger scale national review of schemes, to reveal schemes with best practice and provide patients with optimal outcomes. With this, further updates to national guidelines could be suggested, which include details of the most effective delivery within ERSs (type, mode, intensity, frequency and duration). Some of these characteristics can be seen in other national PA guidelines (intensity, frequency and duration: CMO 2018 2019). However, they must also be incorporated within exercise referral guidelines, making it clear for exercise referral specialists to follow. Exercise referral policies should be developed using the modified taxonomy of policy components (Howlett & Cashmore 2009). This would encourage guideline creators or policy makers to review policy content, with policy aims that focus on the main goals of ERSs, objectives of the policy, and settings for ERSs. It also would encourage the policy makers to review the policy tools, which include the instrument logic, mechanisms used such as incentives, and calibrations which explores whether the guidelines are used in a voluntary or compulsory manner.

It should also be noted, that even by providing details of key characteristics which constitute a successful scheme, it does not mean that all coordinators can incorporate these characteristics into their schemes. Some schemes may not have the resources to conduct exercise prescriptions in the way they should be conducted. Some schemes may not have any funding to buy the relevant equipment, or have the relevant space to conduct specific exercises, therefore, they are trying to provide some sort of service which allow patients to access exercise facilities to improve PA and health outcomes. However, to make schemes comparable, there needs to be more standardised approaches to the implementation and delivery of schemes; this way, schemes can be compared to review the effectiveness on a national scale.

5.5.20 Limitations

Whilst designing this study, it was expected that exercise referral specialists from schemes across the UK would complete this survey. Upon inspection of the data collected, only specialists from England and one from Scotland, completed the survey. Without knowing the actual number of schemes across the UK and not having access to their contact details, this mapping exercise was limited. Wright Foundation (2004) reported that there were approximately 600-800 schemes nationwide, with Pavey, et al. (2011) also suggesting that there were more than 600 schemes nationwide; how this figure was decided, is unclear. Without a centralised database recording every scheme across the UK, there is no way of knowing how many schemes there are in the UK officially. At present, there are only 69 schemes within the NRD, which is expected to increase as exercise providers become more aware of the databases' existence.

The small sample examined within this study prohibits a general inference in terms of how schemes are being delivered at present or the magnitude of variation across schemes. This sample is the first step in providing a snap shot of what is happening on the ground.

Another issue is, even though schemes have stated what they do within schemes, it cannot be assumed that schemes actually do this. Based on the results from the questionnaire, it could be suggested that patients participating in an exercise prescription may not be receiving the stimulus they require from an ERS. Intensity levels of cardiovascular and resistance exercises may not be providing patients with the level of intensity which is required to provide changes in PA and health outcomes; or providing the level of intensity, duration and frequency to meet national PA guidelines (CMO 2018, 2019). Research reviewing cardiac rehabilitation exercise programmes found that the intensity of the prescription was lower than the minimal training intensity guidelines for Phase III cardiac rehabilitation programmes (Khushhal, et al. 2019). This shows that it is not just an issue isolated to exercise referral alone, but affects other exercise interventions for clinical populations in general.

5.5.21 Implications for practice and future research

There is little evidence on the current practices within ERSs across the UK. For a starting point for further research, it is important to understand what is happening within ERSs right now on a larger scale, with the aim to provide insights which may improve the details provided in guidelines.

This study was conducted to provide insights to current practice and observe what is currently happening on the ground within ERSs. Although this study has provided initial insights from schemes scattered across England and one in Scotland, further research is still required to provide in-depth observations of all schemes across the UK. Within the literature, there are gaps, which review the type, mode, intensity, duration and frequency of exercise prescribed within exercise referral, and to review specific outcomes. Many studies still do not provide the vital details of the exercise prescription (Pavey, et al. 2011; Rowley, et al. 2018; Shore, et al. 2019; Williams, et al. 2007). This information could provide awareness of specific prescriptions which have been associated with better outcomes, which could then reduce the risk of dropout and promote longer term behaviour change.

Moving forward, data collection requires a standardised approach, so that all schemes are collecting the same data accurately. Although a standardised approach to this element, exercise prescriptions still need to be designed with the flexibility to tailor prescriptions based on the patient referred. However, with this in mind, a menu of appropriate measures could be created that include various questionnaires/measures which are used specifically to review specific outcomes. With further research and review of best practice, a menu of exercise prescriptions, with their suitability for specific health conditions (referral reasons) could be designed and tested which could standardise the individualised approach to designing prescriptions. By providing a standardised toolkit for exercise referral specialists to use may provide improved data collection, improved fidelity, better exercise prescription design, improved adherence rates, and improved effectiveness of schemes overall. At present, there’s a lack of standardised approaches, which make it difficult to analyse effectiveness (Shore, et al. 2019).

Updated NICE guidelines should provide more information about how schemes should collect and store data. If a toolkit was designed, as mentioned above, then new guidelines could encourage exercise referral specialists to use this, which could then provide a more standardised approach to exercise referral nationally.

After reviewing the data collected, there were still some questions unanswered. This study provides a snapshot of whats currently happening within schemes across, however, the results should be reviewed with caution due to the lack of responses to the survey. A large scale mapping exercise is required over a longer period of time to review schemes characteristics in more depth. To do this, the exact number of schemes must be known and where they situated, which may be a difficult task. One way this could be achieved is to focus on one region of each country at a time (England, Scotland, Wales, and Northern Ireland), contacting local authorities and leisure providers within each region, which may provide information of local schemes. This may be an extensive project, however, by locating all ERSs within the UK, and sending them all a questionnaire about key schemes' characteristics to complete, would provide rich data which have not been collected on this large scale previously.

Although questions were included within the questionnaire to review intensities, types and duration of exercise, more in-depth questions could have been asked to find out more details about the exact exercises prescribed. Reviewing what national and international PA and exercise guidelines schemes use when developing an exercise prescription may shed light on whether ERS guidelines are being used and to what extent. Due to NICE guidelines (2014) being quite vague, exercise referral specialists may turn to other guidelines and policies to develop schemes and prescriptions. This information may provide insights that are useful for future development of guidelines.

The NRD is currently being adapted to provide a more detailed national database for exercise referral specialists. The NRD must be adapted to collect more relevant details relating to the patient, the pre-and post-completion measures, the exercise prescription (including exercise intensity, mode, type, duration, frequency, and effort), reasons for dropout, and post-completion follow ups. With more detailed descriptions of the exercise referral, detailed analysis of the dose-response can be conducted.

5.6 Conclusion

The current study provide insights to what is currently happening within ERSs, including delivery approaches used. This study provides updated and fresh evidence of how schemes are constructed, however on a small scale which provides only a snap shot. Schemes are usually 12 weeks in length, offer participants bi-weekly (twice as week), unsupervised exercise sessions within a fitness gym, using a combination of cardiovascular, resistance, free weights and body weight exercises. Determining progression of resistance exercises are based upon the number of reps and sets completed, for cardiovascular exercises are based upon the rating of perceived effort, and for other exercises is based upon performance. Most schemes offer a variety of home based exercise components, whether it is just advice or a full exercise programme. Adherence is typically measured through attendance. Common motivational strategies used are goal setting, goal achievement and acknowledgement of success.

This research provides useful insights of schemes' characteristics from schemes across England and one from Scotland (total of 73565 participants from all schemes). This evidence can support the development of a large scale mapping exercise to review schemes across the whole of the UK. There has been a lack of research observing or reporting schemes characteristics, therefore this research has been insightful in providing initial evidence of what schemes offer, rather than just surmising from research and guidelines.

This study provides some context for the rest of the thesis. By understanding how schemes are constructed, and with the evidence potentially gained from the next two chapters, this thesis can provide evidence and support for the development of future exercise referral guidelines.

Chapter 6:

Study 2 –

Are exercise referral schemes effective in increasing physical activity levels?

Chapter 6: Are exercise referral schemes effective in increasing physical activity levels?

The second in a line of studies is presented within this chapter. The purpose of this chapter is to provide observational findings of exercise referral schemes and whether they are effective in providing change in physical activity levels after completion of a 12-week exercise prescription. As it can be seen in chapter five, many schemes tend to conclude after 12 weeks, therefore, it is important to review whether this common length changes physical activity levels post-completion.

6.1 Introduction

As discussed in chapter 2, section 2.1, PA is widely known as an effective prevention and management tool for a wide range of chronic health conditions (Pavey, et al. 2011; Pederson & Denollet 2003; Pederson & Saltin 2015). Interventions to increase PA are vital in primary care and provide a solution which may reduce the heavy burden on the NHS (Hanson, et al. 2013), which at present has risen to £1.2 billion per year due to the consequences of physical inactivity and rise in NCDs (BHF 2017).

Exercise referral provides a solution to the physical inactivity crisis at present. Schemes aim to increase the number of sedentary patients becoming active, along with aiding the rehabilitation and management of many chronic health conditions (NICE 2014, 2018; Pavey, et al. 2011; Williams, et al. 2007).

There has been little research documenting the change in PA levels after exercise referral completion; and what has been conducted appears conflicting (Chalder, et al. 2012; Murphy, et al. 2012; Pavey, et al. 2011; Webb, et al. 2016). This is of particular relevance as recent observational findings from ERSs in the NRD suggest that changes in health and wellbeing outcomes may not reach meaningful levels (Wade et al. 2019). It is important to provide an update of the evidence of what is actually happening, with respect to PA levels as a result of ERSs across the UK, in order to understand whether a possible explanation for these findings may be due to insufficient changes in PA levels.

6.2 Aim

Understanding whether ERSs are effective in providing change in PA levels is a key outcome of this study. ERSs aim to increase patients' PA levels (NICE 2014, 2018; Williams, et al. 2007), however, there is a lack of evidence to support this. Within NICE guidelines, under the evidence of effectiveness section, it was suggested that if 36 people participate in an ERS, only one of them will achieve the recommended levels of PA (NICE 2014). There is a lack of evidence to support any changes in PA, therefore, this study aims to provide fresh evidence of whether ERSs are effective in changing PA levels of patients, by reviewing self-reported IPAQ.

6.3 Method

This study required anonymised data to be extracted from the NRD, which was assembled from data exercise referral specialists uploaded from schemes across the UK. Referrals from primary care to ERSs were made between September 2011 and October 2017. There were 5246 participants from twelve scheme sites included within this study. Initially, the database included 24086 participants from nineteen scheme sites. However, due to missing data for paired comparisons either at pre- or post-ERS time point and data entry errors, the total sets of complete data decreased to twelve scheme sites, and included 5246 participants. The database has been described elsewhere including the data cleaning procedures (chapter 4, section 4.5). The study uses a longitudinal study design, as it follows uptake, participation and completion of ERSs. Due to the inclusion of various schemes within the database, an individual patient data meta-analysis with a two-stage approach was used. Ethics approval was provided by Coventry University (P46119).

6.3.1 Exercise referral schemes

At the time of the data cut for this analysis, there were nineteen ERSs within the database, which was then narrowed down to 12 scheme sites as discussed in the section above. Due to the inclusion of various schemes within the database, in order to account for scheme level variance, a multilevel modelling approach was employed involving, an individual patient data random effects meta-analysis with a two stage approach was used (see statistical analysis).

No specific data was provided of the schemes' characteristics or the exercise prescribed to patients referred. Information which was collected included length of scheme, which were all 12 weeks in length (84-90 days).

As previously discussed in section chapter 2, section 2.4, and in line with current practice, participants were offered a referral onto an ERS by a health care professional, if they were 16 years and over. All participants gave informed consent to participate. Referrals had to meet the inclusion criteria (see appendix 4; exclusion criteria: appendix 5) which were set for referral onto schemes. Exercise providers held at least Level 3 exercise referral specialist qualification which is recognised by REPs.

6.3.2 Participants

A total of 12 schemes was included for analysis, including a total of 5246 participants. The average participant age was 53±15 years, and 68% were female. Only participants who had completed a 12-week exercise referral were included within the present analysis.

Referrals attended an induction meeting onto the scheme, which consisted of initial screening and pre-testing. They each participated in a prescription of exercise lasting 12 weeks. The number of sessions participants attended per week is unknown, as this data was not collected in the NRD. The activities conducted with each session are also unknown. Upon completion of the 12-week exercise prescription, participants underwent post-completion testing.

6.3.3 Measures

The National Referral Database used the self-reported International Physical Activity Questionnaire (IPAQ)-short form to measure physical activity levels of participants. This was the PA questionnaire which was used by exercise providers who uploaded data onto the National Referral Database throughout the UK, therefore this was used to measure PA within this study. This questionnaire was used to determine weekly physical activity, in Metabolic Equivalent (MET)-

minutes/week (described below), which was the primary outcome measure. The self-reported IPAQ-short form (appendix 3) was used to determine weekly PA, in MET-minutes per week (mm/pw), which was the primary outcome measure. mm/pw self-reported PA pre- and post- scheme, and was used to examine the impact exercise referral had on the participant's PA levels. IPAQ-short form contains 7 open-ended items surrounding the participants' last 7-day recall of physical activity and sitting behaviours. Items were structured to provide scoring on walking, moderate-intensity and vigorous-intensity activity, in addition to sitting. The IPAQ has been designed for observational research and its test-retest reliability indicates good stability and high reliability (α >.80), along with concurrent validity (Craig, et al. 2003; Lee, et al. 2011). Both continuous and categorical indicators of PA come from IPAQ. The continuous and categorical analysis of IPAQ has been described in chapter 4, section 4.4.2.

6.3.4 Statistical analyses

Analyses performed were with the intention of reporting broadly; do we observe a meaningful change in PA levels in individuals who are undergoing ERSs? Two stage individual patient data meta-analysis was performed on the both the median pre-ERS, and median change scores, (i.e. post- minus pre-ERS scores) for MET-minutes. Analysis was also performed on the breakdown of vigorous and moderate intensity activity, walking, and sitting minutes for pre-ERS, as well as change scores. For stage one, both median pre-ERS for MET-minutes and mean pre-ERS for activity breakdowns, and median change scores for mm/pw and mean for activity breakdowns, and their standard errors were derived for each scheme.

The second stage involved performing a random effects meta-analysis using the 'metafor' package in R (version 3.5.0; R Core Development Team, https://www.r-project.org/) across all schemes to derive a final point estimate and precision of estimate (95% confidence intervals [CI]). A random effects model was used as our aim was to estimate the PA levels and changes in PA levels for individuals undergoing *any* ERS. We assumed that, due to there being considerable uncertainty in the manner in which each individual ERS scheme was delivered, it was not a reasonable assumption to treat them all as providing estimates of a fixed or common effect. That is to say, the variation in effect sizes estimated for each scheme was assumed not due to solely sampling variation. Estimates were weighted by inverse sampling variance and restricted maximal likelihood estimation was used in all models. Schemes without sufficient participants (n<4) were excluded from the analysis. Robustness of main effects was considered through sensitivity analyses by removal of individual schemes and re-analysis of the random effects model. Where significant estimates became non-significant and vice versa, in addition to where there were considerable changes in the magnitude and/or precision of those estimates, the results of sensitivity analyses are reported.

An α of 0.05 was used to determine statistical significance, however results were not interpreted dichotomously based purely on this, or whether the 95%CIs crossed zero. Instead, the point estimate and its precision were considered in light of the PA guidelines, and interpreted with respect to how meaningful the change was. In this sense, progressively greater increases in mm/pw are required as starting PA levels increase to move into a higher category. Based upon the IPAQ 'low' = 0 to 599 mm/pw, 'moderate' = 600 to 1499 mm/pw, and 'high' as either >1500 mm/pw (consisting of vigorous activity on at least 3 days), or >3000 mm/pw (consisting of any combination of activities across 7 days). For high it was considered the lower threshold of 1500 mm/pw. Categorical IPAQ data was also examined and the descriptive proportions both pre- and post-ERS considered across schemes in addition to longitudinal plotting across the entire sample to examine changes between IPAQ categories.

6.4 Results

A total of 12 schemes was included in the final analysis, which included a total of 5246 participants, with an average age of 53±15 years and 68% of whom were female.

6.4.1 Categorical IPAQ Classification

Examination of categorical data revealed that roughly half of participants who began an ERS were not classified as having 'low' levels of PA. There were shifts from pre-ERS to post-ERS in the proportions of participants in each category with decreases in the proportion of those in the 'low' categories and increases in both 'moderate' and 'high'. Table 9 shows the proportions across schemes. Tracking of the entire sample visually (figure 5) showed that participants within the 'low' categories tended to shift into the 'moderate' and 'high' categories. Some participants within the 'moderate' category also shifted into the 'high' category. However, a number of participants in the 'low' category remained in this category, some in the 'moderate' category dropped into the 'low' category, and some in the 'high' category dropped into both the 'moderate' and 'low' categories.

Table 9. Proportions of participants in IPAQ categories pre- and post-ERS.

Table 9. Proportions of participants in IPAQ categories pre- and post-ERS.

