Older people's fitness test, A feasibility study to develop a fitness test for older people that can measure variations in cardiorespiratory fitness.

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ABSTRACT

This study builds on the findings from a wider research investigation entitled '*A complex multimodal activity intervention to reduce the risk of dementia in mild cognitive impairment-ThinkingFit* (Dannhauser et al, 2014). The primary aim of this study is to investigate the feasibility of designing a sub-maximal fitness test for older people that can be used without causing undue discomfort to the participant, is appropriate in multi-settings and does not require expensive equipment. The secondary aim is to evaluate the sub-maximal test to identify if it can distinguish change in participants' cardiorespiratory capacity.

The study reviews the influence of exercise on health, and the role healthcare professionals can play in identifying barriers for older people who wish to participate in fitness activities. It examines the current literature of physiological methods of assessing levels of cardiorespiratory fitness. From this body of literature a modified step test was developed, the Older People's Fitness Test (Op-Ft). The test was then carried out on 53 older adults with a mean age of 73.7 years, over 24 weeks and at three time points, at baseline, at pre-intervention and post-intervention, the intervention being a 12 week walking programme. Attrition, compliance and any adverse effects were recorded. Heart rate variables were tested within this inter-subject, repeated measure design. Data was analysed on six variables using one-way ANOVA and pair wise comparisons. Fifty-three subjects completed the Op-Ft on 159 occasions. Attrition rate and non-completion was zero and no adverse effects were reported. Heart rate variables analysed from the data generated by the Op-Ft were able to demonstrate statistically significant increase in cardiorespiratory fitness after engagement in the 12-week walking programme.

The findings from this study suggest the Op-Ft is an appropriate, safe procedure and an achievable test for older people. The Op-Ft has the potential to identify change in cardiorespiratory capacity. In addition the Op-Ft may also have the ability to provide a baseline that could help in establishing the current level of cardiorespiratory fitness, which in turn would help to guide and prescribe fitness activities for older people.

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Terminology and Abbreviations

Useful terminology and abbreviations: (please see Table 1).

Fitness-related terminology	**List of abbreviations**
Cardiorespiratory: the term cardiorespiratory fitness was chosen rather than aerobic capacity or cardiovascular fitness because it better reflects the four physiological systems – namely: - Respiratory system two consume O_2 - Heart to transport 02 - Vascular system to transport 02 - Muscle cell to use 02 **Dose:** volume of exercise or physical activity reflected by total energy expenditure. **Duration:** the length of time a single exercise or exercise session will be performed as well as the long-term timeframe for the total programme. **Exercise:** "planned, structured and repetitive bodily movement done to improve or maintain one or more components of physical fitness. **Exercise Prescription:** a plan that includes information about the mode, intensity, duration, frequency and progression of each type of exercise in the programme. **Frequency:** the number of times the exercise programme will be performed within a specific timeframe. **Health-related physical fitness:** a subset of physical fitness; "the ability to perform daily activities with vigour, and the possession of traits and capacities that are associated with a low risk of premature development of hypokinetic diseases (e.g., those associated with physical inactivity). **Intensity:** the level of difficulty of each exercise component (includes the number of repetitions for musculoskeletal strength, endurance and flexibility training activities). **Mode:** the exercise technique(s) to be performed along with related equipment. **Overload:** exposure of a tissue or organ to a stimulus in excess of its customary workload to produce improvements in functional capacity or efficiency. **Physical activity:** bodily movement, produced by muscle contractions, that increases energy expenditure above the resting state. **Physical fitness:** physiologic, health-related and skill-related characteristics associated with the performance of physical activity. **Progression:** the manner and pace with which the programme will be advanced over time to provide an increased physiologic demand. **Specificity:** training effects are specific to the muscles involved and the type of exercise performed.	**1RM:** 1 repetition maximum **ATS:** American Thoracic Society **ATPS:** Atmospheric Temperature and Pressure Saturated **bpm:** Beats Per Minute **BP:** Blood Pressure (mmHg) **CO_2**: Carbon Dioxide **CV**: Cardiovascular **EMG:** Electro myogram **EPOC:** Excess post-exercise oxygen consumption **FEV1.** Forced expiratory volume in 1 second (L) **MRH:** Maximum Heart Rate **HRR:** Heart Rate Recovery **HRQOL:** Health-related quality of life **ISWT:** The Incremental Shuttle Walk Test **MAOD**: Maximum accumulated oxygen deficit **O_2:** oxygen **OpFt:** Older people's fitness test **PSA:** Participant safety and Attainability **Rep:** Repetition (exercises performed for one complete cycle) **RFWT:** Rockport fitness walking test **ROM:** Range of motion **RHR:** Resting Heart Rate **RPE:** Rate of perceived exertion **RPM:** Revolutions per minute **RMR:** Resting metabolic rate **TEE:** total energy expenditure **T1:** Times one (first test) **T2:** Times two (second test) **T3:** Times three (third test) **VE:** volume of air expired (L) **VO_2 :** volume of oxygen used at any given time **VO_2 max**: maximum volume of oxygen used at any given time

Table 1. Fitness-related terminology and abbreviations, (Jewell 2006, Gladwell et al 2010)

Chapter One – Introduction

1.1.0 Context

The European Commission (EC) (2009) contends that our aging society is one of the greatest challenges of our time. The World Health Organisation (WHO) report entitled '*Global Health and Aging*' (2011) predicted that by 2015 the world will have more older people than children, and more people at extreme old age than ever before. This situation is without precedent in the history of the world as both the proportion of older people and the length of life increase throughout the world. From this increase the challenge therefore is to provide an aging population with long periods of good health, a sustained sense of well-being, and extended periods of social engagement and productivity.

The UK Government's response is seen in the Health and Social Care Act 2012 (Ham et al 2012), which introduces radical changes to improve care provision in England. The draft Social Services and Well-being (Wales) Bill will also attempt to drive coordination and coproduction between health and social care services to promote health and well-being and support independent community living (The Care Bill 2013-14,). In addition, the National Institute for Health and Clinical Excellence (NICE 2008) and NICE/Social Care Institute for Excellence (SCIE) released guidelines calling for improvement in the well-being of older adults (NICE 2008; SCIE 2006).

Organisations such as Age UK, Kings Fund '*Making our health and care systems fit for an aging population'* (2014) and Public Health England '*Life expectancy: recent trends in older ages*' (2015) are engaged in promoting better understanding of the changing relationship between health and age and creating a future that takes full advantage of the powerful resource inherent in older populations.

The Profession of occupational therapy may also be well placed to contribute in developing meaningful lifestyles for the maintenance of health and well-being in older populations (Hynes et al 2015; NICE 2008). The goal of occupational therapy is a life worth living, which fits well into the current debate on population ageing. The College of Occupational Therapy states the profession aims to enable people who have physical, mental and/or social needs, either from birth or as a result of accident, illness or aging, to achieve as much as they can to get the most out of life (College of Occupational Therapists 2008). The profession of occupational therapy has developed client-centred practice, with problem identification, and uses occupation as a treatment intervention to promote independent living (The College of Occupational Therapists (COT) 2008; Townsend & Polatajko 2007; Atwal & Mcintyre 2013).

In the keynote address at the 9th Council of Occupational Therapy for the European Countries (COTEC2012), Professor Susanne Iwarsson stated that occupational therapy research into active aging should present knowledge that translates into solutions that can be implemented in practice, to benefit health and well-being in the everyday life of senior citizens. Occupational therapy research into 'active and healthy aging' should also incorporate other professional groups' knowledge and definitions, ones that are already understood and used outside of occupational therapy's own field of expertise (Iwarsson 2013). NICE (2008) recommends advice and skills training from occupational therapists to help maintain the independence of older people living with dementia. A feasibility study based on occupational approach to healthy aging recommended the introduction of health aging programmes (Mountain et al 2008). At present two unpublished studies '*Lifestyle Matters for maintenance of health and wellbeing in people aged 65 years and over: study protocol for a randomised controlled* trial ' (Sprange and Mountain et al 2013) and 'Valuing Active Life in Dementia' (VALID) (Orrell and Wenborn 2014) have initiated this drive for more research into occupation-based intervention.

The ThinkingFit study (Dannhauser et al 2014) investigated the use of health-promoting, occupation-based interventions, physical, cognitive and socially stimulation in an attempt to design a complex multi-model activity intervention in which older people could engage.

Research suggests that regular participation in specific physical, cognitive and social stimulating leisure activities during midlife reduces the risk of dementia in later life by 28-47% (Hamer & Chida 2009; Karp et al 2006; Larson et al 2006). Dementia is a collective term to describe a number of pathological conditions in the brain characterised by decline in mental function, emotional problems, and difficulty managing practical tasks in daily life (Engedal 2003). The Alzheimer's Disease International report 'The Global Impact of Dementia' (2013) predicts that dementia will affect 76 million people worldwide by 2030. The World Health Organization (WHO Statistics 2012), suggests this number to be 65.7 million in 2030. Whichever statistic is correct it is still a considerable number of older people that will be affected by dementia. Population aging is the main driver of this projected increase in dementia worldwide (WHO 2012). However recent evidence suggests that a modest decline in dementia prevalence in some higher income countries may be linked to changes in better population health (The Global Impact of Dementia 2013; Matthews 2012), which supports the possibility that there may be modifiable risk factors.

The World Alzheimer's Report, 'Analysis of long-term care for dementia' (2013) suggested recommendations for research. The report highlights the need for treatments that may reduce the incidence of dementia among those with Mild Cognitive Impairment (MCI) to limit the progression and/or the development of dementia. MCI is often prodromal for the most prevalent dementia aetiologies, including Alzheimer's disease, cerebrovascular disease and Lewy body disease (Dannhauser et al 2014). Within 2 years approximately 64% of people who are diagnosed with MCI go on to be diagnosed with the most prevalent dementia, Alzheimer's disease, which accounts for around 50-70% of all diagnosed cases (Geslani, Tierney, Herrmann & Szalai, 2005). However, there is a lack of consensus on the definition of MCI so rates have been estimated as ranging between 3% and 53% in older adults over 65 years (Larrieu 2002).

At present there is no pharmacological cure for dementia but neuroscience research has revealed that plasticity in the brain may provide some preservation (Forbes et al 2015b, Gutchess 2014). Training related plasticity has been studied in a wide variety of experimental approaches, such as juggling, computer games, golf and other training activities. (Bezzola et al 2011; Boyke et al 2008; Draganski et al 2004). Plasticity in older adults could recruit regions of the brain to support cognitive functions (Gutchess 2014). Musical training may also be a useful experimental framework for addressing cognitive plasticity (Herholz & Zatorre 2012; Angevaren et al 2008). Exercise also has cognitive benefits for older adults with MCI (Baker et al 2010; Lautenschlager et al 2010; Elwood 2013). However, more research is needed to evaluate the effectiveness of exercise in delaying the progress of MCI (Orgeta et al 2010).

Activities that have been associated with reducing the risk of dementia in midlife may provide a promising dementia prevention strategy (Dannhauser et al 2014; World Alzheimer Report '*Analysis of long-term care for dementia'* 2013). Activity associated with risk reduction is probably due to the positive effects that specific activities have on known modifiable dementia risk factors that cause an estimated 50% of dementia and include physical and cognitive-inactivity, obesity, hypertension, smoking and diabetes (Barnes & Yaffe 2011). The ThinkingFit pilot feasibility study (Dannhauser et al 2014) attempted to develop complex multi-model activity programmes that combined the most beneficial dementia prevention activities. This required interventions that were acceptable to older people and would result in long-term activity participation and therefore lifestyle change.

Despite the multiple health gains associated with a physically active lifestyle, there are high levels of inactivity in England with only a minority of the population in England achieving the minimum levels as recommended by the 'Start Active, Stay Active report' (2011). The Health Survey for England 2008 reported on a study based on accelerometry data, which found only 6% of men and 4% of women met the government's current recommendations for physical activity, achieving at least 30 minutes of moderate to vigorous intense exercise on at least five days a week (Troiano 2007). Physical activity is important for healthy aging (Herholz & Zatorre 2012; Angevaren et al 2008; Schroll 2003, Crombie et al 2004; Mernitz & McDermott, 2004). It plays a role in reducing pathological causes of mortality and preventing many chronic conditions including coronary heart disease, colon and breast cancer, and type 2 diabetes mellitus (Cress et al 2004). According to Public Health England 'Health Impact of Physical Inactivity' (2013) physical inactivity leads to around 37,000 premature deaths a year in England alone. People also tend to be less physically active as they get older (Department of Health, 'Start Active, Stay Active report' (2011), participation in walking and in sports and exercise fell with age. Based on self-reported data over 50% of people over 65 spend 6 or more hours in sedentary time per day on a weekend (HSE 2008).

However, an increase in physical activity can have a positive impact on health and social care services by reducing the prevalence of chronic disease (Department of Health, 'Start active, stay active' (2011). With the onset of advancing age, muscle tissue can be gradually lost (atrophy) resulting in diminished muscle mass and strength, a condition referred to as Sarcopenia by The European Working Group on Sarcopenia in Older People (EWGSOP). The progression of muscle deterioration often contributes to weakness, decreased independence, and subsequently an increase in health costs (Marcell 2003). There is also increasing evidence that aerobic physical activities, which improve cardiorespiratory fitness, are beneficial for cognitive function in healthy older adults without known cognitive impairment

(Angevaren et al 2008).

In 2004 the Chief Medical Officer Sir Liam Donaldson published a report entitled, '*At least five a day; evidence on the impact of physical activity and its relationship to health*' (CMO 2004). This report published guidelines promoting the health benefits of engaging in regular physical activity. Troiano et al (2007) recommend that individuals should accumulate at least 30 minutes of moderate-intensity physical activity on most days of the week. However, the advice on exercise frequency, intensity, duration, and modality of exercise has been debated (Forbes 2015a; Eurenius et al 2007; Swedish National Institute of Public health 2010).

Frequently cited barriers to regular participation in physical activities for older people include lack of time (Wilcox et al 2003), ill health or changing health status (Cohen-Mansfield 2003), fear of injury (Chodzko-Zajko 2009; Costello et al 2011; Forbes 2015a; Wilcox et al 2003), environmental considerations such as convenience/access (Costello et al 2011; Lees 2005; Age Concern 2006), safety and cost (Belza et al 2004; Age Concern 2006), being self-conscious (Dergance et al 2003) and a lack of motivation (Costello et al 2011). In addition lack of knowledge and education regarding the positive benefits of engaging in physical activity was noted as a barrier for older sedentary adults (Hui et al 2001, Dergance et al 2003). Chronic health conditions were identified as both a barrier and a motivation to physical activity in older adult populations, as individuals may exercise to prevent further physical decline but may be limited in their ability to participate in physical activity by the same conditions (Wilcox et al 2003, Belza et al 2004). In spite of the barriers, lack of clarity and inconclusive evidence into older people's exercise requirements (Forbes et al 2015b) there still appears to be increasing interest in promoting physical activity for the prevention of ill-health and maintenance of good health (Philips et al 2004). Reports such as *At least five a day;* (CMO 2004), *Choosing Health, making health choices* (DoH 2004) and *Making every contact count* (De Normanvill et al 2011) have highlighted the growing prominence of health promotion and how physical activity can be used for disease prevention and the management of health conditions.

1.1.1 The incentive for developing the Op-Ft.

The ThinkingFit (2014) study was set up to examine new ways of engaging people at high risk of developing dementia, to participate in health-promoting activities that may reduce their risk of dementia and the related cost of care. Subjects were encouraged to participate in a 12-week programme of activities, such as walking, social activities and cognitive stimulation. The primary aim of this study was to establish if such an onerous programme could be tolerated by participants. The study by Essex County Council Adult Social Care services was part of collaboration between the Adult Community Learning Service (ACL), Library Services and the North Essex Partnership Foundation Trust (NEPFT), who sponsored the study. Secondary outcomes for this study were to: (1) set up the necessary collaborations, (2) design and implement the multimodal intervention programme, and (3) recruit 128 participants to the study. A secondary outcome was to identify if a change had occurred in the study participants' activity levels. A fitness test was needed that could identify cardiorespiratory capacity, was not maximal effort and would be appropriate for multi-setting use.

The ThinkingFit (2014) study provided the platform to investigate the feasibility of developing an older people's fitness test that could show change in the participants' cardiorespiratory capacity. Therefore the objective of this present study was to investigate the feasibility of developing a sub-maximal step test appropriate for older people that could measure variations in cardiorespiratory fitness. The study would investigate the possibility and the rationale of developing an assessment test that could be utilised by both healthcare professionals and fitness instructors.

The author of the Op-Ft was the principal investigator (PI) for the ThinkingFit (2014) study. As the PI his role was to collaborate in the design, development and implementation of the research protocol. This entailed the investigating the relationship between social, cognitive and physical interventions to delay cognitive decline in older people who were diagnosed with mild cognitive impairment. The PI developed the socially based cognitive stimulation groups: activities such as pottery, painting, cooking, tap-dancing, playing brass instruments, rope craft, genealogy, British sign language, digital photography and chalk charcoal drawing. The individual cognitive stimulation training programme and the use of technology to support these groups was also part of the PI role. The PI designed the physical activity programme using research based on cardiac rehabilitation programmes, falls prevention programmes and the best available research on older people and exercise. This included exercise tests to establish change in physical activity. The PI also had the primary responsibility for achieving the technical success of the project and ensuring that the study was carried out in accordance with ethical approval and that subjects' dignity, rights, safety and well-being were safeguarded. The PI had responsibility for the financial and administrative policies and regulations associated with the sponsor. The management of research assistants and the analysis of data collected during the study and the governance of recording and storing data in accordance with the Data Protection Act 1998. The PI analysed and reported on the data generated and was the second author of the research article (a complex multi-model activity intervention to reduce the risk of dementia in mild cognitive impairment-ThinkingFit: pilot and feasibility study for a randomised controlled trial 2014).

Chapter Two – Literature Review

2.1.0 Search strategy

All searches were conducted between December 2010 and February 2013 (Further searches conducted as recommended following Viva 2015). Keywords were selected from the question '*Was there currently an appropriate test available to assess cardiorespiratory fitness in older people'*. These keywords such as cardiorespiratory fitness, older people, and testing were divided into themes (see example below table 3).

Table 3. Themes

Themes 1	Themes 2	Themes 3
Cardiorespiratory fitness Aerobic capacity Cardiovascular	Older people Older adults Older age	Aerobic testing Exercise testing Fitness testing

The search strategy was constructed using Boolean operators, truncation and parentheses, for example: (Cardiorespiratory fitness ***OR*** Aerobic testing) ***AND*** (Older people ***OR*** Older adults) ***AND*** (Aerobic testing ***OR*** Exercise testing ***OR*** Fitness testing).

Electronic databases searched included AMED, CINAHL Plus, Medline, NHS Evidence, OTseeker, PubMed and Sports Discus. These search engines were selected because of the association to the study's particular field of enquiry. In addition to the above, serendipitous searching was also employed to ascertain current media and public health advice on what levels of exercise older people need to undertake to maintain health and wellbeing.

The search identified 2,865 articles during the initial search strategy. Exclusion criteria for identified articles were as follows: any journal article or papers that were not published in the English language were excluded (resources were not available for translation); Some original research articles were referenced dating back to the development of some of the fitness tests where no updated research could be found. However, where possible journal articles and papers that had been published before 2001 were eliminated, in an attempt to identify contemporary understanding of the subject matter. Cross-referencing of keywords and search categories further reduced the quantity of identified articles. After this preliminary screening, 68 articles remained. The following inclusion criterion was then used: screening for relevance was conducted by assessing the titles and abstracts of any papers (regardless of method used). Government guidelines and documents related to the benefits of exercise on older people's health and the current methods of establishing levels of fitness were also examined to inform knowledge base.

2.1.1 Literature review introduction

The literature review falls into three main categories, the impact of exercise on the health of older people, an understanding of physiological cardiorespiratory fitness and how it has been used to assess levels of fitness and implications for healthcare professionals to undertake fitness assessments on older people with much overlapping in the subject matter of each.

- The benefits of fitness activities for older people
- Should healthcare professionals be involved in fitness testing and implications for practice
- Assessment of cardiorespiratory fitness

The Benefits of Fitness Activity

2.2.0 Exercise contextualised

Physical activity has both health promoting and disease prevention properties (Swedish National Institute for Public health 2010). In the last 15 years knowledge regarding the effects of physical activity and exercise among men and women over the age of 70, and the significance this has on aging, has increased (Cochrane 2008; Fiatarone Singh 2002; Frankel et al 2006).

The American College of Sports Medicine (2006 p3) has defined exercise as:

> *Planned, structured activities with the aim of improving endurance, strength mobility, and repetitive bodily movement done to improve or maintain one or more components of physical fitness*

The above definition provides a description of what most people would understand as exercise. The definition encompasses a wide range of activities such as running, cycling and competitive sport. However, the term exercise in itself may be a barrier for some older people because they associate the word exercise with extreme athletic performance, extreme effort and/or unobtainable goals (Chodzko-Zajko 2009; Costello et al 2011; Forboes 2015a). Many public health publications have replaced the word exercise with terms such as being physically active or physical fitness possibly because of this reason. However, the term physically active is also open to different interpretations.

NICE public health guidance (2008 p25) provided a definition of physical activity as: "*Any force exerted by skeletal muscle that results in energy expenditure above resting level"*. This definition could include a range of competitive sports such as triathlons, marathon running and power lifting. Active hobbies such as walking, playing golf and yoga could also be defined as physical activities.

The Swedish National Institute of Public health (2010) provides comprehensive and scientific definition describing how physical activity can be carried out at different levels of intensity. The more intense, the greater the immediate impact on various bodily functions. Oxygen consumption, which is directly linked to energy expenditure, increases from 0.25 litres per minute at rest to slightly more than 1 litre per minute during a relaxed walk. During maximum exertion, it increases to 2–7 litres per minute, i.e. up to 10–25 times the resting rate. During physical exertion, the pulse rises and cardiac output increases. Ventilation multiplies, blood pressure increases, body temperature rises, perfusion in the heart and muscles increases, more lactic acid is formed and the secretion of hormones such as adrenaline, growth hormone and cortisol increases. Maximum oxygen uptake capacity depends on body size, gender, fitness level and genetics. Maximum oxygen uptake ($VO_{2\ Max}$) also decreases by between 5 and 10 per cent per decade after the age of 30 (Spirduso et al 2005). Factors that limit performance capacity in full-body exertion can also differ depending on the length of the session (Brukner & Khan 2012). This definition is beneficial as it provides a method of calculating intensity when designing an exercise programme and testing fitness improvements in older people because resting heart rate and maximum heart rate can be used as variables.

Bouchard (2001) introduces a linear relationship between physical activity, health-related physical fitness and health outcomes (see below Table 2). Jewell (2006) supports this view, stating healthcare and fitness professionals, as well as researchers, are increasingly distinguishing between elite athletes, exercise for overall fitness and fitness reflective of basic good health.

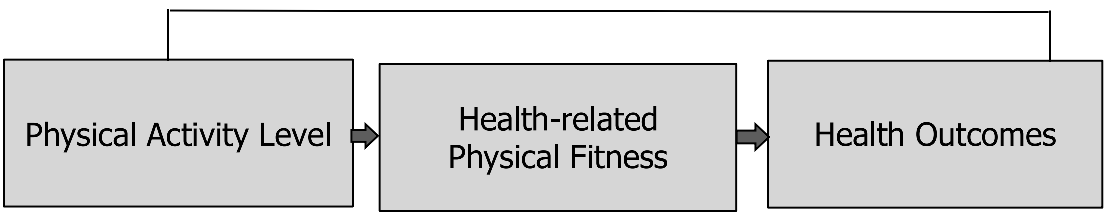


Table 2: Bouchard's (2001) linear relationship between physical activity, health-related physical fitness and health outcomes.

There appears to be an attempt to distinguish between the term exercise and the term physical activity, but unless oxygen consumption or maximum oxygen uptake ($VO_{2\ Max}$) can be measured and the reduction in percentage due to age calculated these definitions can be unclear for older adults (Hui et al 2001). For an older person the term physically active programme may be more appropriate than using the term exercise because of the context they associate with the word exercise. However, any physical activity prescribed for older people as a therapeutic intervention will also need to be considered in the context of any health conditions and the individual's specific capacity (National Academy of Sports Medicine 2012). In an attempt to elucidate definitions the term fitness activities is proposed as an alternative to exercise or physical activity as it suggests elements of activities to promote better health but also implies a physical component.

For the purposes of this research, the terminology used for describing a prescribed intervention to improve an older person's health will be fitness activity. Fitness activities will include activities such as walking and cycling and can be measured in terms of duration, (the time it takes to do the activity) frequency, (how often it occurs) and intensity (the rate of energy expenditure – or rate at which calories are burned).
To aid continuity and consistency and where other authors have used different terminology the description of fitness activity will be preferred.

2.2.1 The Benefits of fitness activity for Older Adults

Many of the disabilities of older adults start with decline in mobility and disuse and are therefore preventable (Swedish National Institute of Public Health 2010). Older people may accept that physical performance declines with age, however, studies have demonstrated that older people who participate in regular exercise programmes can abate or even improve the degenerative process of aging (Nelson et al 2007; Swedish National Institute of Public Health 2010). The long reaching effects of regular exercise in the prevention of ill-health and physical deterioration, which interfere with independence and ADL's have now been universally accepted (Herholz & Zatorre 2012; Angevaren et al 2008; Schroll 2003, Crombie et al 2004; Mernitz & McDermott, 2004).

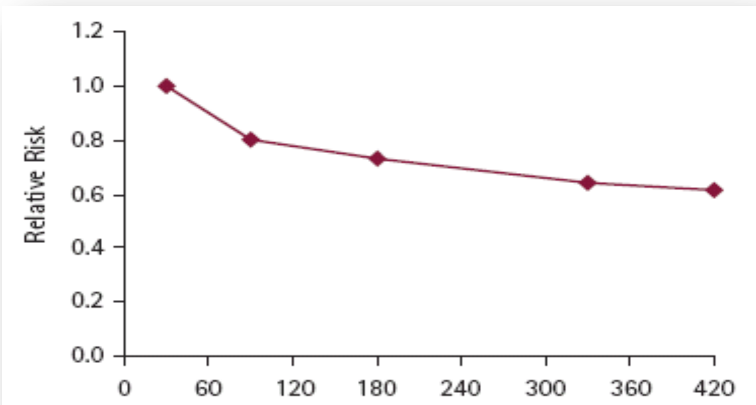
In 2004 the then Chief Medical Officer Sir Liam Donaldson published a report entitled, '*At least five a day; evidence on the impact of physical activity and its relationship to health*' (CMO 2004). The report sets out the available evidence from around the world of the impact that physical activity has on public health. This encompassing 120 page report gives compelling evidence that physical activity not only contributes to well-being, but is also essential for good health throughout all stages of life. Participating in regular exercise is an effective intervention to reduce and prevent a number of functional and health-associated impairments known to occur with advancing age. Older people that are physically active can reduce their risk of developing major chronic diseases such as coronary heart disease, stroke and type II diabetes – by up to 50%, (CMO 2004). The functional benefits of regular exercise include increases in cardiorespiratory fitness, muscle strength and functional capacity, allowing older individuals to maintain their independence and freely participate in their ADL (Tanaka 2009).