Scheme	Low		Moderate		High	
	Pre	Post	Pre	Post	Pre	Post
5001	197 (36.1%)	90 (16.5%)	286 (52.5%)	282 (51.7%)	62 (11.4%)	173 (31.7%)
5002	146 (32.4%)	47 (10.4%)	221 (49.1%)	295 (65.6%)	61 (13.6%)	108 (24.0%)
5036	615 (45.0%)	296 (24.3%)	547 (50.6%)	752 (61.8%)	54 (4.4%)	168 (13.8%)
5056	748 (58.9%)	443 (34.9%)	459 (36.1%)	735 (57.8%)	64 (5.0%)	93 (7.3%)
5063	61 (33.0%)	26 (14.1%)	85 (45.9%)	69 (37.3%)	32 (17.3%)	38 (20.5%)
5072	325 (55.4%)	111 (18.9%)	226 (38.5%)	371 (63.2%)	36 (6.1%)	105 (17.9%)
5089	148 (71.2%)	103 (49.5%)	60 (28.8%)	100 (48.1%)	0 (0.0%)	5 (2.4%)
5108	131 (54.8%)	51 (21.3%)	95 (39.7%)	156 (65.3%)	13 (5.4%)	32 (13.4%)
5119	3 (42.9%)	0 (0.0%)	3 (42.9%)	3 (42.9%)	1 (14.3%)	4 (57.1%)
5131	159 (38.0%)	32 (7.7%)	199 (47.6%)	214 (51.2%)	60 (14.4%)	172 (41.1%)
5144	7 (21.2%)	0 (0.0%)	12 (36.4%)	10 (30.3%)	13 (39.4%)	23 (69.7%)
5156	55 (64.0%)	18 (20.9%)	29 (33.7%)	52 (60.5%)	2 (2.3%)	16 (18.6%)
All schemes	2595 (49.5%)	1217 (23.2%)	2223 (42.4%)	3039 (57.9%)	398 (7.6%)	938 (17.9%)

Note: Where percentages do not sum to 100% this is due to missing data and inability to categorise some participants i.e. Unknown category.

Figure 5. IPAQ category tracking of entire sample.

6.4.2 Pre-ERS MET-minutes

For pre-ERS MET-minutes the estimate from random effects model was 676 MET-minutes [539 to 812 minutes], $p < 0.0001$). Figure 6 shows the forest plot for pre-ERS MET-minutes. Significant heterogeneity was evident among the schemes ($Q_{(11)} = 84.31$, $p < 0.0001$; $I_2 = 90.41\%$), however, sensitivity analysis did not reveal any influential schemes.

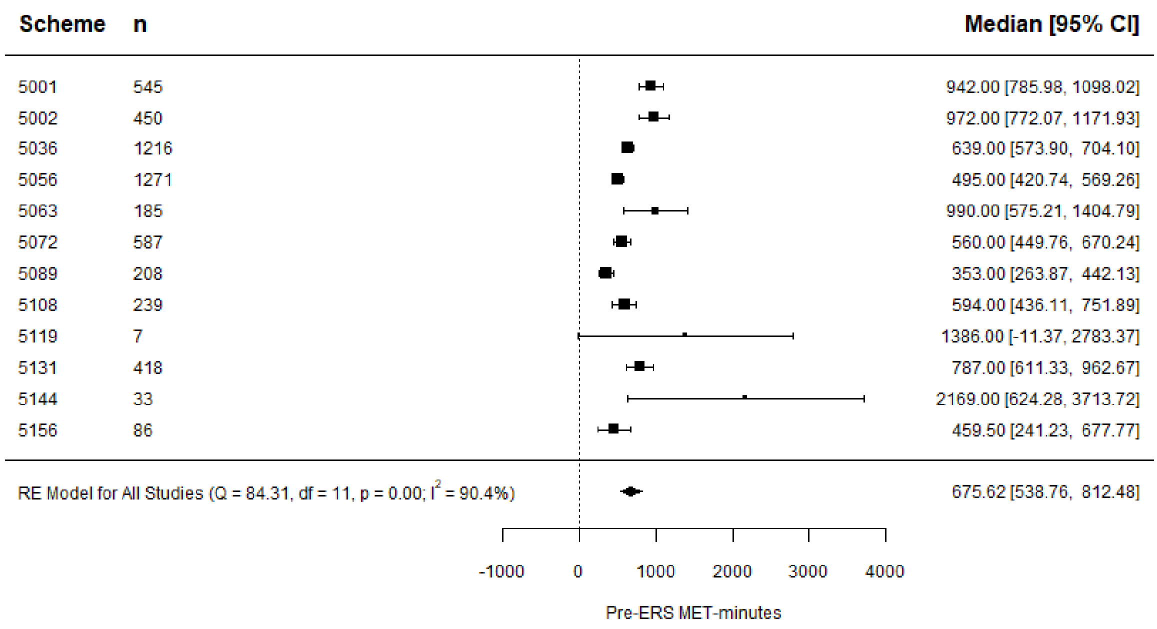


Figure 6. Forest plot of pre-ERS MET-minutes across schemes.

6.4.3 Pre-ERS breakdown of activity minutes

Forest plots are shown for pre-ERS breakdown of activity minutes in figure 7. For pre-ERS vigorous activity the estimate from random effects model was 25 minutes [16 to 34 minutes], $p < .0001$). Significant heterogeneity was evident among the schemes ($Q_{(10)} = 128.54$, $p < .0001$; $I_2 = 87.52\%$), however, sensitivity analysis did not reveal any influential schemes. For pre-ERS moderate activity the estimate from random effects model was 45 minutes [38 to 51 minutes], $p < .0001$). Significant heterogeneity was evident among the schemes ($Q_{(11)}$ = 84.15, $p < .0001$; I^2 = 87.52%), however, sensitivity analysis did not reveal any influential schemes. For pre-ERS walking the estimate from random effects model was 59 minutes [48 to 69 minutes], $p < .0001$). Significant heterogeneity was evident among the schemes ($Q_{(11)}$ = 167.73, $p < .0001$; I^2 = 96.66%), however, sensitivity analysis did not reveal any influential schemes. For pre-ERS sitting the estimate from random effects model was 384 minutes [352 to 415 minutes], $p < .0001$). Significant heterogeneity was evident among the schemes ($Q_{(11)}$ = 365.00, $p < .0001$; I^2 = 97.20%), however, sensitivity analysis did not reveal any influential schemes.

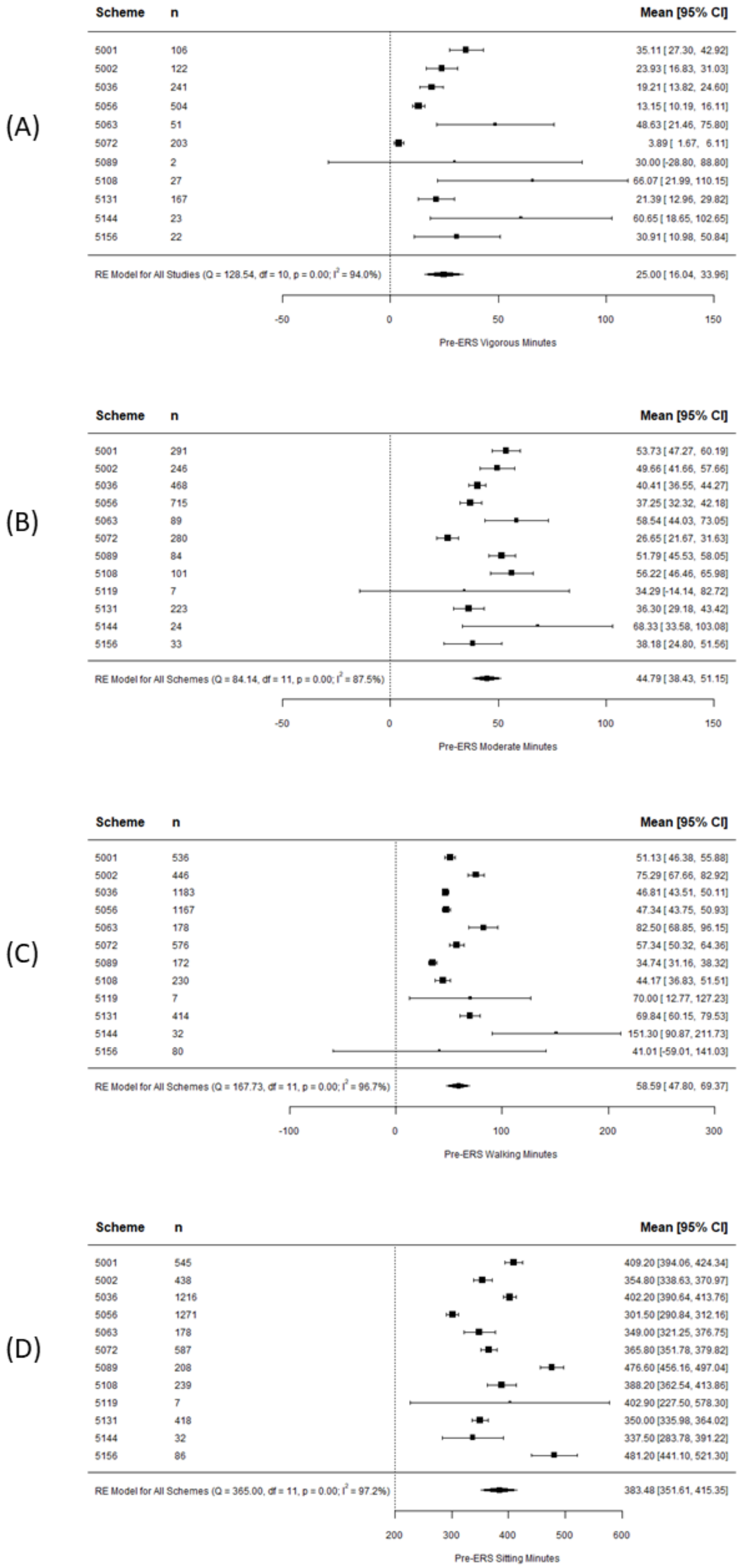


Figure 7. Forest plots for pre-ERS breakdown of activity minutes

6.4.4 Change in MET-minutes

For change in MET-minutes the estimate from random effects model for was 540 MET-minutes [396 to 684 minutes], $p < 0.0001$). Figure 8 shows the forest plot for pre-ERS MET-minutes. Significant heterogeneity was evident among the schemes ($Q_{(11)} = 47.44$, $p < 0.0001$; $I_2 = 84.90\%$), however, sensitivity analysis did not reveal any influential schemes. Considering the estimate for pre-ERS MET-minutes (676 MET-minutes), it would seem that the estimate for change in MET-minutes resulted in participants beginning as moderately active and, though their activity levels increased and categorical analysis showed changed, the effect estimate for change in activity levels were insufficient to result in a change in IPAQ category with them remaining moderately active.

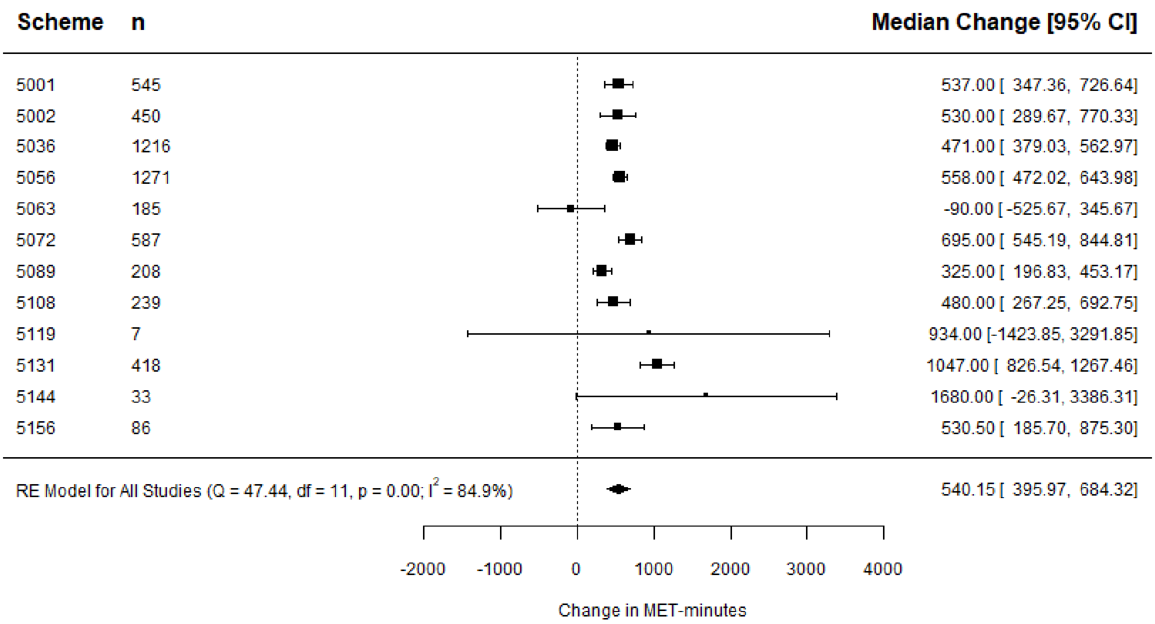


Figure 8. Forest plot of change in MET-minutes across schemes.

6.4.5 Breakdown of change activity minutes

Forest plots are shown for change in activity minutes can be seen in figure 9. For change in vigorous activity the estimate from random effects model was 17 minutes [9 to 24 minutes], $p < .0001$). Significant heterogeneity was evident among the schemes ($Q_{(11)} = 480.16$, $p < .0001$; $I_2 = 97.87\%$), however, sensitivity analysis did not reveal any influential schemes. For change in moderate activity the estimate from random effects model was 29 minutes [22 to 36 minutes], $p < .0001$). Significant heterogeneity was evident among the schemes ($Q_{(11)} = 133.55$, $p < .0001$; $I_2 = 92.14\%$), however, sensitivity analysis did not reveal any influential schemes. For change in walking the estimate from random effects model was -5 minutes [-14 to 5 minutes], $p = 0.3687$). Significant heterogeneity was evident among the schemes ($Q_{(11)} = 94.79$, $p < .0001$; $I_2 = 95.91\%$), however, sensitivity analysis did not reveal any influential schemes. For change in sitting the estimate from random effects model was -61 minutes [-78 to -43 minutes], $p < .0001$). Significant heterogeneity was evident among the schemes ($Q_{(11)} = 88.51$, $p < .0001$; $I_2 = 90.63\%$), however, sensitivity analysis did not reveal any influential schemes.

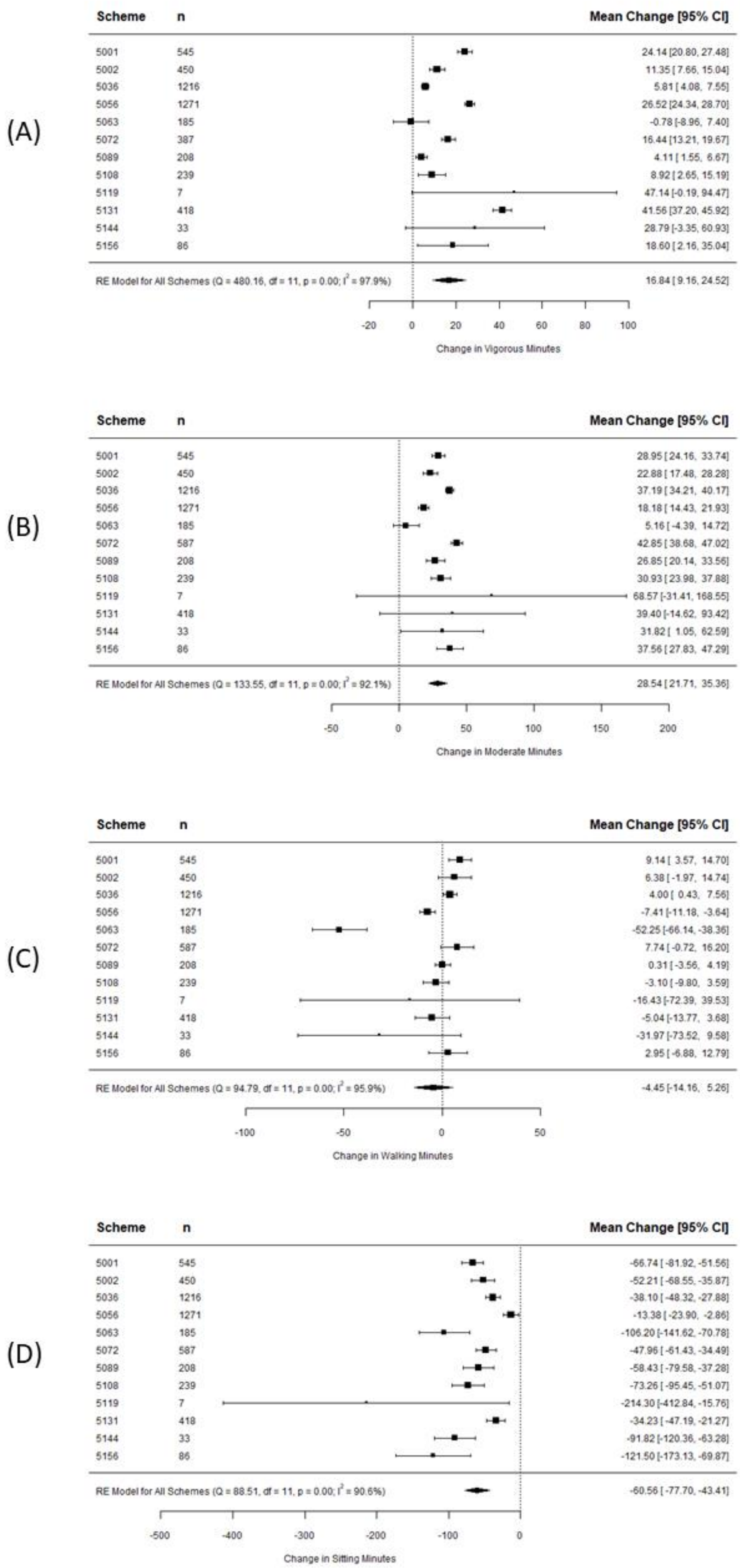


Figure 9. Forest plots for breakdown for change activity minutes.