2.2.2 The effects of exercise on mortality

Both epidemiological and experimental studies indicate that cardiorespiratory fitness reduces the risk of cardiovascular disease and is a key component of cardiac rehabilitation (Sattelmair et al 2011, McKechnie et al 2002, Sandercock 2013). Cardiovascular disease is a significant risk to individuals' life expectancy and a life-changing event for their families, but it is also a significant financial cost to society. The UK spends more of its healthcare budget on cardiovascular disease than any other EU country. The cost to the UK economy in 2004 was £29.1 billion and 69 million workdays were lost (Luengo-Fernandez, et al 2006). There is now strong evidence to indicate physical activity is a major independent protective factor against coronary heart disease in men and women (CMO, 2004). What is more, exercise which includes cardiorespiratory and endurance training has been shown to provide the most protection and markedly reduced the age-related increases in risk factors for coronary heart disease.

Physical activity also has beneficial effects on preventing 'stroke' another major cause of death in developed countries. In 2004, the American Heart Association published exercise and physical activity guidelines for individuals post 'stroke', based on an accumulation of studies (Maron, 2004). The guidelines advise that an individual's chances of experiencing further 'strokes' were greatly reduced if they participated in cardiorespiratory fitness activities. With such evidence, it appears that exercise could be a major preventative intervention to reduce mortality in developed countries. The United States Department of Health and Human Services (U.S. DoHaHS 2008) contributes to this ever increasing evidence and provides a table which identified that the risk of dying prematurely declines in older adults if they are more physically active (see Figure 1).

Fig 1: The Risk of Dying Prematurely Declines as People Become Physically Active Minutes per Week of Moderate- or Vigorous-Intensity Physical Activity '*The Risk of Dying Prematurely'.*



The U.S. Department of Health and Human Services (2008)

2.2.3 Exercise can improve musculoskeletal health

Preventing older people from becoming limited in performing ADL is an important health objective for maintaining quality of life (Ishikawa et al 2006). More and more attention has been paid to devising measures for preventing a decline in muscle strength in an attempt to reduce the burden of long-term care. Muscular atrophy due to disuse, a consequence of an inactive life, plays an important role in the progression of frailty (Suetta et al 2007). The Centre for Disease Control and Prevention assert that, decline in muscular strength leads to an increased risk of falls, which are a major source of death and injury in older adults (CDCP 2009). The National Hip Fracture Database reports the cost to society in both acute care and providing for subsequent dependency is £2 billion per year for the UK (NHFD 2008).

The United States Department of Health and Human Services, (2008) advocates that regular exercise significantly reduces the incidence of falls in older adults and advises multifactorial intervention that includes moderate-intensity, muscle-strengthening activities for 90 minutes a week plus moderate-intensity walking for 60 minutes a week. Falls are an even greater problem for older people with dementia, with 40-80% of people with dementia falling each year (Eriksson et al 2008). The evidence for older adults to participate in falls prevention activity programmes appears to be strong (Gill et al 2005). However, for an older adult with dementia to accomplish the recommended level of activity, they would need support and advice based on an individual person's identified risk of falling (Suttanon et al 2012).

2.2.4 Effect of Fitness Activities on the brain

Dementia is one of the major health and social care issues at the present time (The Global Impact of Dementia (2013). Dementia is characterised by acquired cognitive deficits sufficient to impair activities of daily living.

Currently there is no cure for the leading causes of dementia, which include Alzheimer's disease and vascular disease (Forbes et al 2015b). However, arresting the progression of cognitive decline and delaying the onset of dementia will improve quality of life for patients and reduce the cost of care. Those affected by dementia are primarily determined by physical impairment, cognitive deficits, social isolation and psychological symptoms such as depression. Dementia afflicts 820,000 people in the UK, the economic cost is calculated to be £23 billion but the true social impact for people living with dementia and their families is incalculable (ART 2010). Dementia costs the UK twice as much as cancer, three times as much as heart disease and four times as much as stroke (ART 2010). Mild Cognitive Impairment (MCI) has been described as the prodromal state for developing dementia (Dannhauser et al 2014).

There is now growing interest in lifestyle factors and interventions that enhance the cognitive vigour of older adults and reduce the risk for cognitive impairment. An emerging body of multidisciplinary literature has documented the beneficial influence of physical activity engendered through cardiorespiratory exercise on selective aspects of brain function (Forbes et al 2015b; Angevaren et al 2008; Barnes & Yaffe 2011; Baker et al 2010). Human and non-human animal studies have shown that aerobic exercise can improve a number of aspects of cognition and performance (Hillman et al, 2008). Animal studies have shown that enriched environments, including access to exercise equipment (such as running wheels), have a positive effect on neuronal growth and on the neural systems that are involved in learning and memory, indicating that physically active behaviours influence cognitive function and the supporting brain structures (Vaynman et al, 2006).

In humans regular participation in exercise might not only help to improve physical health, but may also reduce the risk of dementia and keep older adults independent (Hamer & Chida 2009; Karp et al 2006; Larson et al 2006). Physical activity significantly benefits older people with improvements in heart and lung function, balance, coordination, mood and quality of life, all problems associated with MCI (Forbes 2015b; Swedish National Institute of Public health 2010; Brukner & Khan's 2009; Herholz & Zatorre 2012; Cochrane 2008; Rowe & Kahn 1997; Schroll 2003; Crombie et al 2004). Moreover, some studies have shown that lower incidences for both the most prevalent cause of dementia, Alzheimer's disease, as well as all other causes are associated with physical activity (Rovio et al 2005; Lytle et al 2004; Abbott et al 2004; Baker et al 2010; Lautenschlager et al 2010).

A study by Erickson et al, (2011) conducted a randomised control trial with 120 older adults, and showed that cardiorespiratory exercise increased the size of the anterior hippocampus, leading to improvements in spatial memory. The hippocampus shrinks in late adulthood, leading to impaired memory and increased risk of dementia (Duara et al 2011). Erickson prescribed a walking programme that increased hippocampus volume by 2%, effectively reversing age-related loss in volume by 1 to 2 years. Erickson's findings indicate that aerobic exercise training is effective at reversing hippocampus volume loss in late adulthood, which is accompanied by improved memory function.

Previous studies published by Colcomb and Kramer (2004), examined whether cardiorespiratory fitness training can have a robust and beneficial influence on the cognition on older adults. Their findings concluded that fitness training increases cognitive performance, regardless of the type of cognitive task, the training method, or participants' characteristics. Heyn et al (2004) supported this finding in their meta-analysis of 30 trials that included 2020 participants; their conclusion was that exercise was associated with statistically significant positive treatment effects on older adults with dementia and cognitive impairment. Zoeller (2010) explored the relationship between physical fitness and cognitive function. He describes a six-month exercise programme where the subjects participated in regular physical activity three times a week for 30 minutes. The study showed a positive association between physical activity and cognitive, physical activities improved or at the least served to maintain cognitive function in a group of older participants. Nascimento et al (2012) also analyzed the influence of a six-month exercise programme on 20 elderly women with Alzheimers disease. The study compared 10 patients who participated in the walking programme with 10 patients who did not. The study showed a propensity for less deterioration of performance in instrumental activities of the exercise group's members compared to the sedentary group. However, in a randomized control trial conducted by Cott et al (2002) on the effects of a walking-talking programme within a care home, residents did not demonstrate statistically significant differences between the group that received walking-talking groups for 30 minutes five times a week for 16 weeks and those that received talk only groups or no intervention. Variability in these outcomes may be explained by differences in the residents' level of cognitive impairment before the study. The frailty of the subjects may have also influenced the results if the intensity of the walking was not sufficient enough to increase the blood flow to the brain. The findings of Cott et al (2002) are contradictory to those of previous studies.

Even when considering the Cott et al (2002) study it still appears that cardiorespiratory exercise can contribute to the physical and mental well-being of older adults and may have the additional benefit of slowing down or protecting individuals from dementia. However, much more work needs to be done in this area to investigate and define the most beneficial physical fitness programme for older adults (Orgeta et al 2010). The literature for supporting the provision and prescribing of fitness activities for older people as a therapeutic intervention is considerable. Increasing older people's physical activity will not only improve their longevity but also their quality of life.

Promotion of health-related fitness

2.3.0 Healthcare professionals promoting health-related fitness activities

Promotion of fitness activity as part of a general primary prevention programme is an understandable public health initiative in light of ever increasing evidence (Ham et al 2012). The functional benefits of regular fitness activity include an increase in cardiorespiratory fitness, muscle strength, and functional capacity, all of which allows older people to maintain their independence and freely participate in ADL (Swedish National Institute for Public health 2010; Cress et al 2004). Regular participation in fitness activity programmes can keep the older population independent and reduce health care costs by protecting older adults against chronic health conditions (Hynes et al 2015). Habitual fitness activities and specific endurance training, or both can prevent or markedly attenuate the age-related increases in risk factors for older peoples health (DoH, '*Start active, stay active'* 2011). The UK government has recognised this potential and published an impact assessment, which accompanied the published, Policy paper, '*Health Lives Health People: our strategy for public health in England* (2010) states health promotion and ill-health prevention are key government priorities. However, the majority of older adults do not participate in fitness activities regularly, although fitness activities can significantly benefit older people and improve their quality of life (DoH, 'Start Active, Stay Active report' 2011; Centre for Diseases Control and Prevention (CDC) 2008). The barriers to exercise in older adults include limited access to programmes and facilities, lack of support and low awareness of benefits (Belza et al 2004; Mathews et al 2010; Lees et al 2005; Horhota & Price 2013; NICE 2008).

2.3.1 Non-healthcare providers

Non-healthcare professionals have in recent years provided advice and guidance to the general public on the best ways to manage their fitness activity programmes. Many local sports centres employ Registered Exercise Professionals (REP's) who assess people and provide fitness activity regimes specific to individuals needs. However, older people may encounter more barriers when seeking appropriate fitness activities advice from non-health professionals than their younger counterparts (Schutzer et al 2004, Lees et al 2005). This may be due in part to non-health professionals' concerns about some older people's existing health problems such as arthritis, where excessive fitness activities can lead to joint swelling and pain, which can effect balance and can lead to increased risk of falls (Lees et al 2005). Frequently non-healthcare providers of specific fitness activity programmes for older people need to charge participants; these costs can also provide a barrier for some older people (Lees et al 2005). Registered non-healthcare exercise professionals are advised to receive specific training before providing programmes for older people such as the YMCAfit's exercise and aging course (http://www.ymcafit.org.uk/courses/exercise-older-adults). However, these very specific courses may limit older people's access to fitness activity prescription and counselling, due to the lack of available older people's fitness activities specialists in the local area (Lees et al 2005).

Many older people do not have the money to join a health club or transportation to get to a fitness class (Schutzer et al 2004; Belza et al 2004; Lees 2005). As the majority of assessments that are undertaken by non-health professional take place in local health club or sports centres, older people may feel out of place or uncomfortable in these settings (Stathi et al 2002). This may explain why some studies have demonstrated that older people have better long-term adherence if fitness activity exercise is undertaken from the older person's home rather than gym-base or a centre location (Ashworth et al 2005). This would suggest that only registered exercise professionals who would be available to do home visits are best placed to provide exercise programmes for older people. The Centre for Disease Control and Prevention (CDCP) 2012, stresses the need for non-healthcare registered exercise professionals to follow standard operating procedure and refer older people back to their General Practitioner (GP) if they identify a problem or have any concerns regarding the older person's health. However, this reasonable procedure would then preclude older adults from being physically active until they have seen a healthcare professional.

2.3.2 The case for Healthcare Professionals to promote of physical activity

Considering the many preventative and curative effects of physical fitness activities, there would appear to be an increasing argument for healthcare professionals to become more proactive in promoting health-related fitness activities among patients affected by chronic diseases and cognitive decline (Lawton et al 2009). Health care professionals can and should incorporate fitness principles and elements in their plans of care to enhance functional recovery and adaptation (Costello et al 2011; Jewell 2006). Older people frequently identified their GP, hospital consultant or health professional as the primary source of advice and encouragement for physical activity when related to a health problem (Jewell, et al 2006; Karp et al 2006; Balde et al 2003; Yardley et al 2005). As the first point of NHS contact for most patients, GP's are in a unique position to promote the health and well-being of older adults. However, Jewell et al (2006) suggests that GP's are not as proactive in promoting physical activity to their older patients as they should be.