6.4.6 Exploratory meta-regression

Due to the finding that ERSs appear to be attracting those who are categorised as having either 'moderate' or 'high' PA levels despite guidance suggesting they should be aimed at those who have 'low' PA levels, exploratory analysis was performed using mixed effects meta-regression to examine the relationship between proportion of participants (%) in each scheme categorised as having 'low' PA levels, and changes in PA levels. The coefficient for change in total MET-minutes was not significant (-5.7 MET-minutes [-17.3 to 5.9], p = 0.3347) with a significant residual heterogeneity ($QE_{(10)}$ = 39.91, p < 0.0001) and R_2 = 0.00%. Figure 10 shows the meta-analytic scatterplot for change in total MET-minutes and proportion of participants categorised as 'low' physical activity.

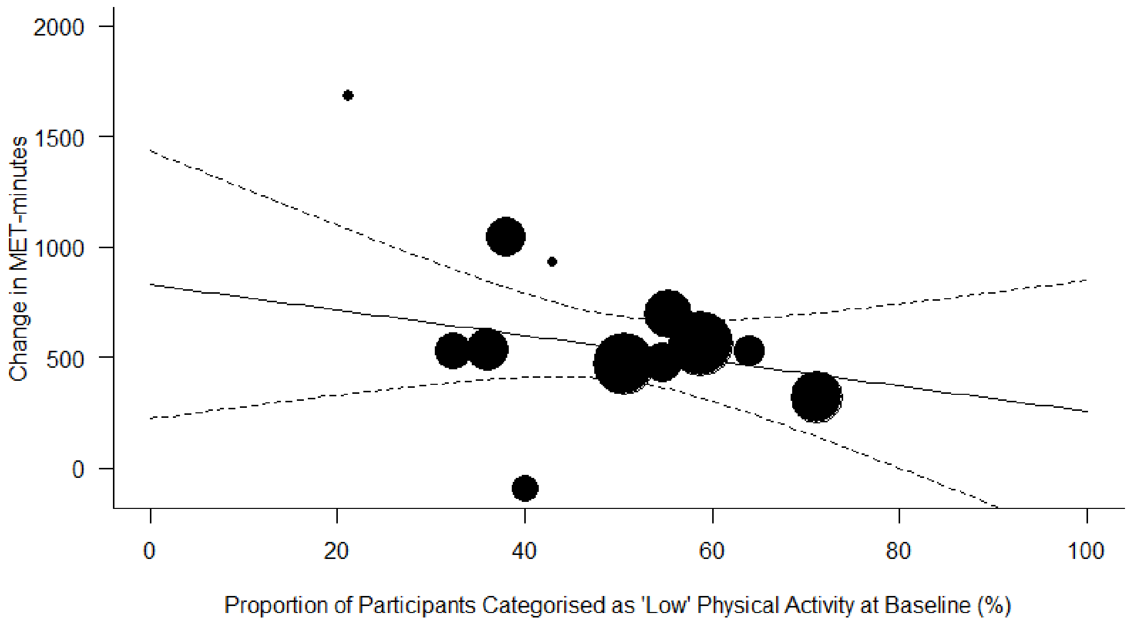


Figure 10. Meta-analytic scatterplot for change in total MET-minutes and proportion of participants categorised as 'low' physical activity.

The coefficient for change in total vigorous minutes was not significant (-0.3 minutes [-0.9 to 0.3], p = 0.3204) with a significant residual heterogeneity ($QE_{(10)}$ = 443.79, p < 0.0001) and R^2 = 0.00%. The coefficient for change in moderate minutes was not significant (0.2 minutes [-0.3 to 0.7], p = 0.4684) with a significant residual heterogeneity ($QE_{(10)}$ = 132.00, p < 0.0001) and R^2 = 0.00%. The coefficient for change in walking minutes was not significant (0.3 minutes [-0.4 to 1.1], p = 0.3788) with a significant residual heterogeneity ($QE_{(10)}$ = 93.03, p < 0.0001) and R^2 = 0.00%. The coefficient for change in sitting minutes was not significant (0.4 minutes [-0.8 to 1.7], p = 0.5230) with a significant residual heterogeneity ($QE_{(10)}$ = 75.60, p < 0.0001) and R^2 = 0.00%. Figure 11 shows the meta-analytic scatterplots for change in breakdown of activity minutes and proportion of participants categorised as ‘low’ physical activity.

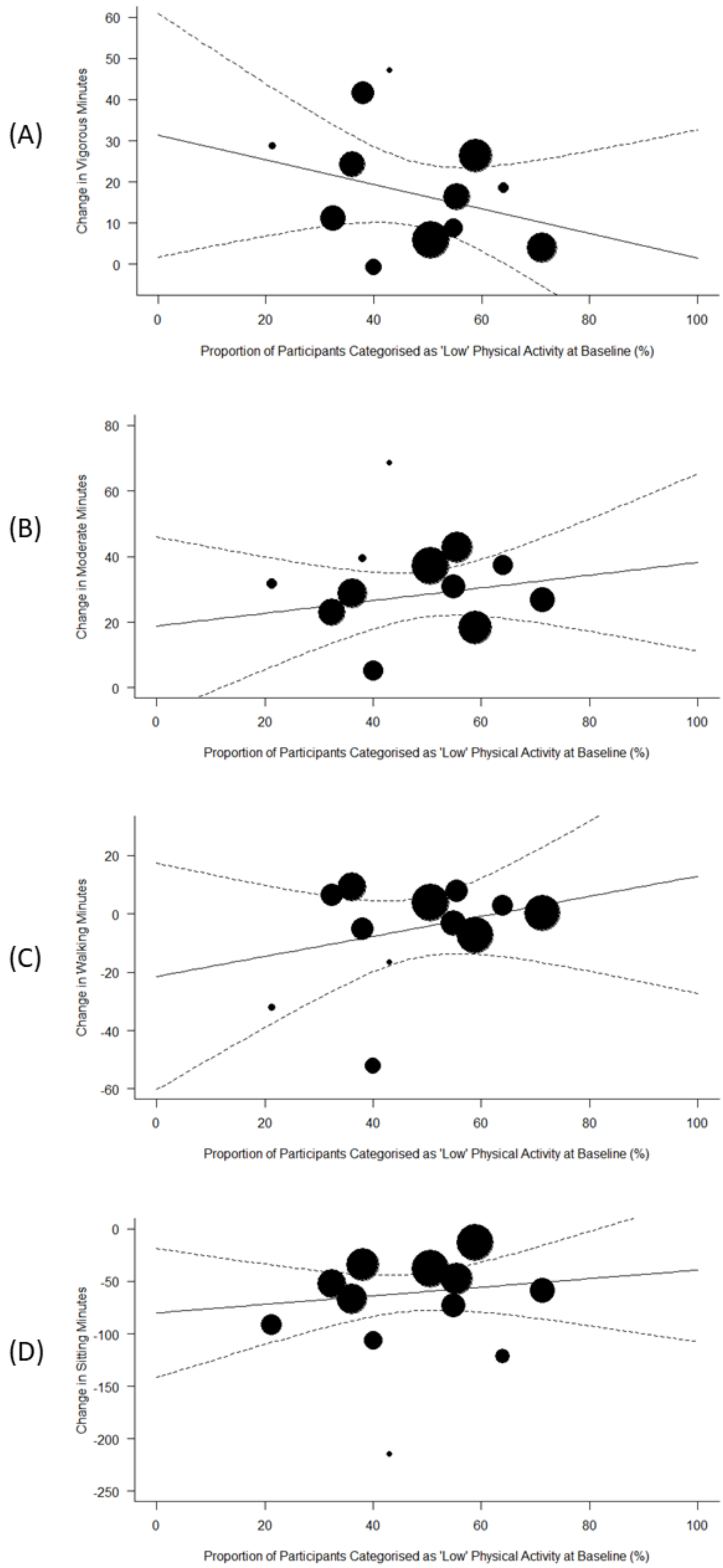


Figure 11. Meta-analytic scatterplots for change in breakdown of activity minutes and proportion of participants categorised as 'low' physical activity.

6.5 Discussion

6.5.1 Main findings

The main aim of the present study was to examine changes in PA in participants who had completed an exercise referral. The results presented in this chapter are initial observational findings from the analysis of the NRD. Previously, there has been a lack of evidence that examines changes in PA levels, thus, being the reason for reviewing this in detail. NICE (2014) recommended that future research should examine change in PA levels, with PA being the primary outcome measured. Therefore, this study aimed to meet this recommendation, providing evidence of the effects of ERSs on change in PA levels.

After data cleaning, 12 different schemes were analysed, with a total of 5246 participants. Categorical data revealed that roughly half of the participants entering the ERSs examined were classified as having 'moderate' or 'high' levels of PA. Effect estimates from meta-analysis showed that pre-ERS participants total PA fell in the 'moderate' category, completing a median 676 mm/pw [539 to 812 minutes], comprising of 25 minutes [16 to 34 minutes] vigorous activity, 45 minutes [38 to 51 minutes] moderate activity, 59 minutes [48 to 69 minutes] walking, and 384 minutes [352 to 415 minutes] sitting. This suggests that participants were already moderately active, and meeting current global guidelines of 600 mm/pw (WHO 2018). Significant increases of 540 mm/pw [396 to 684 minutes] occurred in participants undergoing ERSs, and this change occurred, as a result of increases in vigorous activity of 17 minutes [9 to 24 minutes], increases in moderate activity of 29 minutes [22 to 36 minutes], and reductions in sitting time (-61 minutes; -78 to -43 minutes). Little change was reported in weekly walking minutes (-5 minutes; -14 to 5 minutes). Overall, changes were primarily facilitated by increased MVPA and reduced sitting. Though, categorical data showed at the group level positive changes in the proportions of participants within each IPAQ category (i.e. fewer in the ‘low’ and more in the ‘moderate’ and ‘high’ categories), visualisation of individual data from pre- to post-ERS showed that changes occurred in both directions with some participants moving to higher, and lower, categories. Consideration of the meta-analytic effect estimate for change would suggest that this was not sufficient to result in categorical change within the population and participants where on average still classed as ‘moderately active’.

These results also providing evidence that participants were meeting the PA guidelines of 150 minutes per week, pre-and-post scheme (CMO 2018, 2019; PHE 2017; WHO 2018). According to the WHO’s global PA guidelines, people should conduct at least 600 mm/pw, which equates to 150 minutes per week (WHO 2018), and within this study participants achieved on average an increase of 676 mm/pw, meeting the recommended amount of PA.

Research suggests that a dose-response relationship occurs between PA and health benefits if patients can improve MET-minutes to 500-1000 mm/pw (Nelson, et al. 2007). Here, participants’ change in PA, though statistically significant, only just achieved this threshold, which may explain why only small changes in health and wellbeing outcomes have been previously reported in exercise referral patients (Wade, et al. 2018). It is also thought that the dose-response curve for PA is steepest at the lowest end of the curve (Wasfy & Baggish 2016), i.e. moving from a ‘no’ or ‘low’ to a ‘moderate’ physical activity level. Though, the meta-analytic estimate suggested participants in this study tended to be already moderately active at the beginning of their ERSs. Indeed, in previous studies some proportion of participants undergoing ERSs have reported themselves as being 'moderately inactive' (15.3%; Murphy, et al. 2012). Chalder et al. (2012) also reported that ~25-28% of their participants were already achieving at least 1000 MET-minutes/week of PA at baseline. This is perhaps a cause for concern as the NICE guidelines (2014; 2018) suggest ERSs should be targeted towards inactive individuals. The observational data presented here would suggest that this recommendation is not being followed. However, it should be considered that some participants may be overestimating their levels of PA, and not accurately recording their activity.

A number of participants moved from the 'low' category to both the 'moderate' and 'high' categories and, considering the dose-response nature of PA changes, it may be that the more meaningful PA, health and wellness changes primarily occur in those who begin an ERS categorised as inactive. However, exploratory meta-regression analysis examining whether there was an association between the proportion of participants in schemes classified as having 'low' PA levels did not demonstrate this. Further, supplementary analysis performed by Wade et al. (2020) did not show particularly strong relationships between changes in PA levels and health and wellbeing outcomes in ERS participants from analysis conducted using The National Referral Database.

ERSs can and do increase PA levels, however the value of this to a participant's health outcomes is less clear. In their systematic review and meta-analysis, Pavey, et al. (2011) reported that, compared with usual care, ERSs have a slightly greater impact on the number of participants achieving between 90-150 minutes of moderate activity per week. However, they noted that at the time evidence was weak. Using seven-day PA recall, Murphy, et al. (2012) found that ERS group participants at 12 months' post intervention achieved a median of 200 minutes of exercise compared with 165 for the control group. Chalder, et al. (2012) found increases post intervention, though no significant differences, in proportion of participants meeting at least 1000 MET-minutes/week between ERS or usual care in depressed adults, though descriptively they noted slight differences (ERS = 52% at four months, 63% at eight months, and 58% at twelve months; Usual care = 43% at four months, 49% at eight months, and 40% at twelve months). These results show changes likely do occur, although not of considerable magnitude.

6.5.1.1 Nature of these changes

It is also worth considering the nature of the change in PA levels. The increases in total PA where primarily driven by increases in MVPA and decreases in sitting. Participants increased MVPA per week by approximately 46 minutes (17 minutes vigorous and 29 minutes' moderate), yet walking did not change much in participants undergoing an exercise referral. Though walking and light activities are associated with improvements in all-cause mortality, these seem to be greatest again at the lower end of the dose-response curve (Kelly et al. 2014), and at an equal volume, MVPA is associated with greater benefits (Saint-Maurice et al. 2018). Thus, it could be viewed as positive that MVPA increased in patients undergoing ERSs. Increases in MVPA even in small amounts have been shown to be associated with reductions in all-cause mortality (Jefferis et al. 2019). Though, Jefferis et al. (2019) reported that for each 10-minute increase in MVPA per day, this resulted in 10% reduction in all-cause mortality risk. O'Donovan et al. (2018) have recently reported that inclusion of vigorous activity has an even stronger impact upon CVD mortality risk. Participants in this present study showed gains in vigorous activity, which may still yield significant health benefits beyond the scope of the timeframe of the prescription. Further, there was approximately a 1-hour reduction in sitting time across participants, and recent data shows that reducing sitting time reported point estimates of approximately 30 minutes per day, which is considered clinically meaningful (Peachey et al. 2018).

6.5.1.2 Length of scheme

It is important to consider length of schemes as a factor which could influence changes in PA. In the systematic review in chapter three (also in the published paper: Rowley, et al. 2018), it was found that longer length schemes (20+ weeks) improved adherence to PA prescribed over the course of the scheme. This research emphasises on the importance of possibly increasing length, as changes in IPAQ categories (moving from moderate or high) may be visible, if the participants were exercising for a longer period. However, the results from this study could also suggest that shorter schemes are actually effective in increasing PA, although may not be meaningful in terms of moving participants into the next category on the IPAQ scoring scale. A more meaningful change may be visible if follow ups were conducted post-completion (3 months, 6 months and 12 months).

6.5.2 Limitations

There are several limitations with the current database (Steele, et al. 2019) that are worthy of note and these partially extend to the data analysis here. Length of scheme is a factor that could influence changes in PA. However, in this study only schemes of 12 weeks in length were included. In a recent systematic review (Rowley, et al. 2018) it was reported that longer length schemes (20+ weeks) improved adherence to PA prescribed over the course of the scheme. This research emphasises the importance of increasing length of schemes. Indeed, it may be that if longer schemes where present in the database for analysis these may reveal greater PA increases compared with shorter schemes. Although other research by Webb, et al. (2016) suggests shorter schemes can be effective as it was found that after completing an 8-week ERS, categorical IPAQ scores significantly increased.

Another limitation, considering PA levels specifically, use of self-reported outcomes, is a potential issue. IPAQ is of course a subjective measure and was not designed for examination of change in PA levels and this could mean it does not well reflect participants' changes in PA (Lee, et al. 2011), however, this was the only measure used within the database reviewing PA levels of participants. Although, a recent study has suggested that participants' perceptions of their PA levels relative to others, even when independent of the actual PA conducted (whether self-reported or device measured), are strong predictors of all-cause mortality (Zahrt & Crum 2017).

Other studies measuring PA have used other methods such as attendance, both self-reported, and reported by the exercise provider (Arsenijevic & Groot 2017; Pavey, et al. 2012; Shore, et al. 2019). Again, using self-report methods to measure attendance, has its issues, as it relies on patients being honest about attending, and not under- or over-estimating their PA. Another issue with using attendance to measure adherence, is that it does not truly measure adherence to the exercise prescription; whereas, it only measures whether a patient turns up to the exercise facility, rather than measuring the exercise conducted and effort.

Although this study reviewed the effects of ERSs on change in PA, it does not consider the reasons for why patients chose to attend an exercise referral. Indeed, many factors influence uptake (Birtwistle et al. 2018), and it seems likely these factors could also influence engagement throughout. Some patients may have attended due to their own motivation to improve their health conditions, whereas, other patients may have only attended because their GP advised them. A future study could review the reasoning behind patients' uptake to schemes, along with recorded adherence to PA, or self-report PA through IPAQ.

Lastly, similarly to the health and wellbeing outcomes, there was considerable heterogeneity across schemes with respect to the changes observed. This has been reported previously (Pavey, et al. 2011; Shore, et al. 2019), and discussed throughout this thesis. This is something that requires a review, to find new ways to avoid heterogeneity and increase the opportunity for standardised approaches to be implemented across all schemes.