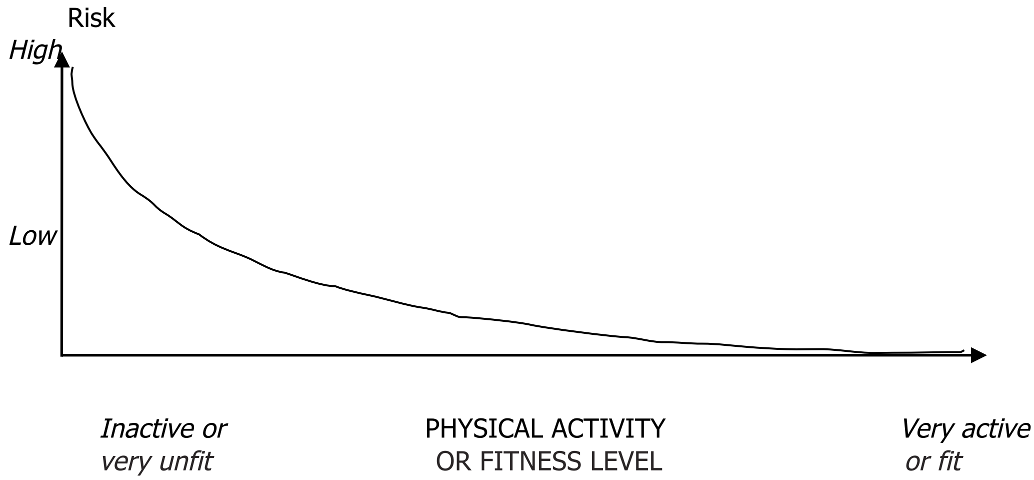
Jewell, et al (2006) suggests not only GP's but all healthcare professionals should counsel older people on the benefits of exercise, based on psychological theories which promote health education and support engagement for better adherence to exercise programmes. Community based exercise programmes can be provided by nurses, physiotherapists and occupational therapists (Suttanon et al 2012; Costello 2011; COT 2008). The College of Occupational Therapy highlights the links between occupation and health, and between occupational therapy and health promotion, in the guidance publication, *Health Promotion in Occupational Therapy* (2008). The guidance supports the view that occupational therapists should engage clients in occupations that have a meaning and value for people, and can promote, maintain and restore health. Occupational therapy therapeutic intervention can be provided to increase functional life skills, which help in the recovery of mobility, maintain health or alleviate the impact of ill-health (COT 2008; Mountain et al 2008). Exercise and fitness programmes appear to promote this tenet. However, occupational therapists and physiotherapists are not traditionally identified strongly with public health, but have a philosophy of care that is a biopsychosocial model, underpinned by enabling service users to learn how to manage their own health and sustain new, positive health behaviours more effectively. The COT in the publication *'Health promotion in Occupational Therapy'* (2008) have highlighted this potential and support the promotion of health-related fitness activities to older adults, encouraging the profession of occupational therapy to contribute to the wider public health agenda. Occupational therapists and healthcare professionals can provide education about the positive health benefits of exercise to improve quality of life for older people and help deliver the government's prevention agenda (Hynes et al 2015; COT 2008; Mountain et al 2008). However, developing a plan of care which incorporates fitness principles in any practical setting depends upon the health care professional's understanding of contemporary concepts and terminology pertaining to fitness, the elements of exercise and the treatment effect dosage.

Research published to date has not validated a dose response relationship between physical activity and the positive health outcomes for older people such as weight, systolic blood pressure, cognitive function, depression, or anxiety (Forbes 2015a; Jewell 2006). Therefore, the health care professional will need to work with the older adult and available research to identify how best to assess and achieve the best health outcomes for their patients (Suttanon et al 2012). There is a greater risk of injury when prescribing physical activity for older people; high-intensity activities and activities that involve sudden or complicated movements should be undertaken cautiously, unless the individual is already used to exercise (Forbes et al 2015b; Chodzko-Zajko 2009) Some activities can also aggravate some existing conditions such as osteoarthritis, a common condition in older people that leads to a decrease in bone density and increased risk of fractures (Chodzko-Zajko 2009; Carter 2001).

2.3.3 Appropriate levels of fitness activity

The United States Department of Health and Human Services (2008) postulates that a total 90 minutes of moderate to vigorous intensity physical activities a week, can decrease the relative risk of premature death by 0.8. However, an increase of 180 minutes will reduce the risk to 2.7% (0.73). The United Kingdom Chief Medical Officer report DoH (2004) estimates that being physically active reduced the risk of premature death by about 20-30% which would suggest an individual would need to participate in physical activities for 5 to 6 hours a week. This equates to 60 minutes of physical activity a day for 6 days a week. Current recommendations on physical activity in England for older adults are 30 minutes five times a week (Annual report Chief Medical Officer 2009). The Health Survey for England (2008) found that only 6% of men and 4% of women met the government's current recommendations, achieving at least 30 minutes of moderate or vigorous activity on at least five days in the week, accumulated in bouts of at least 10 minutes. Research has suggested that even the oldest and most frail segments of the older adult population can benefit from regular increases in physical activity when they are tailored to participant needs (Pahar et al 2006). The Chief Medical Officer report 2004 recommendations state that the people who benefit most from physical activity are inactive people who begin to take part in regular, moderate intensity activity (see Figure 2).

Fig 2: Schematic representation of the dose-response relationship between physical activity
level and risk of disease



Older adults should take particular care to keep moving and maintain their mobility through daily activity. Additionally, specific activities that promote improved strength coordination and balance are particularly beneficial (Chief Medical Officer report 2004).

Table 4 indicates that any increase in physical activity would benefit older adults. However, encouraging participation in a programme that may be considerably greater than the older adult's present activity level, could increase the potential for injury. Older people are fearful of participating in exercise programmes because of concerns of injury unless there are appropriately supported (Chodzko-Zajko 2009; Costello et al 2011; Forboes 2015a). A graded programme, building on the older adult's current activity level would be the most appropriate means of achieving the 60 minutes of physical activity a day for 6 days a week (Pahar et al 2006). Physical fitness programmes for older people would need to be based on their individual capacity, which would require a baseline assessment of the older adult's current physical ability, medical conditions and levels of motivation (Brukner & Khan 2009; Swedish National Institute of Public health 2010). This will allow the prescriber to specifically design a programme to the individual's ability and needs and not current guidelines.

2.3.4 Walking as a prescribed intervention

Recent evidence supports the hypothesis that cardiovascular health, including cardiorespiratory fitness, is linked to cognitive function (Gauthier 2015; Colcomb et al 2004; Heyn et al 2004; Zoeller 2010; Nascimento et al 2012; Baker et al 2010; Lautenschlager et al 2010; Elwood 2013). Exercise improves cardiovascular and vascular health by reducing blood pressure and arterial stiffness (Fleg 2012), oxidative stress (Covas 2002), systemic inflammation (Lavie 2011), and by enhancing endorphial function (Ghisi 2010), all of which are associated with the maintenance of cerebral performance (Ainslie 2008; Churchill 202). Exercise induced elevation in brain-derived neurotrophic factors (BDNF) may also contribute to increased cognitive function (Erickson 2012). BDNF is a key protein in regulating maintenance, growth and even survival of neurons (Rasmussen et al 2009). Improvement in circulation, blood flow to the brain and neural activity during exercise have all been shown to have a strong association with increased cognitive function (Zoeller 2010). However, how much exercise is needed to produce all these positive effects has not been established (Orgeta et al 2010).

The U.S. DoHaHS (2008) suggest some health benefits seem to begin with as little as 60 minutes (1 hour) a week. Wen et al (2011) found that individuals, who were physically active, moving for only 15 minutes each day, reduced their risk of mortality by 14% and added three additional years to their lives. Sattelmair et al (2011) suggest that brisk walking for 30 minutes, 3 days/week, or 90 minutes per week resulted in healthier arteries that reduced the risk of heart attack. This evidence suggests that by engaging in a 30-minute walk three times a week, physiological changes will occur in cardiorespiratory fitness.

Media publications and public health information websites such as, *Walking for health, getting started;* advise that older adults should start their programme of walking slowly and try to build up the regime gradually. Furthermore, they describe the intensity of the walk as a moderate aerobic activity, which poses the question of how would an older adult know what a moderate aerobic activity level is without guidance from a suitably qualified professional. However, a relatively cost effective way of overcoming this problem would be to provide a heart rate monitor which would provide real time feedback via sound or vibratory alerts and could be used to supervise and pace physical exercise as far as intensity and duration are concerned. Exercise intensity could also be adjusted as fitness levels increase. Furthermore, if the older adult undertook an assessment that could identify a baseline for cardiorespiratory fitness and subsequent progression this would be an advantage. A cardiorespiratory fitness test would reduce risk by identifying older adults limitations, monitor progression, and educate the older adult to the required intensity, providing feedback and motivation.

2.3.5 Evidence for walking as a modality

Walking has been utilised by health promotion schemes to improve the health of the general public, and used therapeutically in settings such as psychiatric services (McDevitt et al 2005; Richardson 2005; Wensley & Slade 2012). Although the health benefits for physical activity have received increasing research attention, occupational benefits to walking are not well developed. Wensley & Slade (2012) suggest that the greater the evidence base for how occupations maintain, enhance and promote health and wellbeing, the more this evidence can be implemented in occupational therapy practice.

To improve an older adult’s fitness a healthcare professional can prescribe a walking programme (Fletcher et al 2001). Walking is one or the easiest, safest and most inexpensive forms of exercise (Richardson et al 2005). It has the advantage of being available from the participant's home and can be incorporated into an older adult’s daily routine and does not need any specialist equipment (Richardson et al 2005, *Walk the life* DoH 2011). There is increasing evidence that walking improves health, cognitive function and psychological well-being (McDevitt et al 2005, Richardson et al 2005, Dawson et al 2006, Mind 2007, Roe and Aspinall 2011). The *Walking the way to Health initiative* (WHI) and *Walk4Life* campaigns (Wilde et al 2001, DoH 2011) aimed to improve the health and well-being of the general public through walking. Current guidelines advise 30 minutes of at least moderate intensity physical activity a day, five days a week, which significantly reduces the risk of health problems (At least five a week 2004). However, for some older adults this amount of activity may be impossible to achieve because of pre-existing health problems.

Specific guidelines for physical activity for older adults has not been established in the UK, the American Heart Association have provided guidance to healthcare professionals for exercise standards, testing and training (Fletcher et al 2001). However, this report does not identify treatment effect. No consensus of opinion has been reached regarding the optimum modality, frequency, intensity and duration necessary to establish an exercise programme to maximise falls prevention and increase health and well-being for older adults (Forbes 2015a, Eurenius et al 2007; Swedish National Institute of Public Health 2010). The Chief Medical Officer (2004) states that older people who engage in low to moderate intensity activity for less than the five, 30 minutes activities a week will still produce a health benefit because of their relatively low levels of fitness. A qualitative study conducted by Wensley and Slade (2012), identified that people felt a physical benefit from walking, which helped them relax and established and maintained social contact. However, no specific duration, intensity or frequency was established. Participants were encouraged to walk as much and as far as they felt comfortable. Wensley and Slade (2012) advocated that encouraging participants beyond their physical capacities had a negative impact because if the participant did not meet their prescribed frequency, duration and intensity it would have a negative impact on his or her self-esteem and confidence.

A study by Heyn (2003) used aerobic exercise on older people, which consisted of 15 to 70 minutes of cycling or walking three times a week for eight weeks. He concluded that increased exercise engagement preserved function in older people. However, the most compelling evidence for establishing a walking programme for older people comes from Renaud et al (2010), their study assessed the effects of an fitness programme on older people involving walking. Participants were assigned to a three-month training programme and asked to participate in three 60 minute sessions per week. Their results indicated that 12 weeks of fitness training induced a significant improvement in cardiorespiratory capacity. There appears to be increasing evidence to suggest that older people should be encouraged to walk regularly because it maintains independence and ADL (National Academy of Sports Medicine 2012). However, walking programmes should be designed to take into consideration older people's functional limitations and symptoms of disease (Fletcher et al 2001; Brukner & Khan 2009; Swedish National Institute of Public health 2010).

The role of the healthcare professional when advocating exercise as a therapeutic modality would be to provide education about the benefits of exercise, ensure the exercise regime chosen was appropriate and meaningful to the individual (Fletcher et al 2001; The College of Occupational Therapists (COT) 2008; Townsend & Polatajko 2007; NICE 2008). The healthcare professional would also need to be able to modify the activity, which would be dependent upon the older person's health and the progression of their capacity. The monitoring and assessment of an older person that wishes to participate in exercise to improve fitness and health requires the health professional to include two categories of testing, the measures of health and the measurement of fitness (National Academy of Sports Medicine 2012). Measurements of health are undertaken prior to measures of fitness to identify if the participant is healthy enough to do a fitness test. This initial screening will help to identify any health risks to the participant in any proceeding fitness test or during any fitness programme (Brukner & Khan

2009). Measures of fitness are dynamic and involve bodily movement that may include lower and upper body strength, lower and upper body flexibility, agility and balance and cardiorespiratory fitness (National Academy of Sports Medicine 2012).

Chapter Three - Assessment of fitness

3.1.0 Introduction

Health professionals who consider fitness activity as a meaningful and purposeful occupational activity that can yield positive benefits for older people need to acquire expertise in the use and application of physical fitness activities (Jewell 2006; Gladwell et al 2010). The role of the health care professional when advocating exercise as a therapeutic modality would be to help participants feel comfortable, educate them about the benefits of fitness activities and ensure that they were doing the exercises as intended, in a safe manner (National Academy of Sports Medicine 2012). This would require the health professional to build rapport with patients, review compliance and encourage them with cognitive motivational techniques, and observe tolerance for the fitness regime. A fitness assessment involves a series of measurements that help to determine the current health and fitness level of the client (Clark et al 2012; Brukner & Khan 2012; National Academy of Sports Medicine 2012).

Assessing an individual who wishes to participate in fitness activities to improve their health requires the health professional to include two categories of assessment: measures of health and measures of fitness (Brukner & Khan 2012; National Academy of Sports Medicine 2012). Measures of health are undertaken prior to measures of fitness to see if the participant is healthy enough to do the fitness tests. The tests are static in nature and may include reading medical notes, measuring weight and height to calculate body mass index (BMI), heart rate, blood pressure, waist-to-hip ratio and enquiring about the participant's current health and lifestyle. This initial screening helps to identify any health risks to the participant in the proceeding fitness test or during the fitness programme. Measures of fitness are dynamic and involve bodily movement and may include lower and upper body strength, lower and upper body flexibility, agility and balance and cardiorespiratory fitness (Rikli and Jones 2001; National Academy of Sports Medicine 2012). Once the patient's baseline health and fitness level has been determined, the health care professional can recommend the most appropriate exercise for those patients.

In consideration of the study aim and due to the limitations of this dissertation, the following literature review will focus on cardiorespiratory fitness testing. The cardiovascular and respiratory systems work together to transport oxygen to the tissues of the body (The Swedish National Institute of Public Health 2010; National Academy of Sports Medicine 2012). The capacity to efficiently use oxygen is dependent on the respiratory system's ability to collect oxygen and the cardiovascular system's ability to absorb and transport it to the tissues of the body (Brukner & Khan 2012; National Academy of Sports Medicine 2012). Together, the cardiovascular and respiratory systems make up the cardiorespiratory system (Clark et al 2012). Establishing the older adult's initial level of cardiorespiratory fitness is an important goal and is often referred to as a baseline cardiorespiratory measure (Brukner & Khan 2012; Spirduso et al 2005; National Academy of Sports Medicine 2012). Establishing a baseline can be used to measure the effectiveness of any fitness programme as well as to encourage the participant via the ability to show improvement.

As previously mentioned an important factor when advocating physical exercise is to establish what level of fitness an individual has before they engage in a fitness programme (National Academy of Sports Medicine 2012). Many tests for assessing cardiorespiratory fitness have been designed for elite athletes, younger people or people without disease or disability and therefore would not be appropriate for all older people (The Swedish National Institute of Public Health 2010; Brunker & Khan 2012). Those tests that have been developed specially for older people or people with health problems appear to be mostly adapted from cardiorespiratory tests for healthy younger people and therefore in some part have their own limitations, such as requiring the participant to work to their maximum effort such as maximal direct. However, there appears to be an accepted opinion that adapting existing cardiorespiratory tests to meet the need of specific populations is advantageous (Brunker & Khan 2012). Stafford-Brown et al (2010), emphasises the importance of ensuring the health and safety of participants and that testing procedure meets certain considerations deemed necessary to minimise any risk to the participant. To ensure this, the test must adhere to strict procedures that are outlined in the testing protocol.

Cardiorespiratory fitness testing can also be used in screening individuals to identify whether a person is healthy enough to perform the exercise activities they wish to pursue (Stafford-Brown et al a2010; Brukner & Khan 2012). A cardiorespiratory fitness assessment should identify the current fitness levels of an individual, so the exercise programme can be specifically designed to meet the needs of the older person, for example modality, frequency, duration and intensity (National Academy of Sports Medicine 2012). Stafford-Brown et al (2010) state before people start to exercise they will need to know where they are at any point in time so they can work out how close they are to where they want to be. This statement suggests that continuous assessments using the same assessment techniques will help the older person and exercise prescriber identify progression or deterioration in the individual's fitness levels and provide feedback to enable adaption in the exercise programme.

3.1.1 Cardiorespiratory fitness

Cardiorespiratory fitness is also referred to in literature as aerobic endurance, aerobic fitness or cardiovascular fitness. For the purposes of this dissertation the term cardiorespiratory fitness will be used to standardise terminology. Cardiorespiratory fitness is the capacity of the heart and lungs to supply oxygen-rich blood to the working muscles and the capacity of the muscles to use oxygen to produce energy for movement (Waugh and Grant 2001;The Swedish National Institute of Public Health 2010; National Academy of Sports Medicine 2012). Cardiorespiratory fitness is brought about by sustaining physical activity which increases an individual's ability to deliver oxygen to working muscles which is affected by many physiological parameters, including heart rate, stroke volume, cardiac output, and maximal oxygen consumption (National Academy of Sports Medicine 2012). Cardiorespiratory fitness can be determined by the maximal rate at which a person can consume oxygen known as maximum oxygen consumption (VO_2max). The VO_2max is the greatest amount of oxygen that the muscles can use while exercising to ultimate failure, which reflects the ability of the lungs, blood, heart, muscles and other organs and organ systems to transport and utilise O_2 via aerobic metabolic pathways (Brukner & Khan 2012; Balady et al 2010).

The ability to sustain ADL's and a healthy lifestyle requires an effective and efficient cardiorespiratory system (National Academy of Sports Medicine 2012). As older people's activity levels increase so does oxygen consumption and thus provides the adaptation needed to gradually increase cardiorespiratory fitness. For sedentary individuals the effects of improved cardiorespiratory fitness may be even more profound and it should be the primary focus of training for health outcomes (Carnell et al 2009). Older people who undergo a progressive 12 week fitness training activity programme such as walking should show an increase in their cardiorespiratory fitness levels indicated by their ability to maintain the level or duration of the activity for longer or with less effort, (Stafford-Brown et al

2010; Nascimento et al 2012; Zoeller 2010). Regular exercise for at least 30 minutes at a predetermined moderate intensity (65-77% of maximum heart rate) is beneficial in improving general cardiorespiratory fitness and will still allow sufficient training effects to be identified. The more effective exercise intensity (70 to 85% of maximum heart rate) may be more beneficial but is associated with increased risk of injury and high dropout rates due to discomfort in older people (Carnell et al 2009).

As an older person becomes cardiorespiratorily fitter their resting heart rate decreases (The Swedish National Institute of Public Health 2010; National Academy of Sports Medicine 2012). This is due to the heart getting more efficient at pumping blood around the body, so at rest more blood can be pumped around with each beat, therefore fewer beats per minute are needed (Brukner & Khan 2012). This method has been commonly used as an indicator for a person's cardiorespiratory fitness, therefore it is assumed that the lower the resting heart rate the fitter the individual (National Academy of Sports Medicine 2012). However, this method is not completely reliable because of variations in a person's resting heart rate may be due to other factors such as coffee consumption and the body fighting off the effects of the common cold.

There are numerous cardiorespiratory fitness tests available, many offering different levels of reliability, validity and viability. It was not possible to review all cardiorespiratory tests within the limitations of this literature review, therefore a broad range of the most used and evidenced tests were selected. Although this selection is by no means conclusive the author is of the opinion it gives a broad understanding of current available cardiorespiratory tests.

To determine an individual's cardiorespiratory fitness three types of methods can be distinguished:

- Maximal
- Sub-maximal
- Subjective methods

3.1.2 Maximal Tests

Maximal exercise tests either measure or predict VO_2max and have been accepted as the basis for determining cardiorespiratory fitness (Brukner & Khan 2012; Abdossaleh & AHmadi 2013; Balke and Ware 1959, Patterson 1972). VO_2 maximal direct test requires the subject to exercise to exhaustion, and as a consequence putting themselves under a great deal of distress and discomfort (Abdossaleh & AHmadi 2013; National Academy of Sports Medicine 2012). The advantage of a maximal direct test is that it can provide an accurate and direct measure determining the maximum volume of oxygen utilised during maximal physical effort and has served as a standard against which to compare other measures (Shephard et al 1968; Abdossaleh & AHmadi 2013; Shamsi et al 2011). The maximal direct exercise test is recognised as the "gold standard" method for elite athletes (Abdossaleh & AHmadi 2013; Shamsi et al 2011). The test reflects the body's ability to transport and utilise O_2, with changes in ventilation, perfusion, heart rate and stroke volume, and/or peripheral utilisation of O_2, all having an influence on VO_2max (Brukner & Khan 2012; Abdossaleh & AHmadi 2013; Shamsi et al 2011). Maximal direct test requires a controlled, strict and rigorous protocol in an exercise physiology lab or sports medicine clinic (Abdossaleh & AHmadi 2013). The equipment required for the test is expensive and needs a certain amount of expertise to administer (Abdossaleh & AHmadi 2013). The test includes oxygen and carbon dioxide analysis, which requires the participant to wear a facemask that measures the amount of air being expired per minute. The participant is required to exercise on a machine (usually a treadmill or bicycle) that is equipped with apparatus for measuring the work performed by exercising, referred to as an ergo meter (American College of sports medicine 2010; Fletcher et al 2001). The ergo meter workload is adjusted during each stage of testing. An electrocardiogram (ECG) is also required to monitor the participant's heart rate, and trained professionals will need to take blood pressure and blood lactate readings during the test at the end of each stage (American College of sports medicine 2010; Fletcher et al 2001). A typical test procedure is as follows:

The treadmill protocol requires the participant to place a Douglas bag over his or her face and the mouthpiece into his or her mouth (American College of sports medicine 2010). The participant is instructed to run at a moderate and comfortable pace on the treadmill and every 3 minutes the incline on the treadmill is increased by 2.5%. The increase in the incline will gradually progress in order to transition the subject from a moderate intensity to maximal exertion; this allows the researcher to examine the increase in oxygen consumption and determine when the subject has reached his or her VO_2max (American College of sports medicine 2010). The subject's heart rate is monitored through the ECG readings and his or her blood lactate and blood pressure is taken at the end of each change during the actual test (Fletcher et al 2001; Balady et al 210). The subject is considered to reach his or her VO_2max when the amount of oxygen consumed has reached a plateau and no longer increases with any increase in workload (Maximal heart rate has been reached) (Balady et al 2010). The subject's respiratory exchange ratio has reached 1.00 and above (this indicates anaerobic metabolism), or the subject has reached volitional exhaustion (Balady et al 2010). The advantages of the direct test are an exact measurement of a subject's VO_2max, maximal heart rate can be measured, and the test is standardised so values for subjects can be compared in any clinical facility. The results of the maximal test can be measured against normative tables to establish the level of an individual's cardiovascular fitness (Gladwell et al 2010; Flecher et al 2001; National Academy of Sports Medicine 2012) (see Table 4).

Table 4: Please see below the normative values of VO_2max values.
Maximal oxygen uptake norms for men (ml/kg/min)

	Age (years)					
rating	**18-25**	**26-35**	**36-45**	**46-55**	**56-65**	**65+**
excellent	> 60	> 56	> 51	> 45	> 41	> 37
good	52-60	49-56	43-51	39-45	36-41	33-37
above average	47-51	43-48	39-42	35-38	32-35	29-32
average	42-46	40-42	35-38	32-35	30-31	26-28
below average	37-41	35-39	31-34	29-31	26-29	22-25
Poor	30-36	30-34	26-30	25-28	22-25	20-21
very poor	< 30	< 30	< 26	< 25	< 22	< 22

Maximal oxygen uptake norms for women (ml/kg/min)

	Age (years)					
rating	**18-25**	**26-35**	**36-45**	**46-55**	**56-65**	**65+**
excellent	> 56	> 52	> 45	> 40	> 37	> 32
good	47-56	45-52	38-45	34-40	32-37	28-32
above average	42-46	39-44	34-37	31-33	28-31	25-27
average	38-41	35-38	31-33	28-30	25-27	22-24
below average	33-37	31-34	27-30	25-27	22-24	19-22
poor	28-32	26-30	22-26	20-24	18-21	17-18
very poor	< 28	< 26	< 22	< 20	< 18	< 17

American College of Sports Medicine (ACSM). *ACSM's guidelines for exercise testing and prescription eighth edition.* Philadelphia, PA: Lippincott Williams & Wilkins; 2010.

The Maximal test provides the most reliable and accurate results however they do require the individual to exercise to their maximum capacity (National Academy of Sports Medicine 2012; Abdossaleh et al 2013; The Swedish National Institute of Public health 2010).. The associated problem of asking an older person to exercise to failure could have major ramifications, exposing the older person to unnecessary risk even if they do not have risk factors for coronary artery disease (Abdossaleh et al 2013). It is possible for participants to work up to maximum heart rate without injury. However, in older people it would probably result in sore joints and muscles and raises the risk of musculoskeletal injury. If a test is to be accessible and practical in its application the maximum oxygen uptake test has some very obvious disadvantages. The test is very time-consuming and extremely demanding on the participant’s body (American College of sports medicine 2010). Testing also requires the use of expensive monitoring equipment such as electrocardiograph machines as well as trained staff, which is labour intensive and therefore prohibitive in many settings (Abdossaleh et al 2013). Due to the reasons described maximal effort tests are impractical for general health screening and monitoring of older people's cardiorespiratory fitness and are not recommended outside of specialist settings (Stafford-Brown et al a2010; Noonan and Dean 2000; Abdossaleh et al 2013).