6.5.3 Implications for practice and future research

Exercise referral has shown to improve PA levels of participants upon completion, but further research into the referral reasons, mode and type of exercise prescribed and outcomes need to be reviewed in further detail. It is vital for schemes to provide patients with an introduction to exercise, and to then focus on the longer-term habituation of exercising regularly post-completion (BHFNC 2010), and focus on meeting national PA guidelines (CMO 2018, 2019). Thus, in theory, will increase self-management of health conditions through PA. After completing this introduction to PA, schemes should provide follow up appointments (3 months, 6 months and 12 months after completion), to ensure that patients are still exercising regularly and self-managing PA and health conditions. This would support the NHS's long-term plan (2019), of increasing self-management in the UK.

From the research conducted within this study, exercise prescriptions of 12 weeks do provide changes in recorded MET-minutes, compared to pre-scheme. The PA levels achieved also meet the recommendations of 150 minutes per week and 600mm/pw (CMO 2018, 2019; WHO 2018). Although this achievement was made, there were no significant categorical changes in IPAQ scores. This research provides fresh evidence of the effects of ERSs on changes to PA levels from a cohort of exercise referral patients across the UK.

This research aims to meet one of the research recommendations by NICE (2014). If data collection was improved within the NRD, then a larger scale evaluation could be achieved. The main reason for the smaller sample size within this study, was due to the missing data from paired comparisons either at pre- or post-ERS time point and data entry errors. If data collection was improved, there would be potential for a larger scale study of over 24000 participants from across the UK.

There are some key recommendations which should be taken away from this study; further research is required to explore the different types, mode, intensities and durations of exercise prescribed based upon referral reasons within different sub-populations. This can potentially improve the accuracy of an exercise prescription in the management of chronic health conditions. Another recommendation is, updates to the NRD are required to gain further data which could enable a larger scale evaluation of schemes from across the UK. This would support a key recommendation from the Global Action Plan on PA report (WHO 2018), which suggests that national research and evaluation needs to be strengthened within the application of digital technologies aimed at increasing PA and reducing sedentary behaviour. The NRD is a unique piece of software which can be used by exercise providers to upload data from exercise referral patients. By providing a better platform for data collection and better analysis of schemes, the evidence base for ERSs will increase, providing evidence of the effectiveness, or not, of ERSs.

6.6 Conclusion

To conclude, these results represent the initial findings from first analysis of the NRD considering PA levels. The analyses performed here were with the intention of considering broadly are changes in PA levels observed in patients who are undergoing ERSs? The findings suggest that significant changes in total MET-minutes do occur. Participants in the ERSs assessed here were however predominantly ‘moderately active’ at baseline and remained so post-ERS. Thus, it is not clear the degree to which the changes observed are meaningful or not. Considering the heterogeneity of results across schemes also, future work, including that afforded by this database, should be focused upon determining where best practice exists (i.e. what works best for which population).

Chapter 7:

Study 3 -

Patients' characteristics as predictors of dropout from exercise referral schemes in the UK

Chapter 7: Patients' characteristics as predictors of dropout from exercise referral schemes in the UK

The third in a line of studies is presented within this chapter. The purpose of this chapter is to provide a review of patients' characteristics as predictors of the likelihood of dropout from exercise referral schemes within the UK. There is a lack of research that examines key patients' characteristics to predict the likelihood of dropout within UK exercise referral patients, especially on a larger scale; this study aims to address this issue. By examining key characteristics which could predict whether a patient is more or less likely to dropout, could provide vital evidence for exercise referral specialists to help reduce dropout.

7.1 Introduction

ERSs have the potential to impact PA levels of those who complete (Murphy, et al. 2012). Results from chapter six corroborate with this, as a mean increase in vigorous PA of 17 minutes, mean increase in moderate PA of 29 minutes, and a mean reduction of -61 minutes of sitting time were observed; although these results did not see sufficient IPAQ categorical changes (moving from moderate to high activity levels). The effectiveness of ERSs is heavily influenced by the number of people who adhere to a scheme until completion (Pavey, et al. 2012). A clear challenge of effectiveness is, overcoming low adherence to schemes, and high dropout rates (Beedie, et al. 2015), which can have undesirable bearings on cost-effectiveness; creating implications for schemes who are struggling for funding (Pavey, et al. 2012). There are clear issues with examining adherence until completion. This may be due to under-reporting adherence which affects the effectiveness of interventions (Willinger, et al. 2019).

For the purpose of this study, dropout is defined as when a patient uptakes within an exercise referral, but does not continue until completion where post-completion data is collected. Dropout was inferred from a patient not having any post-completion data. Adherence has been defined as a participant who initially takes part, continues to take part (Pavey, et al. 2012), typically continuing until completion (Kelly, et al. 2016). Completion is defined as adhering to the exercise prescription until the end of the prescription and completing the post-completion measures during the final session. Dropout and completion have been discussed in more detail in chapter 2, section 2.4.9.

At present, there is insufficient evidence to support the effectiveness of exercise referral, with a concerning issue being adherence and completion rates (NICE 2014, 2018). Due to the lack of standardised protocols, interpretation of attendance, adherence and completion rates must be treated with caution (Shore, et al. 2019). There is no standardised practice for reporting adherence and completion, with adherence typically mistaken for attendance (Arsenijevic & Groot 2017; Pavey, et al. 2012; Shore, et al. 2019). Even if a patient has attended every session for the past eleven weeks, but then doesn’t turn up for the final session, exercise referral specialists do not have any specific procedure to follow to determine whether that patient should be categorised as completed or dropped out. There are no standardised procedures in place for reporting dropout and reasons for dropping out, therefore exercise referral specialists may not be following up with these patients to see if they've actually dropped out or just unable to attend.

Adherence to schemes has been reported ranging from 43% to 53% in various studies (Hanson, et al. 2013; Murphy, et al. 2012; Pavey, et al. 2012; Tobi, et al. 2012). However, a more recent systematic review of reviews found that adherence to schemes varied further, ranging from 12% to 49% (Shore, et al. 2019). Many studies report adherence in different ways, with completion rates not always distinctly described in comparison to adherence rates.

NICE guidelines suggest that further research should focus on identifying barriers to participation (NICE 2014, 2018). There have been several studies which have examined adherence and participation of ERSs (Crone, et al. 2008; Gidlow, et al. 2005; Hanson, et al. 2013, 2019), barriers to participation (Jagroo & Ellis 2016; Kelly, et al. 2016) and predictors of dropout (Kelly, et al. 2016; Leijon, et al. 2011; Tobi, et al. 2012). A previous systematic review also suggested that participants' characteristics of who were less likely to dropout were even less well reported (Shore, et al. 2019), therefore, examining these characteristics would provide evidence which would support those who are less likely to dropout. The current study is different to previous studies as it examines participants from a larger cohort of exercise referral patients than previously examined. The current study also includes more characteristics than previously examined, and has more statistical power than previous studies (Kelly, et al. 2016; Leijon, et al. 2011; Tobi, et al. 2012), as this study combines gender, age, ethnicity, disability, employment, IPAQ scores, referring health care professional and referring organisation into one model. The sample for the current study is representative of the wider population, and large enough, so that any tendencies detected within the sample may be generalised to the wider ERS population.

7.2 Aim

Identifying key patients' characteristics which could predict whether a patient is more or less likely to dropout is the key outcome of this study. To date, there has been no large-scale evaluations predicting the likelihood of dropout, therefore this study is the first of its kind. With this research, exercise referral specialists may be more aware of those patients who are more likely to dropout, or at risk of dropout, and can tailor their approach to reduce the likelihood of dropout.

This study also aims to provide evidence from exercise referral which is ecologically valid, due to being conducted within an ERS within a leisure facility, as past research has suggested that efficacy of an intervention in an experimental setting does not necessarily reflect its effectiveness in practice (Estabrooks & Gyurcsik 2003; Gidlow, et al. 2005). By bridging the gap between research and practice, evidence can be translated, providing key characteristics which exercise referral specialists should be aware of, to then tailor the delivery of the exercise prescription in specific ways which could improve the chances of adhering until completion, and even post-scheme.

7.3 Methods

7.3.1 Study design

The study uses a retrospective, longitudinal study design, as it follows participant's uptake, and dropout or completion of an exercise prescription within an ERS, with data already collected through the NRD. Ethics approval was provided by Coventry University (project code: P46119).

7.3.2 Exercise referral schemes

Anonymised data were extracted from the NRD, which comprised of data from referrals to local ERSs throughout the UK. Participants were referred by health care professionals to a local ERS between September 2011 and October 2017. A total of sixteen schemes were included within the analysis. No specific details were provided of the scheme's characteristics, apart from length of scheme which was 12 weeks in length (84-90 days).

Details of the exercise referral process can be seen in chapter 2, section 2.4.4. All participants were referred to a 12-week ERS by various referrers including GP, nurse, physiotherapist or other health care professionals. Participants were aged 16 years and over, and met the inclusion criteria (NICE 2014, 2018; appendix 4). All participants had given informed consent to participate within the ERS. All exercise referral specialists held at least Level 3 exercise referral specialist qualification recognised by REPS.

7.3.3 Participants

Data were collected from 19078 participants who enrolled onto local ERSs in the UK, between January 2011 and October 2017. Mean age of participants who dropped out was 49±14 years, 70% female. Mean age of participants who completed was 53±14 years, 68% female. Only participants that had left early (dropped out) and completed were included within the analysis. Dropout was determined as only having pre-data available, and no post-completion data from the final week of the prescription (week twelve). Regular attendance and date of drop out was not available from the NRD. Completion was determined as completing post-data, which would suggest that the participant was present for post-completion data collection.

The exact details of the prescription participants undertook were unclear, due to this not being collected by ReferAll in the NRD. Participants would have been expected to attend regular sessions, supported by the exercise referral specialist. However, details of how regularly participants attended, what their exercise prescription included and adherence to the prescription are all unknown.

7.3.4 Measures

Baseline demographic data, and IPAQ were collected from participants who attended their first appointment at a local ERS. Referring organisation and referring health care professional were also recorded.

7.3.4.1 Demographics

Baseline demographic data were collected from all participants who attended an induction at a local ERS (baseline: week one); this included: gender, age, ethnicity, disability status and employment status. All data were provided from data which exercise referral specialists uploaded onto the NRD.

7.3.4.2 IPAQ

The self-reported IPAQ-short form (appendix 3) was used at baseline, and upon completion, to determine weekly PA, in MET-minutes per week (mm/pw). mm/pw self-reported PA pre- and post- scheme, and used to examine PA levels. Detailed description of the IPAQ can be seen in chapter 4, section 4.4.2.

The IPAQ is the most feasible approach for this population (van der Ploeg, et al. 2017), allowing for the comparison between programmes. Attendance at the final session at week 12 was determined by the exercise referral specialist recording that the participant was present, and completion of the IPAQ. If attendance and IPAQ was not recorded, then the participant was deemed to have dropped out.

7.3.4.3 Referring organisation and health care professional

The referring organisation and referring health care professional were recorded at baseline. The referring organisations were community, hospitals, medical centres, outreach centres, pharmacies and GP surgeries. The referral organisation's total frequencies and percentages can be seen in table 9. The referring health care professional were categorised into: alcohol services, dietician, exercise specialist, GP, health care assistant, health improvement, nurse, occupational therapist, other, pharmacist, physiotherapist, podiatrist/chiropodist, psychologist/psychiatrist, self-referral, and specialist doctor. The total frequencies and percentages for referrer type can be seen in table 10.

Table 10: Referring organisation type, frequencies and percentages total.

Referral Organisation	Frequency (*n*)	Percentage (%)
Community	2	0.01
Hospital	1321	6.92
Medical Centre	1337	7.01
Outreach	812	4.26
Pharmacy	26	0.14
GP Surgery	15580	81.66
Total	***19078***	***100***

Table 11: Referring health care professional, frequencies and percentages total.

Referring health care professional	Frequency (*n*)	Percentage (%)
Alcohol services	6	0.03
Dietician	64	0.34
Exercise specialist	150	0.79
GP	12857	67.39
Healthcare assistant	1466	7.68
Health improvement	638	3.34
Nurse	2282	11.95
Occupational therapist	108	0.57
Other	512	2.68
Pharmacist	30	0.15
Physiotherapist	1773	9.29
Podiatrist	34	0.17
Psychologist	96	0.50
Self-referral	3	0.02
Specialist doctor	59	0.31
Total	***19078***	***100***

7.3.5 Data cleaning and management

Permission to use the data was provided by ReferAll. Data was stored on a personal, password protected laptop. All data were electronically anonymised by ReferAll prior the data export in October 2017. Only data for participants who had left early (dropped out) or completed were included in the analysis of this study. At the time of the data cut in October 2017, there were 24086 participants in total.

However, due to only including participants who were reported as left early or completed included in this study, this number decreased to a total of 19078 participants. All data were error checked and any missing data was coded as ‘not stated’, with incorrect entries discarded from analysis (e.g. age 680 years). Key demographics including gender (female, male), ethnicity (White/White British, Asian/Asian British, Black/Black British, mixed, other), disability (blind/visual impairment, cognitive impairment, deaf/hearing impairment, not disabled, learning disability, long term health condition, mental health condition, other, prefer not to say) and employment (carer, employed full time, employed part time, other, permanently sick/disabled, retired, self-employed, student, unemployed, volunteer) were all collected using predetermined categories designed by ReferAll, reducing data input errors. IPAQ categorical scores were collected using predetermined categories (low, moderate, high), which also reduced the likelihood of input errors. This data was still checked for clear errors. If an answer was missing, then IPAQ was classed as ‘not stated’.

7.3.6 Statistical Analysis

All analysis of data was performed using IBM SPSS Statistics version 25 for windows. Chi-square (χ^2) analysis was conducted to determine any differences in patients’ characteristics including gender, age ethnicity, disability status, employment and employment status, along with baseline IPAQ scores and referral pathways including the referring health care professional and referring organisation between participants that dropped out and completed an exercise referral. Binary logistic regression analysis was conducted to investigate whether any patients’ characteristics could predict the likelihood of dropout at 12 weeks using data collected at the initial assessment; data included gender, age, ethnicity, disability status, employment status, IPAQ scores, referring health care professional and referring organisation. Binary logistic regression model is the ideal analysis with this data, as this analysis models the event probability for categorical response variable with two outcomes (dropout or completion). The dependant variable (dropout) is categorical dropout (yes or no). There is an independence of observations and the dependant variable has mutually exclusive categories. Prior to conducting this analysis, all assumptions were met. Multiple regression models were used for each independent variable to determine which had a significant effect on dropout. Cox & Snell R_2, Nagelkerke R_2 and Homer & Lemeshow were all utilised to investigate the model's goodness of fit. An alpha level of 0.05 was used, and ORs [95%CIs] were calculated within this study.

7.4 Results

7.4.1 Descriptive analysis

A total of 19078 participants attended a local ERS between January 2011 and October 2017. Overall, 52.9% (*n*=10095) of participants completed an exercise referral, whereas 47.1% (*n*=8983) of participants dropped out. Table 11 provides a full breakdown for each characteristic of patients including IPAQ and referral pathway, along with chi-squared (χ_2) results between dropout and completion groups.

Table 12. Baseline, dropout and completion descriptive analysis, including percentage of dropouts and chi-squared ($\chi 2$) results between dropout and completion groups.