3.1.3 Multi-stage fitness test

A maximal fitness test that does not require either an exercise physiology lab or sports medicine clinic was original describing by Léger and Lambert in 1982, and is commonly referred to as the ‘bleep test’ (Léger and Lambert 1982). The 20m multistage fitness test is a commonly used maximal running aerobic fitness test (Tomkinson et al 2003; Olds et al 2006). The test requires the participants to run between timed bleeps covering a distance of 20 metres, on a descending time scale, (the time between the 20-metre marks becoming shorter and shorter) until the participant fails to reach the 20-metre mark (Tomkinson et al 2003; Olds et al 2006). The test estimates the individuals VO_2max on the level they have obtained during the test using a table. The validity of the test has a high correlation to actual VO_2max scores (Tomkinson et al 2003; Olds et al 2006). However, to establishing a VO_2max the participant is required to exercise until complete exhaustion (see procedure http://www.topendsports.com/testing/tests/20mshuttle.htm). As described the 'bleep' multi-stage fitness test would be considered unsuitable for older people who may be living with chronic diseases or disabilities, limited physically by pain and fatigue or have an abnormal gait or impaired balance. Furthermore, most older people will not achieve a true VO_2max because they would reach a point at which they cannot continue, not because of limitations in their oxygen supply but through other limiting factors such as mental fatigue, fear, lack of motivation or symptoms such as chest pain and light-headedness (Eleanor et al, 2006, Mathieu et al 2004). However, a test that has a recognisable resemblance to the multi-stage fitness test has been developed, in an attempt to meet the needs of individuals with health concerns. The Incremental Shuttle Walk Test (ISWT), much like the multi-stage fitness test, requires the participant to shuttle walk between two cones set ten metres apart in time to a set of auditory bleeps. The ISWT was originally developed for people living with COPD and cystic fibrosis (Singh et al 1992, 1994) however it has now been used as a cardiopulmonary assessment of fitness with other ill-health conditions. Turner et al (2004) and Arnardottir et al (2006) both showed good correlation between the ISWT and the 6-minute sub-maximal walk test (r= 0.73) and also suggested it produced less physiological stress on participants than the sub-maximal 6-minute walk test (Wise and Brown 2009). However, ISWT does have some of the same limitations as the multi-stage fitness test, inasmuch as it requires the walking speed to progressively increase until the participant either become too breathless or can no longer keep up with the bleeps. This in effect is asking the participant to exercise to maximum effort, putting older people at risk of associated injury such as muscle soreness and joint pain. Furthermore, to obtain standardisation, the ISWT must be measured on two occasions on the same day, with at least 30-minutes rest between tests to account for a learning effect. The time required by the test facilitator and the participant are therefore considerably higher than many other tests. It could also be argued that because of the time needed, the results may be dependent on the motivation level of the participants and how willing they are to drive themselves to their physical limits on each test (Stafford-Brown 2010). Applying the test in an older person's home may also be problematic. Marking out a 10-metre distance would only be possible for many older people outside their home, which would mean using their garden, or in the street. The weather and under foot conditions would then need to be considered as well as the privacy of the older person.

3.1.4 Sub-maximal tests

Monitoring of heart rate has been used to evaluate responses to different exercise stressors for a long time (Achten and Jeukendrup 2003). Sub-maximal tests increase the heart rate, but will not require the participant to work to absolute exhaustion. Sub-maximal tests require heart rate to be measured in beats per minute, the recovery rate is recorded and prediction equation used to estimate the VO_2max (Bandyopadhyay 2011; National Academy of Sports Medicine 2012; Abdossaleh et al 2013). The basic principle relies on the fact that there is virtually a linear relationship between heart rate and oxygen uptake during exercise (Abdossaleh and AHmadi 2013; Shamsi et al 2011). Compared with maximal exercise testing, sub-maximal exercise testing appears to have greater applicability to health professionals in the role of prescribing exercise as a health intervention (Noonan and Dean 2000). Sub-maximal exercise testing can overcome many of the limitations of maximal exercise testing and it is the method of choice for the majority of individuals seen by physical therapists because these individuals are likely to be limited physically by pain and fatigue or have abnormal gait or impaired balance (National Academy of Sports Medicine 2012). Various sub-maximal measures of cardiorespiratory capacity have been devised and correlate well with maximal intensity measures (Abdossaleh and AHmadi 2013; Shamsi et al

2011). Three of the most commonly used tests are the Rockport walk test, the Harvard step test that was originally developed at Harvard University in 1943 and the Astrand bike test. These sub-maximal tests are based on a linear relationship between heart rate and volume or oxygen uptake (VO_2); greater exercise intensity or VO_2 then a nomogram can be used to obtain the value of maximum oxygen consumption per kilogram of body weight from the heart rate values observed at two sub-maximal workloads (Tomkinson et al 2003; Olds et al 2006; Margaria 1965).

3.1.5 Rockport Fitness Walking Test

The Rockport Fitness Walking Test (RFWT) has been frequently used for both males and females of all ages to estimate VO_2max in people with low fitness levels (Kline et al 1987). The protocol simply requires a level marked 1-mile track, stopwatch and heart rate monitor (Lunt et al 2013). The procedure requires the participant to walk as quickly as possible to cover 1 mile. Immediately on completion the participant's pulse rate is noted and the time it took the participant to complete the mile. Using bodyweight the following calculation can be applied to determine the persons VO_2max (Kilne et al 1987) (see Table 5).

Table 5: Calculation to determine VO_2max

scoring: A VO_2max score can be calculated using the following equation (Kilne et al., 1987 and McSwegin et al., 1998): <u>females:</u> VO2 = 139.168 - (0.388 x age) - (0.077 x weight in lb.) - (3.265 x walk time in minutes) - (0.156 x heart rate). <u>males</u>: add 6.318 to the equation for females above.

The advantage of this test is that it is easy to administer and is relatively inexpensive, as it does not require specialist equipment (Lunt et al 2013). It can also give a measure that can be repeated to show improvement or deterioration in a person's ability to walk a set distance. However, the RFWT has similar limitations to the ISWT in that it still requires a maximum effort from the participant because they are asked to walk as rapidly as they can over the 1-mile distance (Lunt et al 2013). By encouraging the participant to walk as quickly as they possibly can it could lead to the participant physically over exerting themselves at the start of the test and not pacing the walk, thereby compromising any calculation to determine VO_2max. Furthermore, the test requires a 1-mile course or track that would need to be flat and free of obstacles (Lunt et al 2013). The option of using sports halls or a large gymnasium locally may be problematic because of availability issues and would also require payment. Repeated tests would incur even more additional cost in providing the test. Outdoor environments present their own challenges due to weather conditions, footpath surfaces and incline and decline en route. It would also require the facilitator to measure and mark out the course prior to the test, which again would add to the cost of the procedure. It is possibly because some of the factors listed above that the RFWT has been shown to be a poor predictor of determining VO_2max. Forrest et al (2013) attempted to validate RFWT infield against a treadmill test in college students. Forrest et al made comparisons between the measured VO_2max and the VO_2max predicted using Kline, et al (1987) equations it revealed an over predicted VO_2max by 16–18% in the males and by 22–23% in the females. The correlation coefficients between the measured and predicted VO_2max values ranged from .39 to .59. It was concluded that the original RFWT over predicts VO_2max in college students and should not be used with this population.

3.1.6 The 6 Minute Walk Test

An alternative walk distance test is the 6 Minute Walk Test (6MWT). The 6MWT was developed in 1963 by Balke to evaluate functional capacity. The test measures the distance an individual is able to walk over a total of six minutes on a hard, flat surface. The primary outcome is the distance covered in metres or converted measure (such as feet) over 6 minutes. The further the distance covered indicates a greater function and ability of the participant to sustain cardiorespiratory workload (American Thoracic Society: Guidelines for the 6MWT 2002). The 6MWT was also introduced as a functional fitness test by Lipkin to assess exercise capacity in chronic heart failure (Lipkin et al 1986). Peeters and Mets (1996) further extended the test by studying the appropriateness of the 6MWT on elderly patients with chronic heart failure. They compared the results of the 6MWT against the VO_2max treadmill exercise test and concluded that whilst patients with chronic heart failure found it difficult to complete the VO_2max test the 6MWT was better tolerated by elderly patients. Moreover, the results correlated well against the treadmill test. Thereafter, it was considered the test of choice and a reliable assessment to establish the exercise capacity of elderly patients with chronic heart failure and chronic obstructive pulmonary disease. In 1999 Trooster et al attempted to establish normal values for the 6MWT for healthy older people. They recruited 51 healthy volunteers aged 50-85 years. The tests were performed in a 50-metre long hospital corridor. Analysis of the data showed that age, height, sex and weight were independent contributions to the 6MWT in healthy subjects. Although the sample size was small and they showed a large variability, they concluded the 6MWT could be an adequate predictor of a healthy older person's exercise capacity at levels corresponding to their ADL's (Trooster et al 1999). Rikli and Jones (2001) extended the general acceptance of the 6MWT by incorporating the test in their screening procedure that precedes the start of the physical exercise programme in the senior fitness test manual.

Although the 6MWT has been widely accepted as an appropriate fitness test for older people it is important to note that there are variations among studies in how the test is conducted, which affects performance. The American Thoracic Society (ATS) guidelines 2002 emphasize that patients may become out of breath or exhausted and instructs them on taking rest breaks. In contrast, some articles instruct people to walk as quickly as possible for the full 6 minutes (Lord and Menz 2002). While many studies do not report the exact instructions, most describe the instruction as having participants walk at their usual pace or a comfortable pace and to walk as far as possible. The distance covered in six minutes in healthy adults has been reported to range from 400 metres to 700 metres (Enright 2003). Age and sex-specific reference standards are available and may be helpful for interpreting 6MWT scores for both healthy adults and those with chronic diseases (Casanova et al 2011). An improvement of 54 metres has been shown to be a clinically important difference in healthy older adults (Redelmeier et al 1997). The minimal clinically important difference for patients with coronary disease after acute coronary syndrome is 25 metres (Gremeaux et al 2011). However, using normative values is problematic because of the differing methods used in studies. With such a range of instructions between studies and the need for a test to be carried out in the older person's home, comparisons in the distance older people cover could be very diverse.

The 6MWT test requires a hard flat surface where the participant would not be interrupted or disturbed by other pedestrians (American Thoracic Society: Guidelines for the 6MWT 2002). Alternatively, if the test is undertaken outside or in a local sports centre some participants may feel conscious about performing the test in a public environment. The 6MWT also requires the participant to traverse back and forth along a marked course (American Thoracic Society: Guidelines for the 6MWT 2002). The ATS recommends an indoor, 30-metre corridor or walkway with cones placed at the beginning and end to indicate turns. However, across studies, the corridor distance varies which is likely due to the need to use readily available surroundings. Two studies have described how varying the distance between turning points to 10 or 20 metres resulted in the participant covering a shorter distance. Furthermore, although treadmills have been used to conduct the 6MWT, treadmills may underestimate total distance compared to the standard method done in a hallway or exercise room (Lenssen et al 2010 and Olper et al 2011). Marking out a distance in a participant's home would doubtless be less than 10 metres and would therefore not be comparable in the distance covered by a participant who had a longer straight course. This would lead to inconsistencies in evaluating a participant's ability against normative values. It is possible that for this reason the ATS suggests all tests should adhere to the standardised 30-metre procedure to minimize variances.

For some older people just walking for 6 minutes could result in discomfort and pain. However, attempts to shorten the distance to 4 minutes has been found to be not as sensitive in assessing functional exercise capacity and the ability to engage in physically demanding activities of daily living (Strijbos et al 1996 & Du et al 2009). The accuracy and distance covered in the 6MWT could be dependent on the older person's ability to pace themselves. Participants who start out too fast and subsequently have to slow down towards the end of the test because they are in pain or discomfort would not give an accurate indication of ability. Repeated tests could establish overtime a norm for every participant and would also allow for a learning effect. However, how many times the test would need to be repeated to determine the norm has not been established.

Motivation through verbal cuing may also lead to disparate results. High levels of encouragement and constant prompting may animate the participant to overreach their ability and wellbeing. As the 6MWT does not recommend any mechanism to monitor the older person's heart rate, there is no direct way of assessing if the participants safety is being compromised. By exceeding the predicted heart rate max; older people may put themselves at risk of over exertion.

3.1.7 Step Test

Step tests are one of the most widely used filed tests for indirect method of determining cardiorespiratory fitness (Shamsi et al 2011; Abdossaleh & AHmadi 2013). Step tests can be an easy and inexpensive alternative to using maximal exercise tests and walk distance tests (Shamsi et al 2011). Step tests can record the recovery of an individual's heart rate for a period of time after they have completed the test, then use prediction equations to estimate VO_2max. The basic premise is that a linear relationship exists between heart rate and oxygen uptake during exercise (Stafford-Brown et al 2010; Shamsi et al 2011). Post-exercise heart rate recovery is a readily obtainable parameter and a powerful and independent predictor of cardiorespiratory fitness (Dimkpa 2009). The heart rate of people who are physically fit recovers more rapidly because their cardiorespiratory systems are more efficient and adapt more quickly to an imposed demand (National Academy of sports Medicine 2010). Recovery heart rate has two decreasing phases: the first minute after physical fitness activity, during which the heart rate drops sharply, and the resting plateau, during which the heart rate gradually decreases which may last as much as one hour after exercise (National Academy of sports Medicine 2010). Therefore, you would expect to see a higher percentage drop in the first minute post exercise and then a slower percentage drop thereafter. If individuals have a lower heart rate during post-recovery phase of the test compared to previous results, it is assumed that they would have a higher VO_2max (Abdossaleh & AHmadi 2013). If an individual has a high heart rate and slower recovery rate than a previous test it would indicate a reduction in VO_2max.

3.1.8 Harvard Step Test

The Harvard Step Test was developed by Brouha et al. (1943) in the Harvard Fatigue Laboratories during WWII. Since the original description of this test, there have been variations in the test procedure such as reducing the bench height for females. The Harvard step test consists in stepping up and down onto a 45-cm bench at a frequency of 30 completed steps per minute (one second up, one second down) for 5 minutes or until exhaustion. Exhaustion is defined by the participant not being able to maintain the stepping rate for 15 continuous seconds the cadences of which is dictated by a metronome. On completion of the test the participant sits down and their heart rate is measured each minute for 3 minutes (Mackenzie 2007). Measuring heart rate recovery (HRR) can be defined as the rate at which the HR declines from either maximal or submaximal exercise to resting levels and has been identified as a powerful and independent predictor of cardiorespiratory capacity (Dimkpa 2009, Cole et al 2000). Therefore, the test does not produce VO_2max results but produces scores that are representative of a person's cardiorespiratory capacity as determined by the heart rate recovering from a prescribed dose of effort. Results are determined by the following equation (see Table 6):

Table 6: Results *= (100 x test duration in seconds) divided by (2 x sum of heart beats in the recovery periods)*

Scores are categorised as follows: Heart rate at 1 minute post exercise (**HR1)**
Male/Female Excellent <79 <85 Good 79-89 85-98 Above Average 90-99 99-108 Average 100-105 109-117 Below Average >106 >118 Fitness levels can be calculated using the following formula Result = 30000 Ö (HR1 + HR2 + HR3)
Excellent, Above Average, Average Below, Average Poor Male >90 80-90 65-79 55-64 <55 Female >86 76-86 61-75 50-60 <50

An example, would be if the total test time was 300 seconds (if the client completed the whole 5 minutes), and their number of heart beats between 1-1½ minutes was 90, between 2-2½ it was 80 and between 3-3½ it was 70, then the fitness index score would be: (100 x 300)/(240 x 2) = 62.5. Note: using the total number of heart beats in the 30 second period, not the client's heart rate (beats per minute) during that time (Gladwell et al 2010, Stafford-Brown et al 2010).

The advantages of this test are that it needs minimal equipment and can be administered in a variety of settings including the participant's home (Mackenzie 2007). The variability of the data obtained from this test, correlated to VO_2max has been reported between 0.6 to 0.8, and as such is not particularly good validity. Reliability may be improved by the participant maintaining close adherence to the procedure and maintaining the stepping rate (Stafford-Brown 2010; Mackenzie 2007). One of the big advantages of these types of fitness test is that the results can be compared with previous results enabling a comparison to be made between previous tests. It is expected that if an appropriate cardiorespiratory training programme has been prescribed and the participant has adhered to the programme, the test would indicate an improvement in their heart rate recovery.

However, the Harvard step test does have some limitations. The duration of five minutes for the test may be excessive considering the possible mobility problems that older people may have and the motivation that is required to complete the test. Furthermore, if the older person stopped before the end of the test they may consider this as a failure and be reluctant to retake the test at a later date. If the step height is modified or the duration of the test shortened the comparative data in the table above cannot be used. Biomechanical characteristics vary between older people who commonly complain of hip and knee mobility problems, balance and poor quadricep strength, therefore, the step height of 50cm may be difficult to achieve. The mobility problems described would also compromise any true reading of cardiorespiratory fitness when calculating scores. Bandyopadhyay (2007) supports this argument describing how several sedentary males who were asked to participate in the Harvard step test were unable to complete due to lower limb discomfort rather than cardiorespiratory exhaustion and he concluded that the height of the step and the stepping cadence leads to the onset of premature failure.

3.1.9 Queen's College step test

The Queen's College step test was adapted from the Harvard step test and employs the same measurement of recovery heart rate to estimate the participant’s level of fitness. Using the principle that heart rate returns to resting values more quickly following sub-maximal exercise in fitter people, than it does in those who are less fit. The Queen's College step test was originally developed to estimate the fitness necessary for fire fighters and other physically demanding occupations (Mackenzie 2001). However, because of attempts by participant’s to circumvent the results by using drugs such as beta-blockers, thus inflating their appearance of fitness it is no longer used.

However, the test remains useful for testing fitness levels. The Queen's College step test differs in three major respects to the Harvard step test. Firstly, the height of the step used is slightly lower at 41.3 cm (Abdossaleh and AHmadi 2013). Secondly, the cadence of stepping differs from males to females, 24 steps per minute for males and 22 steps per minute for females and finally, duration of the test is three minutes not five (Abdossaleh and AHmadi 2013).

As previously discussed post-exercise heart rate does not immediately return to resting levels after exercise but remains elevated during recovery (Dimkpa 2009). This is the key process known as excess post-exercise oxygen consumption (EPOC; formerly termed the oxygen dept). As heart rate mirrors respiratory recovery, the Queen's College step test uses this formula to estimate the individual's cardiorespiratory fitness. The formula proposes that the quicker the individual's heart rate returns to the pre-exercise heart rate the cardiorespiratory fitter they are. On completion of the three-minute step test, the participant is required to sit down and their heart rate is counted every 15 seconds. VO_2max is then predicted using the following equations (see Table 7):

Table 7: equation to predict VO_2max.

For Men: V02 Max (ml · kg□1 · min□1) = 111.33 - 0.42 x HR (bpm)
For Women: V02 Max (ml · kg□1 · min□1) = 65.81 - 0.1847 X HR (bpm)

Mackenzie, B. (2001)

Step test: *(A)* starting position and *(B)* taking the pulse at the conclusion of

the test. *A* *B*

Adapted, from Cooper Institute, *Physical fitness assessments and norms for adults and law enforcement* (Dallas, The Cooper Institute),

As with the Harvard step test correlation to VO_2max has been reported as between 0.6 to 0.8. However, it also shares some of the same limitations. The step height is lower 41.3 cm, but this height may still be difficult to achieve for an older person. The height of the step would also disadvantage shorter participants and favour taller individuals. As previously discussed mobility problems may also limit the ability of an older person to maintain a true rhythmic cadence, compromising any estimation of an older person's VO_2max. The facilitator also has no means of monitoring the participant's heart rate during the test, therefore the participants may exceed the moderate intensity, 65-77% of maximum heart rate, increasing the risk of injury and enhancing the risk of discomfort or pain to the participant, all of which may lead in turn to high dropout rates and decreased reliability for older people (Juneau *et al.* 1987).

3.1.10 Subjective method

Questionnaires and activity diaries are considered subjective methods. The Rate of Perceived Exertion (RPE) is a measure used to monitor exercise intensity. RPE is a scale that is used by participants to rate how hard they feel they are working. One of the most widely used scales of this type was developed by Gunner Borg and is a scale which can be used by participants to rate their perceived exercise intensity (Stafford-Brown et al 2010). Rather than monitoring heart rate, the participant is familiarised with the scale and asked during a fitness session to rate where they feel they are on the scale of 1 to 15. The Borge scale was further modified to a 10-point scale because some participants found working between 1 and 15 difficult. Although this is a subjective measure, a person's exertion rating provides a fairly good estimate of the actual heart rate during physical activity. A high correlation exists between a person's perceived exertion rating and the actual heart rate during physical activity (Borg, 1998). For example, if a person's RPE is 12, then 12 x 10 = 120; so the heart rate should be approximately 120 beats per minute (Carter et al 2001).

However, the calculation is only an approximation of heart rate, and the actual heart rate can vary considerably depending on the age and physical condition of the participant. RPE is the preferred method to assess intensity among those individuals who take medications that affect heart rate or pulse such as people who have been fitted with a pacemaker and people who are on beta-blocker medication. In clinical settings it has been modified and used to document a patient's exertion during a test or procedure, especially in clinical diagnosis of breathlessness and dyspnoea, chest pain, angina and musculoskeletal pain. The big disadvantage of the Borg scale is although it has a strong correlation between participant scores and actual heart rate, it does not account for the relationship between the rate of perceived technique and rate of perceived discomfort. An older adult may perceive the discomfort of an activity as a limiting factor not how hard the heart is working.

Moreover, as older peoples technique improves the activity will become easier, which may be perceived as an improvement of cardiorespiratory fitness. This would especially be the case if the participant were required to repeat the fitness measure on a regular basis. Therefore, it may not be a reliable indicator of an increase in cardiorespiratory fitness but more an indication of improvement in overall performance (see Table 8).

Table 8: Standard and modified Borg scales for rating perceived exertion

Standard scale	Modified scale
6	0 Nothing at all ("no intensity")
7 Very, vary light	0.3
8	0.5 Extremely weak (just noticeable)
9 very light	0.7
10	1 Very weak
11 Fairly light	1.5
12	2 Weak (light intensity)
13 Somewhat hard	2.3
14	3 Moderate
15 Hard	4
16	5 Strong
17 Vary hard	6
18	7 Very strong
19 Very, very hard	8
20	9
	10 Extremely strong ("strongest intensity")
	11
	H Absolute maximum (highest possible intensity)

Subjective methods/ratings of perceived exertion may be used as gross estimates of effort.

Chapter Three - Summary of literature Review

3.2.0 Conclusion

The literature review has demonstrated that they are positive health benefits resulting from increased cardiorespiratory fitness (Herholz & Zatorre 2012; Angevaren et al 2008; Schroll 2003, Crombie et al 2004; Mernitz & McDermott, 2004; Hamer & Chida 2009; Karp et al 2006; Larson et al 2006). Physical fitness activities are associated with a reduced risk of heart disease, coronary artery disease, type 2 diabetes, some types of cancers, and overall mortality (Sattelmair et al 2011, McKechnie et al 2002, Sandercock 2013 Herholz & Zatorre 2012; Angevaren et al 2008; Schroll 2003, Crombie et al 2004). Furthermore, being physically active can improve musculoskeletal health and ameliorate psychological well-being (Wen et al., 2011; Jewell 2006, Yonas, et al 2010). Participating in fitness activities may also be protective against dementia and Alzheimer disease; similar studies also suggest a similar protective effect for MCI (Rovio et al. 2005; Lytle et al. 2004; Abbott et al. 2004; Lautenschlager et al 2008; Zoeller 2010; Erickson 2011). With such overwhelming evidence it could be argued that being physically active for older adults is the best preventative intervention that they can engage in to maintain a productive and fulfilling longer life.

Promotion of physical activity as part of a general primary prevention programme is of increasing importance when considering the ever-growing older population (Hynes et al 2015; Kings Fund 2014; Mountain et al 2008; Ball et al 2007; COT 2208). Health promotion and ill-health prevention are key government priorities (NICE 2008; NICE/SCIE 2006; Public Health England 2015). However, GP's need to be more proactive in promoting physical activity to their older patients (Jewell et al 2006). Furthermore, other health care professionals such as Occupational Therapists and Physiotherapists, whose philosophy of care is a bio psychosocial model, underpinned by enabling service users to learn how to manage their own health and sustain new, positive health behaviours more effectively, may also need to contribute to public health initiatives. There is an enormous potential for healthcare professionals to promote and prescribe health-guided fitness activities to older adults. However, they will need to incorporate fitness principles into practice which will depend upon health care professionals' understanding of contemporary concepts and terminology pertaining to fitness, the elements of exercise and the treatment effect dosage.

To establish an older adult's current level of function, a comprehensive assessment of the older person's physical, emotional and cognitive ability will need to be undertaken. Consideration of the older person's diagnosis and medication-related changes, the presence of risk factors for injury or death, and the effects of environmental conditions on exercise tolerance will need to be taken into account. Furthermore, any health professional wishing to prescribe a health related physical fitness programme would need to establish a baseline from which the older person can progress their existing level of fitness. A health related assessment could also increase adherents to a prescribed exercise programme as it could motivate individuals to progress the performance on each occasion they are tested. There are many appropriate and effective health screening and assessment tools and procedures available to health care professionals. The literature review identified several methods of establishing a person's cardiorespiratory fitness. However, an area of contention is the need for an assessment test that is appropriate for older people and can measure variations in cardiorespiratory fitness. Tests that have been associated with establishing older people's cardiorespiratory fitness have some identifiable disadvantages and have become evident in this review (For further clarification please see Table 9 (Summary of reviewed fitness tests).

Table 9: Summary of reviewed fitness tests

Name of Fitness test	Advantage	Disadvantage
Maximal direct test	Most reliable and valid indicator of a person's cardiorespiratory capacity.	Requires the individual to exercise to their maximum capacity, expensive equipment needed, procedure requires expert staff, time consuming, high risk of injury.
Multi-stage 'bleep test'	Does not require an exercise physiology lab or sports medicine clinic, reliable correlation with VO_2max scores.	Requires the individual to exercise to their maximum capacity therefore increasing the risk of injury. Reliability is subject to mobility or disability.
Incremental Shuttle Walking Test	Requires minimal equipment, good repeatable measures, can track changes in exercise capacity over time.	Walking a determined distance in the quickest possible time to a pre-set audible 'beep' could encourage an older age participant to exceed a safe and comfortable level. Requires the participant to work until they can no longer keep up with the beeps.
Rockport Fitness Walking Test	Requires minimum equipment, is easy to administer, inexpensive.	Requires the individual to walk as fast as they can for one mile, need a flat I mile course, encourages the individual to work to they maximum ability.
Six minute walk test	Better tolerated by elderly patients than VO_2max test, correlated well against the treadmill test, adequate predictor of a healthy older person's exercise capacity.	May required to walk as quickly as possible for six minutes (maxim effort) no mechanism of monitor heart rate during test therefore could exceed 65-75% of predicted maximum, procedure not suitable for in the home use.
Harvard step test	Simple to conduct and requires minimal equipment, is suitable for home use, is a good repeatable measure.	Step height 50cm, difficult to achieve, frequency of step 30 times per minute may be hard to maintain, total time stepping 300 seconds (5 minutes)
Queen's College step test	Measures recovery heart rate from a standard measure of effort, frequency of 24 steps per minute, duration three-minute.	Step height 41.3 cm, difficult to achieve for people with mobility problems, no mechanism of monitor heart rate during test therefore could exceed 65-75% of predicted max.
Subjective method (Borg Scales)	Good for evaluating effort during any physical activity.	High inter-individual variability in-respect to heart and work rate levels. Is not a reliable repeat measures test.