	Baseline (*n*=19078)		Dropout (*n*=8983)		Completion (*n*=10095)		Overall % dropout
	n	%	n	%	n	%	
Gender							
Male	5960	31.2	2692	29.9	3268	32.4	45.1
Female	13117	68.8	6290	70.0	6827	62.6	47.9
Transgender	1	0.01	1	0.01	0	0	100
							$\chi 2(1)>= 12.760$, $p < 0.001$*
Age							
16-30	1780	9.3	1041	11.6	739	7.3	58.5
31-40	2872	15.1	1570	17.5	1302	12.9	54.6
41-50	4764	24.9	2455	27.3	2309	22.8	51.5
51-60	4906	25.7	2217	24.7	2689	26.6	45.1
61-70	3029	15.9	1111	12.4	1918	18.9	36.6
71+	1698	8.9	570	6.4	1128	11.2	33.5
Not stated	29	0.2	19	0.2	10	0.1	65.5
							$\chi 2(5)>= 455.648$, $p < 0.001$*
Ethnicity							
White/White British	6742	35.3	2930	32.6	3812	37.7	43.5
Black/Black British	4820	25.3	2192	24.4	2628	26.03	45.4
Asian/Asian British	2937	15.4	1409	15.7	1528	15.1	48
Mixed	477	2.5	244	2.7	233	2.3	51.2
Other	486	2.6	220	2.4	266	2.6	45.3
Not Stated	3616	18.9	1988	22.1	1628	16.1	54.9
							$\chi 2(5)>= 135.740$, $p < 0.001$*
Disability							
Not disabled	2518	13.1	1098	12.2	1420	14.1	43.6
Long term health condition/illness	220	1.2	88	0.9	132	1.3	40
Mental health condition	156	0.8	88	0.9	68	0.7	56.4
Learning disability	51	0.03	21	0.2	30	0.3	41
Blind/visual impairment	13	0.06	7	0.07	6	0.06	53.8
Cognitive impairment	11	0.05	5	0.06	6	0.06	45.5
Deaf/hearing impairment	19	0.09	9	0.10	10	0.09	47.4
Other disability	252	1.3	128	1.4	124	1.2	50.8
Prefer not to say	15	0.08	6	0.06	9	0.1	40
Not stated	15823	82.9	7533	83.9	8290	82.1	47.6

							$\chi^2(4)$> = 26.504, p = 0.002*
Employment							
Employed full time	2735	14.3	1248	13.9	1487	14.7	45.6
Employed part time	1530	8.0	672	7.4	858	8.5	43.9
Self-employed	146	0.8	70	0.8	76	0.8	47.9
Retired	1368	7.2	462	5.1	906	8.9	33.8
Student	84	0.4	54	0.6	30	0.3	64.3
Permanently sick/disabled	192	1.01	102	1.1	90	0.9	53.1
Unemployed	3701	19.4	1897	21.1	1804	17.9	51.3
Carer	53	0.3	29	0.3	24	0.2	54.7
Volunteer	39	0.2	18	0.2	21	0.2	46.2
Other	1495	7.8	600	6.7	895	8.9	40.1
Not stated	7735	40.5	3831	42.7	3904	28.7	49.6
							$\chi^2(10)$> = 193.236, p < 0.001*
IPAQ							
Low	8503	44.6	3910	43.5	4593	45.5	45.9
Moderate	4660	24.4	1964	21.9	2696	26.7	42.1
High	918	4.8	409	4.6	509	5.04	44.6
Not stated	4998	26.2	2700	30.1	2297	22.8	54
							$\chi^2(3)$> = 148.931, p < 0.001*
Referring health care professional							
GP	12857	67.4	6123	68.2	6734	66.7	47.6
Physiotherapist	1773	9.3	847	9.4	926	9.2	47.8
Exercise specialist	150	0.8	42	0.5	108	1.1	28
Healthcare assistant	466	2.4	241	2.7	225	2.2	51.7
Health improvement	638	3.3	261	2.9	377	3.7	40.9
Nurse	2282	11.9	1084	12.1	1198	11.9	47.5
Occupational therapist	108	0.6	47	0.5	61	0.6	43.5
Specialist doctor	59	0.3	56	0.6	3	0.03	94.9
Self-referral	3	0.01	1	0.01	2	0.02	33.3
Dietician	64	0.3	25	0.3	39	0.4	39.1
Alcohol services	6	0.03	3	0.03	3	0.03	50
Pharmacist	30	0.2	28	0.3	2	0.02	93.3
Podiatrist	34	0.2	0	0	34	0.3	0
Psychologist	96	0.5	39	0.4	57	0.6	40.6
Other	512	2.7	186	2.1	326	3.2	36.3
							$\chi^2(14)$> = 175.724, p < 0.001*
Referring Organisation							

Community	2	0.01	0	0	2	0.01	0
Hospital	1321	6.9	599	6.7	722	7.2	45.3
Medical centre	1337	7.0	899	10.0	438	4.3	67.2
Outreach	812	4.3	275	3.1	537	5.3	33.9
Pharmacy	26	0.1	25	0.3	1	0.001	96.2
Surgery	15580	81.7	7185	79.9	8395	83.2	53.9
							($\chi^2(5)>$ = 309.306, $p < 0.001$*

* indicated χ^2 statistically significant difference between dropout and completion groups (α=0.05).

7.4.1.1 Gender

Nearly 48% of females and 45% of males dropped out, representing a statistically significant difference between gender for dropout and completion groups ($\chi^2(1)>$ = 12.760, $p < 0.001$). A total of 52% of females and 55% of males completed an exercise referral.

7.4.1.2 Age

Age was statistically significant between dropout and completion group ($\chi^2(5)>$ = 455.648, $p < 0.001$). Mean age of participants who dropped out was 49±14 years and mean age of participants who completed was 53±14 years. A total of 59% of 16-30 year olds dropped out, reporting the highest dropout. Completion was reported at only 31% for this age range. A total of 34% of participants aged 71+ years dropped out, reporting the lowest dropout, and highest completion rates of 66%.

7.4.1.3 Ethnicity

Ethnicity was statistically significant between dropout and completion group ($\chi^2(5)>$ = 135.740, $p < 0.001$). A total of 51% of participants reporting mixed ethnicity dropped out, reporting the highest dropout, compared to 44% of White or White

British participants who reported the lowest dropout rates. For completion, highest completion rates were for White or White British participants, reporting 56% completing. Lowest rate of completion was for mixed ethnicity (49% completing).

7.4.1.4 Disability

Disability was statistically significant between dropout and completion group ($\chi^2(4)> = 26.504$, $p = 0.002$). A total of 56% of participants with a mental health condition dropped out, with this sub-group having the highest dropout, and lowest completion rates (44%). A total of 40% of participants dropped out within the long-term condition category, having the lowest dropout rates across all groups; this group had the highest completion rates of 60%.

7.4.1.5 Employment

Employment was statistically significant between dropout and completion group ($\chi^2(10)> = 193.236$, $p < 0.001$). A total of 64% of participants who reported being a student dropped out, with only 36% of participants within this category completing, having the highest dropout rates and lowest completion rates overall. Nearly 34% of retired participants dropped out, having the lowest dropout rates across all groups. A total of 66% of participants who reported being retired, completed, with this category having the highest completion rates.

7.4.1.6 IPAQ scores

IPAQ scores were statistically significant between dropout and completion group ($\chi^2(3)> = 148.931$, $p < 0.001$). A total of 46% of participants who reported low IPAQ scores dropped out, with participants in this category reporting highest dropout, and lowest completion rates (54%) across all categories. A total of 42% of participants who reported moderate IPAQ scores dropped out, with participants in this category reporting the lowest dropout and highest completion rates (58%) across all categories.

7.4.1.7 Referring health care professional

Referring health care professional was statistically significant between dropout and completion group ($\chi^2(14)> = 175.724$, $p < 0.001$). Dropout was highest within the specialist doctor category with 95% of participants dropping out, with only 5% of participants referred by a specialist doctor completing (thus, being the lowest completion across all categories). This was followed by the pharmacist category, with dropout of 93% of participants. The lowest dropout was participants referred by a physiotherapist, with 0% dropout. This was followed by referral by an exercise specialist with only 28%.

7.4.1.8 Referring Organisation

Referring organisations were statistically significant between dropout and completion group ($\chi^2(5)> = 309.306$, $p < 0.001$). A total of 96% of participants referred from a pharmacy dropout, having the highest dropout, and lowest completion rates of 4%. Thus, correlates with the second highest dropout for referring health care professional, being a pharmacist. The lowest dropout was participants referred from a community pathway, with 0% dropout, however only 2 people were referred through community pathways. The second lowest dropout was seen from participants referred from outreach pathways with 34% dropout.

7.4.2 Main Analysis

Regression models analysed each independent variable in order the predict whether each participant were more or less likely to dropout. The model contained all predictors which were statistically significant (p<0.05) indicating the model was able to distinguish between participants who were more or less likely to dropout. Table 12 below contains the results from the binary logistic regression for dropout.

Table 13. Binary logistic regression results for dropout.

		95% CI		
	OR	**2.5%**	**97.5%**	***p* values**
Gender				
Female	1.00	(ref)		
Male	1.118	1.052	1.189	0.000***
Age				
16-30	1.00	(ref)		
31-40	0.361	0.314	0.414	0.000***
41-50	0.413	0.366	0.465	0.000***
51-60	0.586	0.525	0.655	0.000***
61-70	0.756	0.677	0.844	0.000***
71+	0.857	0.761	0.966	0.012*
Ethnicity				
White/White British	1.00	(ref)		
Black/Black British	1.085	1.007	1.169	0.031*
Asian/ Asian British	1.200	1.100	1.309	0.000***
Mixed	1.362	1.131	1.641	0.001***
Other	1.076	0.894	1.295	0.437
Not stated	1.589	1.465	1.723	0.000***
Disability				
Not disabled	1.00	(ref)		
Long term health condition/illness	0.862	0.651	1.142	0.301
Mental health condition	1.674	1.208	2.319	0.002*
Learning disability	0.905	0.515	1.590	0.729
Blind/visual impairment	1.509	0.506	4.502	0.461
Cognitive impairment	1.078	0.352	3.541	0.902
Deaf/hearing impairment	1.164	0.471	2.873	0.742
Other	1.335	1.030	1.730	0.029*
Prefer not to say	0.862	0.306	2.430	0.779
Not stated	1.175	1.080	1.279	0.000***
Employment				

Employed full time	1.00	(ref)		
Employed part time	0.933	0.823	1.058	0.282
Self-employed	1.097	0.786	1.532	0.585
Retired	0.608	0.531	0.695	0.00***
Student	2.145	1.364	3.372	0.001**
Permanently sick/disabled	1.350	1.007	1.811	0.045*
Unemployed	1.253	1.135	1.383	0.000***
Carer	1.440	0.834	2.486	0.191
Volunteer	1.021	0.542	1.925	0.948
Other	1.169	1.071	1.276	0.000***
Not stated	0.799	0.703	0.908	0.001**
IPAQ scores				
Low	1.00	(ref)		
Moderate	0.856	0.796	0.920	0.000***
High	0.944	0.823	1.082	0.409
Not stated	1.381	1.287	1.481	0.000***
Referring health care professional				
GP	1.00	(ref)		
Physiotherapist	1.006	0.911	1.111	0.907
Exercise specialist	0.428	0.299	0.612	0.000***
Healthcare assistant	0.823	1.178	0.979	0.083
Health improvement	0.761	0.648	0.895	0.001**
Nurse	0.915	0.910	1.088	0.915
Occupational therapist	0.847	0.578	1.242	0.395
Specialist doctor	20.529	6.423	65.619	0.000***
Self-referral	0.550	0.05	6.066	0.625
Dietician	0.705	0.426	1.166	0.173
Alcohol services	1.100	0.222	5.451	0.907
Pharmacist	15.397	3.666	64.660	0.000***
Podiatrist	0.000	0.000	.	0.998
Psychologist	0.752	0.500	1.132	0.173
Other	0.627	0.522	0.754	0.000***
Referring organisation				
Surgery	1.00	(ref)		
Medical centre	2.774	2.449	3.142	0.000***
Hospital	0.924	0.803	1.064	0.273
Community	0.000	0.000	.	0.999
Pharmacy	9.833	0.802	12.057	0.074
Outreach	0.625	0.512	0.764	0.000***

** p<0.05; ** p<0.01; *** p<0.001*

7.4.2.1 Gender

Gender was found to be a significant predictor of dropout, with males demonstrating a strong statistically significant contribution to the model, with odds that reduce the likelihood of dropout (males (OR=1.118, CI=1.052 to 1.189; *p<0.001)).*

7.4.2.2 Age

Age was found to be a significant predictor of dropout, with all age groups demonstrating a statistically significant contribution to the model. All age groups provided a significant contribution to the model. The middle aged participants (age groups 31-40 years, 41-50 years, 51-60 years) demonstrated a statistically significant contribution to the model, with odds that decreased the likelihood of dropout (31-40 years (OR=0.361, CI=0.314 to 0.414; $p<0.001$); 41-50 years (OR=0.413, CI=0.366 to 0.465; $p<0.001$); 51-60 years (OR=0.586, CI=0.525 to 0.655; $p<0.001$)). Whereas, participants aged 61-70 years and 71+ years, were still less likely to dropout compared to the reference group (16-30 years), but more likely to dropout compared to the lower age ranges (61-70 years (OR=0.756, CI=0.677 to 0.844; $p<0.000$; 71+ years (OR=0.857, CI=0.761 to 0.966; $p=0.012$)).

7.4.2.3 Ethnicity

Ethnicity was found to be a significant predictor of dropout, with participants who did not reported their ethnicity, or reported ethnicity as mixed, demonstrated a statistically significant contribution to the model, with odds that increased the likelihood of dropout (not stated (OR=1.589, CI=1.465 to 1.723, $p<0.000$); mixed (OR=1.362, CI=1.131 to 1.641; $p=0.001$).

7.4.2.4 Disability

Disability was found to be a predictor of dropout, with participants who reported having a mental health condition demonstrating a statistically significant contribution to the model, with odds that increased the likelihood of dropout (mental health condition (OR=1.674, CI=1.208 to 2.319; p=0.002)).

7.4.2.5 Employment

Employment was found to be a predictor of dropout, with participants who reported being retired demonstrating a strong statistically significant contribution to the model, with odds that reduce the likelihood of dropout and were least likely to dropout (retired (OR=0.608, CI=0.531 to 0.695; p<0.000)). Participants who reported being a student were most likely to dropout, demonstrating a statistically significant contribution to the model, with odds that increased the likelihood of dropout (student (OR=2.145, CI=1.364 to 3.372; p=0.001). Participants who reported being permanently sick/disabled were second most likely to dropout, demonstrating a statistically significant contribution to the model, with odds that increased the likelihood of dropout (permanently sick/disabled (OR=1.350, CI=1.007 to 1.811; p=0.045)). This was followed by unemployed participants who were third most likely to dropout, demonstrating a statistically significant contribution to the model, with odds that increased the likelihood of dropout (unemployed (OR=1.253, CI=1.135 to 1.383; p<0.000)).

7.4.2.6 IPAQ scores

IPAQ scores were found to be a predictor of dropout, with participants who reported moderate IPAQ scores demonstrating a strong statistically significant contribution to the model, with odds that reduce the likelihood of dropout (moderate (OR=0.856, CI=0.796 to 0.920; p<0.001)).

7.4.2.7 Referring health care professional

Referrer type was found to be a predictor of dropout, with participants referred by an exercise specialist least likely to dropout, demonstrating a strong statistically significant contribution to the model, with odds that decreased the likelihood of dropout (exercise specialist (OR=0.428, CI=0.299 to 0.612; p<0.001)). Participants referred by health improvement demonstrated a statistically significant contribution to the model, with odds that reduced the likelihood of dropout (health improvement (OR=0.761, CI=0.648 to 0.895; p=0.001)). Participants referred by a specialist doctor demonstrated a strong statistically significant contribution to the model, with odds that increased the likelihood of dropout (specialist doctor (OR=20.529, CI=6.423 to 65.619; p<0.001)). Participants referred by a pharmacist were second most likely to dropout, demonstrating a strong statistically significant contribution to the model (pharmacist (OR=15.397, CI=3.666 to 64.660, p<0.001)).

7.4.2.8 Referring organisation

Referring organisation was found to be a predictor of dropout, with participants referred from a medical centre most likely to dropout, demonstrating a strong statistically significant contribution to the model, with odds that increased the likelihood of dropout (medical centre (OR=2.774, CI=2.449 to 3.142; p<0.001)).

Participants referred from outreach demonstrated a strong statistically significant contribution to the model, with odds that decreased the likelihood of dropout (outreach (OR=0.625, CI=0.512 to 0.764; p<0.000)).

7.5 Discussion

7.5.1 Main findings

The main aim of this chapter was to explore patients' characteristics as predictors of dropout from an exercise referral across the UK, and whether specific characteristics could predict whether patients were more or less likely to dropout. The results presented are findings from analysis of the NRD. After data cleaning a total of 19078 participants were analysed within this study. Uptake was higher in woman (69%), than it was in men (31%). A total of 53% participants completed, with 47% dropping out early. Compared to baseline, 52% of females completed, which was lower than completion for males (55%). A total of 48% of females dropped out, which higher than dropout for males (45%). Being male was a statistically significant predictor, with males less likely to dropout (OR=1.118, CI=1.052 to 1.189; p<0.001). These results are similar to those found in previous systematic reviews, which found that more women took up the referral than men, but men were more likely to adhere until completion than women (Gidlow, et al. 2005; Pavey, et al. 2012). Therefore, this research provides further support to the literature, that males are less likely to dropout than females, and more likely to adhere until completion (Gidlow, et al. 2005; Pavey, et al. 2012).

All age groups were less likely to dropout compared to the reference group (16-30 years), however age groups 31-40 (OR=0.361, CI= 0.314 to 0.414; p<0.000), 41-50 (OR= 0.413, CI=0.366 to 0.465; p,<0.000) and 51-60 (OR=0.586, CI= 0.525 to 0.655; p<0.000) years were all less likely to dropout compared to 61-70 (OR=0.756, CI=0.677 to 0.844; p<0.000) and 71+ years (OR=0.857, CI=0.761 to 0.966; p=0.012) groups. These groups (61-70 and 71+) were both still less likely to dropout compared with the reference group, but were more likely to dropout than participants aged 31-60 years. It could be argued that with increasing age, participants are more likely to dropout compared to the middle aged groups. Previous studies have found that older adults were more likely to adhere until completion (Cooper, et al. 1999; James, et al. 2009; Pavey, et al. 2012; Tobi, et al. 2012), with increasing age being associated with the likelihood of completion (Dugdill, et al. 2005; Gidlow, et al. 2005; Leijon, et al. 2011; Kelly, et al. 2016; Morgan, et al. 2016); this may be due to older adults having more time to exercise due to most being retired. However, this study does not support this completely. This study does suggest that older adults are less likely to dropout compared to the reference group, which would support this research, however younger age groups were more likely to not dropout.

ERSs offer individuals social interaction which has been seen as valuable to older adults (Stathi, et al. 2004; Stathi 2009), and has been seen as an important contributing factor to older adults completing an exercise prescription (James, et al. 2009). Therefore, encouraging older adults to take part in an ERS isn't just beneficial for their health outcomes, but for their wellbeing too. Older adults are at greater risk of social isolation (Cho, et al. 2019), therefore ERSs could provide the ideal setting to meet new people which could lead to further interactions outside of the exercise referral.

It could be suggested that older adults may have less time commitments such as work, therefore in theory, should have the time to prioritise exercise (Leijon, et al. 2011). At the other end of the spectrum, younger participants may find that they have more commitments than those of an older age. Reasons for dropout have been reviewed with a lack of time and economic factors being key factors in younger adults (Leijon, et al. 2011). This could have serious implications on their health and PA levels, as these participants may prioirtise other commitments over being physically active and self-managing their health.

In total 66.2% of participants who were retired were less likely to dropout, which does correlate with the results relating to age in the above paragraph to some extent. Being retired was found to be a statistically significant predictor for participants that were less likely to dropout (retired (OR=0.608, CI=0.531 to 0.695; p<0.000)), supporting findings from previous research which suggested that being retired was associated with better attendance (Lord & Green 1995). Being retired, individuals may find that they have more time to do certain activities, one being exercise. Having more time to exercise, may give older adults the chance to focus on becoming physically active. Researchers found that retired individuals' habits changed during retirement, which included the initiation of becoming physically active (Van Dyck, et al 2017).

Whereas, participants who reported their employment status as being a student, were more likely to dropout (64.3%) and less likely to complete (35.7%). Being a student, permanently sick/disabled, or unemployed were all statistically significant predictors of the likelihood of dropout (student (OR=2.145, CI=1.364 to

3.372; *p*=0.001); permanently sick/disabled (OR=1.350, CI=1.007 to 1.811; *p*=0.045); unemployed (OR=1.253, CI=1.135 to 1.383; *p*<0.000)). Younger participants, in particular students may have more commitments, compared to older, retired individuals, therefore, potentially prioritising other commitments over exercise (Leijon, et al. 2011) which may have serious repercussions on their health. Thus, correlates with employment status within this study, which found that students were most likely to dropout, compared to participants who had retired; this could be due to the commitments, and pressures students have, therefore, not having the time to prioritise exercise, which was the case for younger participants within another study (Gidlow, et al. 2005; Leijon, et al. 2011). Being unemployed was also a statistically significant predictor of dropout, which correlates to previous findings (Tobi, et al. 2012), which found that more unemployed participants dropped out, compared to those who completed. However, it could be argued that being unemployed gives an individual more time to do other activities, such as exercising, although, there are financial constraints of being unemployed. Reviewing schemes' funding streams may be necessary, to review whether schemes can fund individuals who are unemployed to part take in a prescription of exercise. However, with the previous study not providing ERSs with glowing evidence and with the evidence base for ERSs still weak, policy guidelines and commissioners may question whether funding schemes is beneficial for public health in the long term, when that money may be better spent on more effective interventions.

The lack of diversity may also affect other populations such as disabled and/or younger individuals. ERSs are typically perceived as an intervention for older adults, with marketing materials usually portraying older people exercising under the supervision of younger exercise specialists. This may be extremely misleading to potential new referrals. Reviewing the type of activities available may also be of interest; if schemes offer aerobics sessions only, younger people may be put off by this, as the intensity may not be suitable, or they would prefer not to exercise with older adults; or, individuals with disabilities may think they cannot part take in this activity, therefore avoid exercising. Schemes must provide alternative activities for individuals to choose from, which may broaden diversity within schemes.

Mixed ethnicity was found to be a statistically significant predictor of the likelihood of dropout, with 51% of participants in this category dropping out (OR=1.362, CI=1.131 to 1.641; *p*=0.001). Participants who reported White or White British ethnicity were less likely to dropout (57%), compared to those who reported mixed ethnicity who had the lowest completion rates (49%). James, et al. (2009) found that participants of mixed ethnicity were more likely to complete, however, in this study, participants who reported mixed ethnicity were more likely to dropout. This may be due to the number of participants with mixed ethnicity referred to schemes. Typically, when observing the marketing and advertising used for local ERSs, images of White, older adults are usually portrayed within these images, with schemes lacking in diversity. Although the reasons for why these participants dropped out wasn't explored, the lack of ethnically diverse advertising for schemes may not attract individuals to these schemes. also, the type of activities on offer may not be culturally appropriate; offering mixed gender sessions may be off putting to some cultures, therefore, providing the option of same-gender classes/sessions may increase diversity in ethnicity within patients who adhere to schemes. Further analysis, preferably qualitative, is required to examine the in-depth reasons behind this dropout.

More participants with long-term health conditions completed (60%), compared to those with a mental health condition (44%). However, long-term conditions were not found to be a statistically significant predictor of completion. Reporting disability as a mental health condition was found to be a statistically significant predictor of the likelihood of dropout (OR=1.674, CI=1.208 to 2.319; p=0.002). Participants who reported disability as other, were second most likely to dropout (51%) and were a significant predictor of dropout (OR=1.335, CI=1.030 to 1.730; p=0.029). This correlates with research conducted by Crone, et al. (2008) who found that the number of participants with a mental health referral who went on to compete (22%), was lower than participants with a physical health referral (34%).

For IPAQ scores, compared to baseline, 57.9% of participants who reported moderate levels of PA were less likely to dropout. Reporting moderate levels of PA on the IPAQ was found to be a significant predictor of the less likelihood of dropout (OR=0.856, CI=0.796 to 0.920; p<0.001). More participants who reported low levels of PA in the IPAQ (54%) dropped out, however this was not statistically significant. This correlates with previous research in that more active participants were less likely to drop out (Leijon, et al. 2011). Leijon, et al. (2011) also found that less active participants do not dropout; in the current study, the percentage of less active participants that dropped out (reporting low on IPAQ: 46%), was higher than the other two categories (moderate and high levels), although it was not found to be statistically significant. However, ERSs should be aimed at individuals who are not active and are sedentary (NICE 2014), therefore schemes should be using adequate behaviour change techniques to overcome dropout of those with low PA. Individuals who are already active may have sought out the referral, therefore want to continue until completion. Whereas, individuals who are not physically active, may have been advised by a health professional to take up the exercise prescription and not actively seek it themselves; this needs further exploring.

The results provided for IPAQ can be linked to the results found in study two (chapter six). Patients entering an ERS were already classified as moderately active; therefore, referring health care professionals may be targeting the wrong patients entering an ERS, or patients are over-reporting on the IPAQ. However, within the current study, being moderately active was a statistically significant predictor of the less likelihood of dropout. Whether health care professionals may be referring the wrong patients in terms of baseline PA levels, or participants are incorrectly reporting their PA levels, those who did report moderate PA levels at baseline are the people who are actually completing an exercise referral and contributing to the overall completion rates and effectiveness of ERSs. If these patients were not referred to ERSs, then the overall dropout may be higher. Supporting patients with low PA levels is required, to reduce dropout, and improve the likelihood of completion. ERSs should be aimed at patients who have low PA levels and are sedentary, therefore in theory, ERSs should be focusing on these patients and improving their PA levels from baseline to completion.

For referring health care professional, participants referred by a specialist doctor, were more likely to drop out (95%) and least likely to complete (5%), which was found to be a statistically significant predictor of the likelihood of dropout (OR=20.529, CI=6.423 to 65.619; $p<0.001$); compared to participants referred by an exercise specialist who was less likely to drop out (28%) and more likely to complete (72%). Referral from an exercise specialist was found to be a statistically significant predictor of the less likelihood of dropout (OR=0.428, CI=0.299 to 0.612; $p<0.001$). Being referred by exercise specialist would include referral from specialists who already work within the leisure environment and potentially on the ERS. This could influence participation as the exercise specialist may already be working with the individual with a programme of exercise, but could potentially be referring them to a subsidised schemes which has less financial implications for the participant.

Past research also found that patients respond to the referrer who advised them to participate in exercise referral (Stathi, et al. 2004), which may determine whether they participate or not. This research provides some evidence that could support the theory of referring health care professionals influencing participation. Stathi, et al. (2004) found that older adults held GPs in esteem, which could contribute to the evidence within the current study which found that being of older age (61-70 and 71+ years) was a statistically significant predictor of the less likelihood of dropout. Previous evidence has found that health care professionals think PA promotion is important, however, some believe it is outside of their expertise and less important than other health promotion techniques such as smoking cessation (Din, et al. 2015). To review this in more detail, an in-depth mixed analysis is required to examine health care professionals' views in relation to types of referrer as predictors of the likelihood of dropout.

For referring organisations, more participants referred from a pharmacy dropped out (96%), however, this was not statistically significant. A statistically significant predictor of dropout was medical centre (OR=2.774, CI=2.449 to 3.142; *p*<0.001)), with 67% of participants dropping out, compared to only 33% completing. Participants referred from outreach were found to be less likely to dropout (34%), and more likely to adhere until completion (64%); outreach was found to be a statistically significant predictor of the less likelihood of dropout (OR=0.625, CI=0.512 to 0.764; *p*<0.000). When understanding the meaning of outreach, there were mixed definitions; ReferAll refer to an outreach service being drug or alcohol counselors or bereavement services, however NHS define outreach as being a service for people who cannot access mainstream services (NHS 2017). There needs to be clearer definitions used through the NRD so that providers are not providing incorrect information.

Understanding adherence and dropout in exercise referral is limited due to small datasets previously examined (*n*=6894, Kelly, et al. 2016; Leijon, et al. 2011; *n*=1358), or the focus of studies being adherence rather than dropout (Crone, et al. 2008; Gidlow, et al. 2005; Hanson, et al. 2013; James, et al. 2009; Tobi, et al. 2012). This research provides evidence for specific characteristics as predictors of the likelihood of dropout. With this research, those patients who are at risk of dropout, should be given the right attention and suitable motivational techniques to avoid dropout. However, due to the limited data provided by the NRD, adequate data collection should be made compulsory to avoid missing data sets.

Various motivational techniques can help reduce dropout, with 76% of schemes in study one using additional motivational techniques to encourage adherence (chapter five). Within the data for the current study, there was no recall of motivational techniques used, therefore it is unknown whether any of the participants included within this study were using motivational strategies. Goal setting is a common motivational strategy used in exercise referral (Littlecott, et al. 2014; Mills, et al. 2013; Morgan, et al. 2016; Murphy, et al. 2012), which focuses the patient's attention on behaviour change (Locke & Latham 2002). By setting realistic and quantifiable goals regularly (Fabricatore 2007), can be an effective method for fostering PA across a diverse range of settings and populations (McEwan, et al. 2015). Motivational interviewing is another common motivational technique used with ERSs (Murphy, et al. 2012), which can improve PA levels (Hardcastle, et al. 2012; Moore, et al. 2012; NICE 2014). By incorporating motivational techniques within an ERS may improve adherence rates and reduce dropout.

7.5.2 Limitations

The main limitation of this study, is that the scheme's details were not known. There were no details of the exercise prescription (including frequency, intensity, effort, and duration) available within the NRD. It could be possible that there may be a degree of statistical heterogeneity in uptake and completion, due to the variations in exercise prescriptions. Pavey, et al. (2012) found within a systematic review, that there was an elevated degree of statistical heterogeneity in levels of uptake and adherence across studies. This was partly due to the different methods of referral and the quantity of sessions within the prescription, which was not controlled for. Thus, similar to the situation within this study, as there were different referring health care professionals, which may have provided different methods of referral. As discussed in the previous section, the referring health professional can influence participation.

Without knowing key details, such as how many sessions patients attended per week, and what they consisted of, could implicate findings within this study. If using the evidence found in study one (chapter five), it could be suggested that sessions involved a varied prescription, including both cardiovascular and resistance exercises, using a wide range of equipment, under the supervision of the exercise referral specialist. However, this data was not available for this study directly, therefore only generalised predictions can be made.

In regards to referral method, there was no evidence of self-referral. This may be an under-utilised method of referral which may affect the number of patients who uptake in an ERS, causing implications, as people may act differently depending on who advised them or not, to participate within an exercise referral. If referred by a health care professional, the importance of that referee to the patient, could depend on whether they uptake in an ERS (Din, et al. 2015). However, self-referral may open the doors to individuals who do not have contact with a health care professional and may want to self-refer themselves to supervised exercise prescriptions.

The NRD at present is weak and requires extensive work to improve data collection. Ideally, the database should consist of compulsory standardised measures which each scheme must collected. There are no legal requirements for schemes to collect data, however, future guidelines should encourage schemes to collect specific data to improve the standardisation of data collection across all schemes. Research has found that there is extensive heterogeneity in outcomes measured across schemes (Morgan 2005). If outcome measures were standardised across the UK, then researcher could provide more reflective evidence of whats actually happening within ERSs at present, whilst reviewing key outcomes.

The final limitation is linked to the context of dropout. Dropout was reported as not attending the final session to report post-completion measures (IPAQ). The patients deemed as dropped out could have attended and adhered to the prescription right up until the final week, but may have been on holiday or had other commitments, and not made their post-completion appointment for assessment. Of course, it’s reasonable to suggest that the majority of patients without post data did actually dropout, but this is something that must be explored through further research.

7.5.3 Implications for practice and future research

Key predictors of the likelihood of dropout were mixed ethnicity, reporting disability as a mental health condition, being a student, permanently sick/disabled or unemployed, referred by a specialist doctor or pharmacist, or from a medical centre, This is important evidence from a large-scale evaluation of the NRD. This evidence should be translated into practice. By informing exercise referral specialists of key predictors of dropout, may allow for scheme coordinators to tailor their approach which may encourage participation. By providing more diversity within schemes in terms of activities available, may encourage diversity in participants who complete.

Future research is required to understand reasons for dropout, and how it can be avoided in the future. By making exercise referral specialists aware of patients who may be more likely to dropout, specific behaviour change techniques can be deployed to reduce the likelihood of dropout before it happens.

Key predictors of completion were being male, aged 31+ years, retired, reporting moderate PA levels at baseline, referred by an exercise specialist or health improvement or from an outreach service. This is valuable information which could potentially be translated into practice, so that exercise referral specialists can make sure that the appropriate motivational techniques are deployed to ensure patients with these characteristics do complete and avoid dropout.

Further research is required to understand how to avoid dropout, and how to maintain adherence using behaviour change techniques and motivational techniques on a larger scale across the UK. There are various behaviour change techniques and motivational techniques which are used within ERSs, which were touched on in study one, however, using these are not compulsory within schemes and not all schemes are based on solid theory such as SDT. An extensive review of BCTs used within ERSs and their success is required, to inform future guidelines of the benefits of using BCTs to encourage adherence and long term behaviour change.

It should also be noted that completion of an exercise referral does not necessarily mean that the participant adhered to the exercise prescribed. The participant may have attended every session, but not adhered to the exercise prescription exactly. Typically, adherence is often measured by attendance, due to adherence being referred to as the percentage of sessions attended (Arsenijevic & Groot 2017; Pavey, et al. 2012; Shore, et al. 2019). Attendance alone does not indicate the effort and intensity level of the patient's activity, which would show whether they are benefiting from the exercise prescribed. Therefore, the association between adherence to an exercise referral and attendance may be misleading. Clearer definitions are required within ERSs, with adherence and attendance often confused for being the same thing.

Insufficient profiling of referrals is a major discrepancy within many schemes within the UK, with a lack of patient targeting in existing scheme evaluations (Gidlow, et al. 2005). Guidelines must be developed to provide exercise referral specialists with adequate information for schemes to develop tools to gather sufficient information about the characteristics of patients with a standardised approach. Within this study, there were missing data, from patients either not disclosing the information when completing induction forms and questionnaires, or schemes not acquiring this information accurately. Further examination of key elements of schemes is required, to inform updated guidelines; clearer definitions for adherence, attendance and completion are required, along with a set of standardised measures for all schemes to use to collect data. A clear protocol is required to provide exercise referral specialists with support on how to enforce better data collection within schemes so that research can examine key predictors of dropout on a larger scale.

7.6 Conclusion

The current chapter presents results which provide evidence for specific patients' characteristics that predict dropout and completion, which may prove beneficial for exercise referral specialists who want to understand which type of patient's dropout. This research is the first of its kind, providing a large-scale evaluation across the UK. It should be acknowledged that there are many primary issues relating to adherence and completion of schemes, which goes beyond patients' characteristics, but includes reviewing definitions. Further studies should build upon this research, to develop such schemes which aim to reduce dropout using the predictors found within this study. It should also be acknowledged that there were missing data, which meant that a true reflection of key characteristics could not be provided; this was due to participants not disclosing this information or exercise referral specialists not collecting this data accurately. Going forward, it is important for key patients' characteristics which were found to be predictors of the likelihood of dropout, to be translated from research to practice to help schemes who are struggling with dropout. Providing the evidence is important, but needs to be translated appropriately so that specialists can benefit from the evidence.

Chapter 8:

General Discussion

Chapter 8: General Discussion

The purpose of this chapter is to discuss the results found in the previous three chapters, and to discuss a range of recommendations which have come from the research within this thesis.

8.1 Results

Exercise referral schemes have been recently described as ‘wild and woolly’, lacking precision in the conceptualisation of exercise, and little agreement between stakeholders of how to determine impact or effectiveness (Henderson, et al. 2018). Henderson, et al. (2018) disputed that ERSs do not work, but their effectiveness is controlled by participants’ interpretations of whether they see improvement. The evidence over recent years has been mixed. There has been no large-scale evaluation of the effectiveness of ERSs in the UK. This thesis aimed to provide an initial overview of ERSs in the UK at present, along with initial analysis of data from the NRD. This thesis has added to the literature, providing the following:

- Systematic review of the evidence of the effectiveness of ERSs in the UK in CV, MH and MSK conditions.
- Unique and new insights of what is currently happening within exercise referral schemes, in terms of delivery approaches presently used.
- Scientifically relevant and robust evidence concerning the effects of ERSs on changes in PA levels.
- New evidence from a larger dataset that previously analysed, observing key patients’ characteristics which act as predictors of the likelihood of dropout.

- Initial observations from the new exercise referral database, the NRD. Exercise referral research of a centralised, national database has never been conducted before, therefore this research is the first of its kind.

Interestingly, within this thesis it was found that schemes are targeting primarily those who are already moderately active, with more participants who reported low activity at baseline dropping out (although not statically significant). Patients with low activity levels at baseline are the people who should, theoretically, benefit the most from exercise referral participation. Also, schemes are not providing exercise prescriptions that are sufficiently intense enough to provide benefits, and if they are, it’s unlikely that people are adhering to them. This supports previous findings of the ineffectiveness of schemes (Henderson, et al. 2018; Jones, et al. 2005; Pavey, et al. 2011), which could suggest that schemes are a waste of public money. Nonetheless, it is well known that exercise does improve PA and health outcomes (Pavey, et al. 2011; Pederson & Denollet 2003; Pederson & Saltin 2015), however, this research which primarily focuses on ERSs, has drawn some conclusions on the issues in the implementation, delivery and evaluation of schemes which must be addressed, to translate efficacy to effectiveness.

8.1.1 What is currently happening within exercise referral schemes, in terms of delivery approaches?

This study provided some insights into whats actually happening on the ground within ERSs at present. There hasn’t been any evidence providing insight in terms of actual delivery approaches within ERSs. This study provides some useful perceptions of what exercise providers include within prescriptions, how schemes are designed, and how data is collected. From the varied results found within this study, it would suggest that schemes have looked further than current national guidelines (NICE 2014, 2018), and toolkits (BHFNC 2010), to find the best ways to get patients active and improve health outcomes, as the current NICE guidelines lack any details relating to the most important schemes' characteristics, and how they are key to the implementation and delivery. The current widespread delivery of ERSs may be ineffective, but the current delivery doesn't actually reflect policy recommendations that well (active people taking part). This could suggest there needs to be some change in policy to ensure that practice follows the evidence base.

Schemes reported being 12 weeks in length, offering participants bi-weekly (twice a week), unsupervised exercise sessions in a fitness gym using a combination of cardiovascular, resistance, free weights and body weight exercises. Determining progression of resistance exercises were based upon the number of reps and sets completed; cardiovascular exercises were based upon the rating of perceived effort, and for other exercises, based upon performance. Most schemes offer some home-based exercise components, ranging from advice to a full exercise programme. Adherence is typically measured through attendance. Common motivational strategies used are goal setting, goal achievement and acknowledgement of success. Although questions about specific BCTs wasn't included, when asking about motivational strategies, there seems to be a lack of focus on including behaviour change techniques with schemes. This is also an issue within national guidelines. When reviewing national ERS guidelines (NICE 2014; 2018), there was a lack of advice on the use of BCTs; with a lack of BCT implementation advice within guidelines and how to implement BCTs effectively, there's no wonder why schemes do not implement BCTs. Previous research has found that overall reporting of BCTs used in interventions needs improvement (Howlett, et al .2019).

This study provides some key contributions to knowledge, as it provides useful insights which isn't typically reported within studies (Shore, et al. 2019). There is a lack of research reviewing current practice; without knowing what is actually happening on the ground within ERSs, recommendations for improving schemes and guidelines cannot be suggested. This study takes an exploration view to research, by providing purely insights of current delivery approaches.

8.1.2 Increasing physical activity levels through exercise referral

Study two examined whether ERSs are effective in increasing PA levels of participants over a 12-week prescription. This study was designed to meet one of the recommendations for further research by NICE (2014, 2018), which suggested that changes in PA levels should be the primary outcome measured. This study found that ERSs do provide change in PA levels, however, this change was not sufficient to result in any IPAQ categorical changes, and participants were still classified as moderately active. These changes were facilitated by increases in MVPA and reduced sitting.

Results from this study suggest that participants were already moderately active before beginning their prescription. This could imply issues with the translation and implementation of policies; national guidelines suggest that inactive individuals should be the target audience, whereas moderately active individuals were discovered to be referred within this study. Healthcare professionals may be referring the wrong individuals which requires further review. Asking GPs to screen patients prior to referral may not be feasible due to time constraints. The idea of patients overestimating their PA levels at baseline should also be explored.

Further research is required to review the reasons for referral, compared to pre-scheme IPAQ scores. Patients may not be referred just to increase PA levels, but to improve a health condition. It could be argued that this is a more important outcome, as PA is often the mediator, rather than viewing it as a primary outcome. With this, health condition-specific measures are required to examine whether the exercise prescription has adequately improved health outcomes. This requires further review to provide a list of health condition-specific measures which are both valid and reliable to be used within exercise referral for different populations.

This research provides some key contributions to knowledge. This research has provided evidence that participants are already moderately active prior to starting their exercise prescription. This is new knowledge which needs further exploration. This evidence could suggest that schemes are not taking on board the guidelines that inactive individuals should be referred; this provides issues in the implementation procedures used within schemes. This research provides key methodological contributions, with in-depth analysis of data through a two stage individual patient data meta-analysis which was performed on both median pre-ERS and median change scores, which found new evidence of those being referred and whether PA levels changed upon completion.

8.1.3 Patients' characteristics as predictors of the likelihood of dropout

The purpose of this study was to review patients' characteristics as key predictors of the likelihood of dropout from an ERS. Previous research reviewed predictors of dropout, but not key patients' characteristics as predictors on a nationwide scale. All schemes were 12 weeks in length; thus, being the only detail retrieved about the schemes from the NRD. Key predictors of the likelihood of dropout were mixed ethnicity, reporting disability as a mental health condition, being a student or permanently sick/disabled, referred by a specialist doctor or a pharmacist, and being referred from a medical centre. Key predictors of the less likelihood of dropout were being male, aged above 30 years old, retired, reporting moderate PA levels on the IPAQ, being referred by an exercise specialist or health improvement services, and being referred from an outreach service.

This study provided key contributions to knowledge due to the methodological approach taken; these results are from a larger cohort of participants (*n*=19078), compared to previous research (Kelly, et al. 2016; Leijon, et al. 2011; Tobi, et al. 2012), which provides new refreshing evidence from across the UK.

A key challenge of effectiveness is to overcome low adherence and high dropout rates (Beedie, et al. 2015). This study provides evidence of key patients' characteristics as predictors of the likelihood of dropout. By reviewing key characteristics of patients who are more or less likely to dropout, and comparing the applicable exercise prescribed to them, may provide insights into what schemes' characteristics need to be altered to encourage patients to adhere until completion and not drop out prematurely. However, this data was unavailable in the NRD.

Further exploration of the wider literature reviewing PA in general may help influence the BCTs used within schemes to avoid dropout. Within exercise referral research, there has been a lack of evaluation of current BCTs used, and exploration of BCTs which should be used within schemes. With some changes in policy to ensure that practice follows the wider evidence base, may improve the quality of schemes and reduce dropout through the use of BCTs to enhance behaviours.

All three studies have provided new evidence from the first national database of exercise referral patients across the UK. The results from these three studies provide important information which should be translated into practice for exercise referral specialists to utilise, so that it can enhance current practice. From the research conducted within this thesis, a set of recommendations have been produced to aid the improvement of exercise referral in the UK.

8.2 Key Recommendations

8.2.1 National Referral Database

The database provides a wealth of data which can support the examination of larger cohorts of exercise referral patients across the UK. This database is the first of its kind that provides the demographics and pre- and post-completion data, although not always complete sets, of patients referred to multiple schemes across the UK.

However, at present, the database is lacking strength in many areas. At the point of data extraction in October 2017, there were many irregularities within the data, including missing data (referral reason, reason for dropout), typing errors, and multiple outcome measures used to examine the same outcome; this led to many issues. The database also lacked clear definitions of each outcome, which may lead to different perceptions of each outcome.

Moving forward, proposing a set of recommendations to improve the database should be provided. These are all based on the research conducted within this thesis, which include:

- **Compulsory and standardised measures**: At present, exercise referral specialists can upload as much or as little data as they want. Whilst cleaning the data for study two, it was found that the number of paired comparisons for pre- and post- ERS time points for IPAQ, decreased by 78% (from 24086 to 5246 participants). If IPAQ was made compulsory, the paired comparison may have been very different. The database requires a set of clearly defined, standardised measures which are made compulsory for all schemes to collect to allow for better comparisons across the UK.
- **Drop down menu of options**: Whilst cleaning the data, multiple answers were given for referrer types (doctor: GP, specialist doctor; health improvement services: assistants, specialists, officers; nurses: nurse practitioner, cardiac nurse, diabetes nurse, community nurse). ReferAll should provide an extensive list of referrer types for providers to choose from, and adapt this when there are new types of referrers. This could be adapted for multiple measures used within the database.
- **Reason for referral**: Collecting this data is essential for future researchers to review outcomes relating to the reason for referral. By understanding reason for referral, various large-scale studies could be conducted, which could

support the development of individualised exercise prescriptions based on referral reason.

- **Review visits to GP:** Although not usually collected, recording GP visits during and after completion of exercise referral, could potentially see decreased GP-patient contact time and increase self-management. It costs the NHS £242 per hour of patient contact (Personal Social Services Research Unit 2017). A 12-week exercise referral costs £225 per patient, if paid for through funding, which is less than per hour of patient contact. This could provide longer-term benefits to the NHS, as GP visits may reduce if the patient continues to exercise because of the referral.
- **Reason for dropout:** Understanding dropout is important. Study three reviewed the likelihood of dropout, however, reasons behind why this happened was unavailable. This may be due to continuing self-guided exercise, other commitments, or cost of participation (Beers 2006; Crone 2002; Hardcastle 2002; Mills, et al. 2008), however, it is unknown from the data collected within the NRD.
- **Record of exercise prescription**: The NRD does not collect details of the exercise prescribed. Clear details of the prescription must be provided so that different modes/types/intensities/frequencies can be analysed for effectiveness. There is a lack of reporting the exercise prescribed within studies (Hanson, et al. 2013; Murphy, et al. 2013; Slade, et al. 2019; Webb, et al. 2016), therefore, to improve the evidence base, exercise prescriptions must be recorded (including type, mode, intensity, effort, duration, frequency of exercise).

8.2.2 Exercise referral guidelines

As discussed throughout this thesis, national exercise referral guidelines are weak (NICE 2014, 2018), potentially due to the uninformative evidence base of inconclusive evidence. Due to this, there has been a lack of updates to national guidelines. This thesis has begun by providing insights of current practice using data from the NRD, which must be continued post-completion of this thesis. For further updates to current guidelines to be implemented, further insights of current practice is required. Reviewing best practice through a nationwide mapping exercise may provide the evidence required to update guidelines.

Without guidance, schemes may be implementing insufficient schemes, which could contribute to the heterogeneity of schemes across the UK (Morgan 2005; Pavey, et al. 2011; Shore, et al. 2019). Although, it should be noted that guidelines may be broad to allow specialists to design and implement schemes in different ways. However, to date, and according to the literature, this broad approach is not working (Oliver, et al. 2016; Pavey, et al. 2011; Shore, et al. 2019). Although guidelines should allow for personalisation of exercise prescriptions, a standardised approach to the varied delivery and implementation methods are required. Exercise referral policies should be developed using the modified taxonomy of policy components (Howlett & Cashmore 2009). This would encourage guidelines to review policy content, with policy aims that focus on goal of ERSs, objectives of the policy, and settings for ERSs. It also would encourage the policy makers to review the policy tools, which include the instrument logic, mechanisms used such as incentives, and calibrations which explores whether the guidelines are used in a voluntary or compulsory manner.

Once reviewing current practice, a new set of guidelines should incorporate the following:

- **Define exercise referral:** Clearer definitions are required. Defining what ERSs are and should include is priority. Providing guidance on the different referral pathways, appropriate referrals, design of schemes, delivery approaches of individualised exercise prescriptions (length, type, mode, intensity, frequency), standardised implementation and evaluation techniques, and use of fidelity checks is important to improve the quality of schemes.
- Define **the aims of exercise referral:** An aim of exercise referral is to increase patients PA levels, however, arguably PA is often the mediator. Although schemes aim to increase PA, they also use exercise prescriptions to improve a patients' health condition, for which they are typically referred with. Therefore, the main aims of ERSs need to be made clear. A key aim which should be emphasised is that schemes provide patients with an introduction to exercise, which should be continued post-completion, to aid longer-term behaviour change (BHFNC 2010).
- **Clear distinction between adherence and attendance:** Providing clear definitions of adherence and attendance may change the way specialists collect data about a patient's effort to complete the exercise prescription. At present, the literature does not report the term adherence often, rather attendance (Shore, et al. 2019). By providing clear definitions and ways to measure adherence to the exercise prescribed, a clearer assessment can be made of whether a patient has conducted the prescription accurately.

To make it clear, guidelines need to provide more precise definitions of what an ERS is and who should be referred, along with clear examples of best practice focusing on the design, implementation and evaluation of schemes. At present, there is a lack of evidence to support specific prescriptions within ERSs, however, there has been an overall lack of evidence reviewing best practice and insights into what is actually happening on the ground in terms of delivery approaches used.

8.2.3 Exercise referral schemes

At present, schemes across the UK are all disconnected from each other, collecting various outcomes, using different outcome measures, and recording data in different ways. Schemes need to be united to improve overall effectiveness.

During the exercise referral qualification training, there's a lack of support of how to accurately collect and record data. This is apparent in the data exported from the NRD, with missing data, data entry errors and lack of paired comparisons. Although updates to guidelines would provide specialists with support on how to collect data, the training provided to gain the qualification also needs adapting to improve the standards of the exercise specialists.

Due to a lack of clarification from national guidelines, ERSs' effectiveness differs greatly across schemes. Proposing some recommendations to improve schemes is required:

- **Standardised data collection**: Schemes should provide standardised and complete datasets. If a patient does not complete, not allowing for post-completion data to be collected, reasons and date of dropout should be collected. Upon inspection of the NRD data, it was clear that not all schemes collect the same data. Data entry is not checked for errors and collection of specific measures is not compulsory. Exercise prescribed should also be reported in a standardised manner (length, type, mode, intensity, frequency).

- **Fidelity checks**: Fidelity checks should be made compulsory within schemes, supported by guidelines. Study one found that fidelity checks were carried out in a manner of ways including staff being observed, training records, in-house training and contact with patients. Fidelity is rarely reported within ERSs (Pavey, et al. 2011; Shore, et al. 2019; Williams, et al. 2007), and when reported, it is low, compromising the effectiveness of ERSs (Campbell, et al. 2015). These checks are important within ERSs and for research purposes reviewing the effectiveness of schemes.
- **Recording of exercise prescribed:** Exercise providers must record the prescription of exercise prescribed to patients; this process requires a standardised process, to ensure that prescription details are recorded accurately.

ERSs could provide the beneficial environment for long term behaviour change, with schemes acting as facilitators to long term exercise, however, many changes are required before schemes become the ideal setting for patients to enhance their health outcomes whilst becoming physically active, whilst ensuring that BCTs are included within the design (Howlett, et al. 2019). This thesis should be viewed as a starting point for improving the design, delivery, implementation and evaluation of schemes, with a focus on translating evidence into best practice within the UK.

A crucial emerging finding from this research, is that the key details of exercise prescriptions must be further explored, with a comprehensive mapping of schemes across the UK required to uncover best practice and review the variety of prescriptions delivered at present. A lot more work is required before updating current guidelines, with the support from national PA policies guiding the detail relating to the prescription. There are various PA guidelines (CMO 2018, 2019; Fisher, et al. 2011, 2017) which should be incorporated within national ERS guidelines to aid the implementation of exercise prescriptions.

8.2.7 The cycle of exercise referral

Collectively, the NRD, national guidelines and ERSs need to improve their standards, as they all affect each other. If the NRD doesn't start collecting standardised data, then the ability to conduct larger scale studies won't be feasible with studies then lacking comparison. Consequently, national guidelines won't have large scale evidence to support updates, leading to a lack of national guidance to support the development of schemes. Local schemes may develop an effective and sustainable scheme, therefore observing best practice is also key to developing better tools for the future.

At present, some schemes are offered at a subsidised cost due to funding from local authorities (NICE 2014). However, if schemes are underperforming, then funding may be cut, meaning patients will have to pay themselves or they will leave; previously, cost of participation has been viewed as a barrier (Beers 2006; Crone 2002; Hardcastle 2002; Mills, et al. 2008). Politically, cutting funding is a reasonable action, if schemes are not producing positive outcomes. So far, the evidence isn't great and it could be argued that commissioners should stop wasting public funds on them at present. However, with improvements made to the design and delivery of ERSs, this could be revaluated in the future if schemes are then reviewed as being effective. There is ample evidence for efficacy of exercise referral, but understanding how to best implement and translate that into effectiveness is required. However, with good data collection, this could be achieved, and therefore, it is important to advance the case for evaluation, and the important role the NRD could play.

The NRD provides the ideal tool for researchers to produce updated evidence of the effectiveness of exercise referral. However, as discussed, the database needs improving to become a gold standard big data analytic which can provide data for a larger cohort of patients across the UK. With anticipated increasing evidence supporting the use of exercise referral to improve health outcomes and increase PA levels, could potentially support further updates to national guidance. The database, if improved, could break the vicious cycle of lack of evidence of the effectiveness of ERSs (see table 15).

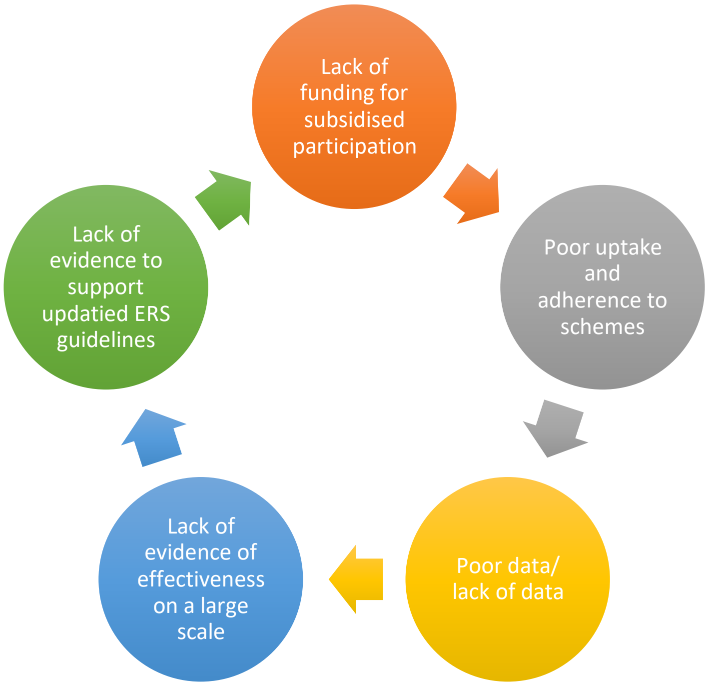


Figure 15. The vicious cycle of exercise referral schemes.

8.3 Future research

Moving forward, there are still many gaps within the literature which require examination (previously highlighted throughout this thesis). Future research should include:

- **Effectiveness of exercise referral in health condition-specific measures**: To examine the effectiveness of different exercise prescriptions (length, type, mode, intensity, frequency) in patients with (multiple) health conditions using condition-specific outcome measures.
- **Menu of exercise prescription options**: With evidence of the effectiveness of different exercise prescriptions, a menu of individualised prescriptions for various conditions should be piloted, to test effectiveness. If successful, this menu of options would provide individualised prescriptions in a standardised approach.

- **Large scale mapping exercise**: Building on the insights from study one, a large scale mapping exercise is required to map out where schemes are, review their delivery approaches on a larger scale and review BCTs implemented within schemes. This could potentially explore best practice and the use of behaviour change within local areas.
- **Examine the use of BCTs in ERSs across the UK:** There's a lack of research examining the key BCTs used within ERSs. This needs further exploring which could potentially lead to the development of a scheme embedded with BCTs to promote long term behaviour change.

There are various researchers examining ERSs in the UK at present, but these researchers must work together to uncover the key benefits of specific exercise prescriptions. A menu of successful and evidence-based prescriptions could be developed to allow for individualisation of the exercise prescribed, within a standardised approach. Having a mutual interest in research could potentially maximise schemes' ability to translate the known efficacy of PA and exercise into effective implementation. With further research, connectivity, and examples of best practice, ERSs could be the ideal facilitator for improving the management and treatment of many health conditions whilst improving PA levels across the nation.

8.4 Final Conclusions

This thesis provides some insights into what is currently happening within ERSs which should be used as a starting point for all future research which focuses on improving the implementation, delivery and evaluation of schemes across the UK. ERSs do provide patients who adhere until completion with the opportunity to engage in an exercise prescription over a set period of time. Exercise referral should introduce patients to becoming active, which then acts as a facilitator to long term behaviour change. Findings suggest that schemes' delivery approaches do vary by scheme, which could account for the heterogeneity within the research (Morgan, et al. 2016; Pavey, et al. 2012; Shore, et al. 2019). ERSs do provide change in self-reported IPAQ continuous scores, however, there was insufficient evidence for categorical changes, with participants staying moderately active. Key predictors of the likelihood of dropout also highlighted issues with individuals who are less likely to dropout (moderately active individuals). ERSs should be aimed at inactive individuals, therefore further exploration of who is referred and why, needs to be examined.

A key finding to come from this thesis relates to the implementation and delivery of schemes. At present, there is a lack of support for the best implementation strategies, and appropriate delivery approaches of schemes. There are two main approaches which are required; providing a more standardised approach to the *implementation* of schemes nationwide (including design, implementation, measuring adherence accurately, measuring outcomes with health condition-specific measures and fidelity checks), whilst also allowing for variation in the *delivery* of individual exercise prescriptions. However, this evidence may not come from the literature, but from examples of best practice across the UK.

Future research should focus on improving standards within ERSs, ensuring schemes are standardised across the UK (supported with evidence and examples of best practice), but also allowing for individualised, tailored exercise prescriptions based on a variety of factors (referral reason, baseline testing and personal preferences to exercise). Although schemes need consistency so that they can be comparable, they also require some uniqueness in the design of the actual prescription, which encourages long term behaviour change and reduces dropout. A prescription cannot have a ‘one size fits all’ approach, but needs to be easily adapted depending on patient’s characteristics. This provides many difficulties in designing national guidelines, but by providing examples of best practice and evidence from ERS and PA/exercise literature, exercise providers can develop schemes which can be evaluated for effectiveness, and could lead future guidelines by enabling other schemes to replicate their delivery approach.

8.5 Reflection

The PhD process has been an eye opening experience, battling with my own biases and developing as an independent researcher. I have met many people along the journey, who have challenged my thoughts and opinions, which have all supported me in getting to this point within the process. I believe I have great knowledge of ERSs, some which was developed during my time as an exercise referral specialist prior to beginning this PhD, but a further critical understanding of ERSs from an independent researcher’s point of view. I have learnt how to reduce bias within my writing (something which was hard to begin with), and develop my academic writing. Looking back at my writing skills at the beginning of this journey, my academic writing was weak. I believe that this has improved, and is something I will continue to work on through my academic journey.

My view point on ERSs has changed somewhat. From working on the ground, I have seen first-hand the benefits of an exercise prescription, in terms of improving health outcomes, physical activity levels, quality of life and social interactions. However, when I started reading the exercise referral literature, I had to challenge my own thoughts about ERSs. I started to question the guidelines, the way schemes were implemented, the lack of evidence for individualised exercise prescriptions and the lack of evidence to support the effectiveness of schemes. With support from my supervisors, I was able to push my way of thinking and to see things from a more critical standpoint.

I am determined to continue my research within ERSs. I want to support the need for changes within guidelines, however, there needs to be much more research evaluating the effectiveness and reviewing best practice across the UK. There is a lack of mapping of schemes, with the total number of schemes at present unknown. There are many aspects of ERSs which need improving and I cannot tackle them all, but I would like to add my contribution and help to improve the quality of schemes, with the focus of my future research aimed at the delivery and implementation of schemes. I want to collaborate with other researchers who work within this topic area, as I believe it is important that we are all connected and supporting one another.

This experience has been tough, with many challenges along the way, but is something I have thoroughly enjoyed. I believe we are always learning, and I want to keep developing as an independent researcher and to continue producing evidence to support the development of better ERSs in the UK.

Appendices

Appendix 1: First publication from PhD.

Rowley *et al. BMC Public Health* (2018) 18:949
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BMC Public Health

RESEARCH ARTICLE Open Access

The effects of exercise referral schemes in the United Kingdom in those with cardiovascular, mental health, and musculoskeletal disorders: a preliminary systematic review

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Abstract

Background: Exercise referral schemes within clinical populations may offer benefits for inactive and sedentary individuals, and improve and aid treatment of specific health disorders. This systematic review aims to provide an overview, and examine the impact, of exercise referral schemes in patients with cardiovascular, mental health, and musculoskeletal disorders. This review focuses on populations within the United Kingdom (UK) only, with an aim to inform national exercise referral policies and guidelines.

Method: Data was collected from specific sources using validated methodology through PRISMA. Systematic searches were performed using Locate, PubMed, Scopus and Pro Quest: Public Health databases. Thirteen studies met inclusion criteria set for each sub group. This included that all studies aimed to prevent, observe, or decrease ill-health relating to the disorder, participants over the age of sixteen, and health disorders and outcomes were reviewed. All studies were conducted in the UK only.

Results: In the 13 articles, a variety of modes and types of exercise were utilised. One-to-one supervised exercise sessions based in a gym environment were most frequently employed. Results showed that longer length schemes (20+ weeks) produced better health outcomes, and had higher adherence to physical activity prescribed, than those of shorter length (8–12 weeks). In patients referred with cardiovascular disorders, cardiovascular-related measures showed significant decreases including blood pressure. Schemes increased physical activity levels over the length of scheme for all disorders.

Conclusion: Longer length schemes (20+ weeks) improved adherence to physical activity prescribed over the course of the scheme, and could support longer term exercise adherence upon completion, however additional research on larger samples should examine this further. An implication is that schemes currently recommended in guidelines do not tailor programmes to support long term adherence to exercise, which must be addressed. There is currently a lack of research examining programmes tailored to suit the individual's health conditions thus further research might allow providers to tailor delivery and build upon policy recommendations in the UK.

Keywords: Exercise referral schemes, Physical activity, Cardiovascular, Mental health, Musculoskeletal

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Appendix 2: Second publication from PhD.

Are exercise referral schemes associated with an increase in physical activity? Observational findings using individual patient data meta-analysis from The National Referral database

Pre-print article published on: 12/01/2019
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Research conducted by the ukactive Research Institute

Article in submitted to The BMJ

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Appendix 3: International Physical Activity Questionnaire (IPAQ)- Short Form

International Physical Activity Questionnaire - Short Form

Some materials have been removed from this thesis due to Third Party Copyright. Pages where material has been removed are clearly marked in the electronic version. The unabridged version of the thesis can be viewed at the Lanchester Library, Coventry University.

Appendix 4: Inclusion criteria for acceptance onto exercise referral schemes.

Inclusion Criteria to Exercise Referral Schemes
Must be clinically stable.
Have own ability to regulate and monitor intensity of their activity.
Recognise their optimum level of exercise intensity.
Acknowledge importance of and demonstrate a commitment to modify risk-related behaviours.
Ability to sit in a seat indignantly (time unlimited).
Ability to mobilise more than 5 meters with or without a walking aid/supervision.
Adequate communication for individuals with aphasia to allow participation.

Appendix 5: Exclusion criteria for acceptance onto exercise referral schemes.

Exclusion Criteria to Exercise Referral Schemes
Anyone under the age of 18 years.
Currently physically active (more than 30 minutes of moderate PA on 5 days a week).

Appendix 6: Absolute contraindications to exercise and relative contraindications to exercise.

Absolute Contraindications to Exercise	**Relative Contraindications to Exercise**
Recent significant changes in resting ECG or recent myocardial infarction.	Tachydysrhythmia or bradydysrhythmia.
Unstable angina.	Left main coronary stenosis.
Uncontrolled cardiac dysrhythmias.	Hypertrophic cardiomyopathy.
Symptomatic severe aortic stenosis.	Neuromuscular, musculoskeletal, or rheumatoid disorders.
Uncontrolled symptomatic heart failure.	High-degree atrioventricular block.
Acute pulmonary embolus or pulmonary infarction.	Ventricular aneurysm.
Acute myocarditis or pericarditis.	Uncontrolled metabolic disease.
Suspected or known dissecting aneurysm.	Chronic infectious disease.
Acute systematic infection.	Mental or physical impairment leading to inability to exercise adequately (American College of Sports Medicine 2013).

Appendix 7: PAR-Q form.

Physical Activity Readiness Questionnaire

PRE-TEST QUESTIONNAIRE

NAME …………………………………. Ref. No.………………...

Date of Birth …………………………… Age:…………………….

Test procedure …………………………..

As you are to be a subject in this laboratory/project, would you please complete the following questionnaire. Your cooperation in this is greatly appreciated.

Please tick appropriate box

	YES	**NO**
Has the test procedure been fully explained to you?	☐	☐

Any information contained herein will be treated as confidential

		YES	**NO**
1.	Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?	☐	☐
2.	Do you feel pain in your chest when you do physical activity?	☐	☐
3.	In the past month, have you had chest pain when you were not doing physical activity?	☐	☐
4.	Do you lose your balance because of dizziness or do you ever lose consciousness?	☐	☐
5.	Do you have a bone or joint problem that could be made worse by a change in your physical activity?	☐	☐
6.	Is your doctor currently prescribing drugs for your blood pressure or heart condition?	☐	☐

7. Do you know of any other reasons why you should not undergo physical activity? This might include severe asthma, diabetes, a recent sports injury, or serious illness. ☐ ☐

8. Have you any blood disorders or infectious diseases that may prevent you from providing blood for experimental procedures? ☐ ☐

- If you have answered **NO** to <u>all</u> questions then you can be reasonably sure that you can take part in the physical activity requirement of the test procedure

I ………………………………. declare that the above information is correct at the time of completing this questionnaire Date ……/……/…….

Please Note: If your health changes so that you can then answer YES to any of the above questions, tell the experimenter/laboratory supervisor. Consult with your doctor regarding the level of physical activity you can conduct.

- If you have answered **YES** to one or more questions:
  Talk with your doctor in person discussing with him/her those questions you answered yes.
  Ask your doctor if you are able to conduct the physical activity requirements.

Doctor's signature ……………………………….……… Date ……/……/…….

Signature of Experimenter……………………………….. Date ……/……/…….

Appendix 8: CERT-based Questions for Exercise Referral Providers

The purpose of collecting this data is so that further analysis of the ERS can be conducted.

Question 1: Please state which scheme you are:

Question 2: Please state the location of your scheme:

Question 3: What types of exercise equipment, if any, are used? (select all that apply)

- Resistance machines (e.g. weight stack, plate loaded)
- Cardiovascular machines (e.g. treadmill, bike, rowing machine)
- Free weights (e.g. barbells, dumbells, kettlebells)
- Balance/ ‘core’ equipment (e.g. Swiss balls, bosu balls)
- No equipment used (e.g. bodyweight training, walking/running without a treadmill)
- Other (please specify)

Question 4: What specific exercise related qualifications do the exercise providers have? (select all that apply)

- None
- Level 2 gym instructor
- Level 3 personal trainer
- Level 3 exercise referral specialist
- Level 4 cardiac rehabilitation
- Level 4 obesity
- Level 4 back pain specialist
- HNC/HND in related subject
- Undergraduate degree in related subject
- Post graduate degree in related subject
- I don’t know

Question 5: How are the prescribed exercises performed by the referral? (select all that apply)

- Individually unsupervised
- Individually but with supervision
- Group
- Combination of both gym and home based exercise

Question 6: Do you measure adherence?

- Yes
- No

Question 7: If ‘yes’, how do you measure adherence? (select all that apply)

- Attendance when signing into leisure environment
- Sign in and out of exercise prescription session
- Self-report (can be used for home based exercise)

Question 8: Do you use any motivation strategies alongside the exercise prescription?

- Yes
- No

Question 9: If ‘yes’ please select all that apply (select all that apply)

- Goal setting
- Goal achievement
- Shared decision making
- Acknowledgment of success
- Graphic, visual, or verbal cues
- Diary keeping
- Motivational interviewing
- Preferred environments
- Problem solving advice
- Other, please explain in detail….

Question 10: Is the exercise prescribed in a progressive manner?

- Yes
- No

Question 11: How do you determine progression for resistance exercises?

- Based upon rating of perceived effort
- Based upon number of reps/sets completed
- Based upon load used
- Other

Question 12: How do you determine progression cardiovascular exercises?

- Based upon rating of perceived effort
- Based upon heart rate
- Based upon duration completed
- Based upon speed/power/etc. used
- Other

Question 13: How do you determine progression other exercises?

- Please explain how you determine progression…

Question 14: Are exercises prescribed to target:

- Predominantly lower body
- Predominantly upper body
- A combination of both
- Depends on the individual

Question 15: Do you provide the referral with any home program components?

- Yes
- No

Question 16: Which home program components do you provide the referral with? (select all that apply)

- A full program to conduct at home
- A partial program which can be conducted at home
- Advice on activities which can be done at home
- Advice on activities which can be done outside of the leisure environment, but not at home

Question 17: Do you use any non-exercise components included in addition to your exercise prescription?

- Meditation
- Cognitive behavioural therapy
- Massage
- Informational materials
- Fitness tracker
- None
- Other

Question 18: Do you record and monitor any adverse events that could happen during exercise?

- No
- Yes

Question 19: How are these managed and documented?

Question 20: Where are the exercises performed?

- Gym
- Sports hall

- Studio
- Outside on grass
- Outside on a hard surface
- Spinning studio
- Community hall
- Other

Question 21: Where possible, please provide a detailed description of manner in which exercises are typically performed for those included in your prescription for CARDIOVASCULAR exercises:

  - Frequency
  - Intensity (% heart rate, or perceived effort)
  - Duration

Question 22: Question 21: Where possible, please provide a detailed description of manner in which exercises are typically performed for those included in your prescription for RESISTANCE exercises:

  - Frequency
  - Intensity (perceived effort)
  - Load (i.e. weight)
  - Sets
  - Reps

Question 23: Do you tailor each referral's prescription?

- Yes, tailored to suit an individual and their condition referred for
- Yes, tailored to suit an individual's preferences to exercise
- No, use a generic program which is used for every referral

Question 24: Do you use any decision rule to determine the starting level for referrals entering the program?

- Yes
- No

Question 25: Which decision rule do you use?

- Conduct baseline fitness testing
- Use referral self-report
- Other

Question 26: Are the exercise programs delivered and performed as planned?

- Yes, exactly as planned
- No, they can be tailored each session

- No, they can adjust depending on the how the individual is on the day of exercise

Question 27: How is fidelity of the exercise programs measured?

- Staff observed
- Checklists to report
- Training records are kept
- Regular contact with the referral to see what they have been doing and how they are managing
- Other

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