3.2.1 The Older People Fitness Test

Considering the reported limitations of the cardiorespiratory tests in this limited literature review, it was postulated that an older people’s fitness test could be developed that would expand on the current theories, protocols and designs. This test would adapt and utilise components of existing tests in an attempt to circumnavigate some of the identified concerns and limitations that had been described. Because of the dangers in asking an older person to work to maximum capacity a maximal direct test was not considered an option. Walking a determined distance in the quickest possible time or to a pre-set audible ‘beep’ could encourage an older age participant to exceed a safe and comfortable level. Furthermore, it requires a specific environment that would need to be duplicated on every test and therefore was not a preferred option. Subjective measures were not considered a realistic option because of the low reliability in repeated tests and it was not believed the most appropriate method indicator if any physiological change had occurred in an older persons fitness.

Step tests are suitable for indoor and home use and are a good repeatable measure. Therefore, a step test was identified as the most appropriate option. However, most existing step tests required the step height to be too high or the cadence of stepping to be too rapid for an older person to perform comfortably or without undue risk.

Op-Ft step height was set at 150mm, which was 250mm lower, than Queen's College step test and 350mm lower than the Harvard step test. 150mm was considered to be a more comfortable height for older people who may have mobility and balance problems. Op-Ft relied on audible beats so the participant’s cadence was regulated and consistent with previous tests. Furthermore, the speed of stepping onto the step was reduced to 10 complete steps a minute timed on a four-beat cycle. To monitor participants’ heart rate during the test a heart rate monitor was fitted that would raise an audible alarm if the participant exceeded 77% of their predicted heart rate Max, this would ensure the participant maintained a comfortable level of effort. Measuring recovery heart rate post-test was considered to be a valid objective as it had the potential of revealing changes in heart rate during repeated tests.

The Aim of this study:

The primary aim of this study is to investigate the feasibility of designing a sub-maximal fitness test for older people that can be used without causing undue discomfort to the participant, is appropriate in multi-settings and does not require expensive equipment.

The secondary aim is to evaluate the sub-maximal test to identify if it can distinguish change in participants' cardiorespiratory capacity.

Hypotheses

Heart rate response to a standard, sub-maximal exercise test has long been employed by investigators as a measure of one aspect of physical fitness. Two of the most widely used tests for estimating cardiorespiratory fitness are the measurement of a person's resting heart rate and the measurement of recovery heart rate after exercise. Two hypotheses will be tested.

1. Null Hypothesis: No difference will be observed in resting heart rate and recovery heart rate between baseline (T1) scores and pre-intervention (T2) scores. Alternate Hypothesis: there will be a difference observed between baseline (T1) scores and pre-intervention (T2) scores.

2. Null Hypothesis: there will be no difference in resting heart rate and recovery heart rate between (T2) and (T3). Alternate Hypothesis: there will be a difference in resting heart rate and recovery heart rate between (T2) and (T3).

Chapter Four - methodology

4.1.0 Chapter Introduction

This chapter outlines the justification of the quantitative research design, with consideration to research rigour and ethics. It gives a rationale for the selection of participants and discusses strategies employed for rigour, including participants' physical and emotional welfare. The process is identified for analysing data in relation to the walking programmes and subsequent data collection. The importance of confidentiality in data handling, gathering and analysing information will also be discussed.

4.1.1 Feasibility

It was the study's intention to investigate the feasibility of using a specific test to identify change in cardiorespiratory capacity for older people. The objective would be to design an assessment protocol that is easily administered by any health care professionals or qualified fitness instructor within an older person's home and be able to show a variation in cardiorespiratory capacity during and after a prescribed exercise programme.

- Develop a step test that is sympathetic to the needs of older people
- Develop an accurate measure which can show variations in fitness levels

4.1.2 Methodology

Traditional research methodologies have commonly used two forms of data collection and analysis, qualitative and quantitative (Moule & Hek 2011). Date that is generated through quantitative approaches tends to be numerical and analysed using computer packages. A qualitative approach generates data such as text, which is problematic to analyse statistically (Moule & Hek 2011).

Quantitative methodology is a formal, objective, systematic process involving empirical research whereby data is analysed through tables and figures (Bowling 2009). Quantitative research collects facts using measurable scientific techniques that are likely to produce quantitative and, if possible, generalisable conclusions (Peat 2002). A feature of collecting data using quantitative approach is that it can be measured and quantified by statistical analysis and tends to emphasise relatively large scale studies. It is used to describe and test relationships to examine cause and effect and represents the data that is often perceived as being about gathering 'facts', (Bowling 2009, Robson 2002). A physiological technique such as heart rate that can be analysed in a statistical format to inform investigation would fall into this construct.

Research methodology is dependent on the nature of the enquiry and the type of information required. Therefore, the methodology has an important impact on the type of knowledge that the research produces and the kind of knowledge it is possible to generate. Moule & Hek (2011), advocate that health care professionals should become familiar with the tenets of both qualitative and quantitative approaches in order to increase their awareness in conducting research relevant to clinical practice. It is another contention that health professionals are not particularly enthusiastic about the validity of statistical approaches involved in quantitative methodology (Moule & Hek 2011). However, Bowling, (2009) argues that true understanding in health care cannot be achieved without adding both qualitative and quantitative evidence to the professional knowledge base of medicine. Ultimately, the approach adopted by the researcher will depend on the nature of the issue being investigated and on the type of data required.

On reviewing the literature a quantitative methodology was selected for this study. The purpose of this research is to reach a well-founded and valued conclusion about the effects of the Op-Ft intervention and the conditions under which it operates (Moule & Hek 2011). The physiological adaptations of a physical fitness programme on participants and the effectiveness of the Op-Ft intervention to identify these adaptations are best examined through a quantitative process that can measure these physiological changes (Stafford-Brown et al 2010). Resting pulse, maximum heart rate and heart rate recovery are all numerical measures and as such can be analysed in a quantitative method. The author will be testing his hypothesis, which is to investigate the feasibility of developing an appropriate fitness test for older people that can measure variations in cardiorespiratory fitness. As this research will require a systematic and scientific approach, where variables and controls are measured to identify change in an inter-subject group, an experimental method was chosen. Experimental methods aim to be able to predict phenomenona, typically constructed in an attempt to explain some kind of causation or relationship between variables (Bowling 2009). Another advantage using quantitative data, as opposed to qualitative data is numerical findings providing evidence of change, which is of greater importance within an outcome driven healthcare sector.

4.1.3 Participants

The Op-Ft study utilised older people who consented to participate in a 12-week fitness programme conducted as part of the ThinkingFit study. It enabled the research to identify a period of time where participants have shown an improvement in their health and particularly their cardiovascular fitness. The Thinkingfit programme aims to promote the benefits of exercise and diminish the barriers to older adults. The majority of older adults do not exercise however, as previously mentioned regular exercise can significantly benefit older people with improvements in heart and lung function, balance, co-ordination, mood and quality of life (Spirduso 2005; Brukner & Khan 2012; The Swedish National Institute of Public health 2010). The barriers to exercise in older adults include limited access to programmes and facilities, lack of support and low awareness of benefits (Chodzko-Zajko 2009; Costello et al 2011; Forbes 2015a; Wilcox et al 2003; Lees 2005; Age Concern 2006; Belza et al 2004; Age Concern 2006; Dergance et al 2003). Evidence suggests that regular exercise for at least 30 minutes at a predetermined moderate intensity (65-77% of maximum heart rate) may be more beneficial than unsupervised exercise in improving general cardiovascular fitness. The most effective exercise intensity (70 to 85% of maximum heart rate) may be more beneficial but is associated with increased risk of injury and high dropout rates due to discomfort (Chodzko-Zajko 2009; Costello et al 2011; Forboes 2015a; Wilcox et al 2003; WHO 2010). Heart rate monitors which provide real time feedback via sound or vibratory alerts are used to supervise and pace physical exercise as far as intensity and duration are concerned. Exercise intensity can also be adjusted as fitness levels increase. Systematic analysis of available evidence on physical exercise programmes, have identified certain design aspects that are associated with larger treatment effects and better long term adherence. Home-based programmes have better long term adherence and centre based programmes have better short term effects, whilst high intensity exercise on 3 days a week had better adherence than low intensity on 5 days a week (Ashworth et al. 2005; Costello et al 2011; Lees 2005; Age Concern 2006). Adherence and outcomes are further improved by regular telephone contact, goal setting and relapse prevention training.

As part of the ThinkingFit (2014) study, subjects were health screened to identify potential problems or exclusion criteria. As part of the health screening process participants participated in the Op-Ft modified step test. It was acknowledged that these participants in the ThinkingFit (2014) study have been diagnosed with Mild Cognitive Impairment (MCI) (amnestic and non-amnestic), which is characterised by impairment in one or more cognitive domains, such as memory or attention, while performance of everyday activities is preserved. Four subtypes of MCI have been described. Amnestic MCI-single domain (AMCI) is characterised by isolated episodic memory impairment in the absence of other obvious cognitive or behavioural deficits and not related to pre-existing physical or emotional disorders. The current diagnostic criteria for AMCI include (1) memory complaint corroborated by an informant, (2) objective memory impairment for age (3) essentially preserved general cognitive function, (4) largely intact functional activities, and (5) not demented (Petersen 2004). Considering the above characteristics of MCI it was considered that the condition would have no influence on the Op-Ft study, as MCI is not related to any physical considerations.

The Op-Ft study recruited 70 participants from a possible 227 who met the inclusion criteria. All had been assessed by the North Essex Mental Health Foundation Trust memory services and had received a diagnosis of MCI. The sample comprised of 41 females and 29 males; 69 were Caucasians, 1 of Asian descent, all were middle class and living independently in the community and had agreed to be part of the larger ThinkingFit study. All participants agreed to undertake a 12-week supported walking programme to improve their physical health and cognitive function. The age range of the participants was between 51 - 89 (*M = 73.7, SD = 8.2*). The general practitioner of all the subjects was informed of the participant's participation in the study. At the end of the 12-week walking programme 17 participants' data was excluded due to low participant completion and/or incomplete data collection.

4.1.4 Inclusion Criteria

All participants in the Op-Ft had a diagnosis MCI, that is typified by memory impairment for age and education. However, the individuals can still maintain normal social activities and are not considered to be demented (Petersen et al, 2004). On recruitment all participant's reported having sedentary lifestyles with no regular participation in physical exercise defined as two or three times a week for at least 20 minutes duration, or participation in active organised sport more than once a week, in the previous six months. Participants who reported exceeding the defined activity level were not selected for Op-Ft as it was theorised these individuals would not demonstrate a significant change in the cardiorespiratory fitness. All participants were willing and able to give informed consent as described in Participant confidentiality and consent. All participants needed to have availability and access to safe exercise environments, such as paths or roads with sidewalks for walking or cycling. All participants completed the Physical Activity Readiness Questionnaire (PAR-Q) in an attempt to reduce risk from serious adverse effects from an increase in physical activity. The PAR-Q is a self-screening tool that can be used by anyone who is planning to start an exercise programme. The PAR-Q was developed by the British Columbia Ministry of Health and the Multidisciplinary Board on Exercise and revised by an Expert Advisory Committee of the Canadian Society for Exercise Physiology in 2002. It is widely used throughout the fitness industry to determine the possible risk of exercise for an individual and has a recommended age range between 15 to 69 years. Even though a significant number of the study participants were over the age of 69 the PAR-Q screening tool was chosen for this study because it was used in conjunction with other risk considerations. During memory clinic assessments a doctor reviewed the participants' medical history, current medication and physical checks such as blood pressure, weight and resting heart rate. The PAR-Q was also used in conjunction with the Physical Activity Readiness Medical examination (PARmed-X); any concerns regarding the participants' physical health were highlighted either at the memory clinic assessment or during initial contact for the ThinkingFit study. The Op-Ft was also administered as a progressive exertion, building up the heart rates of participants slowly and monitoring them in real time (throughout the test) during submaximal exertion (Please see supporting evidence and Appendices).

4.1.5 Exclusion criteria for participants

Due to the associated health problems many older people experience, which can exclude them from many of the existing fitness test, it was the study's intention to be as inclusive as possible. However, because of the associated risk, some health conditions were excluded from the walking programme and as a consequence were not included in the Op-FT study. Type 1 (insulin dependent) diabetes mellitus as an increase in physical activity would require closer monitoring of insulin levels. Blood pressure above 160/100 mmHg. High blood pressure is associated with an increased risk of stroke. Body weight more than 140% of ideal body weight because of the associated health implications of people engaging in physical activity who are obese, such as heart disease and stroke. Musculoskeletal or other medical problems preventing safe participation in regular moderate intensity exercise (65-77% of predicted maximum heart rate). This included a resting tachycardia (heart rate above 100bpm) and history of myocardial infarction or unstable angina within the last month. Age was not considered to be an exclusion factor because the mean of all participants would be analysed.

4.1.6 Clinical assessment

A medical assessment was conducted on participants during their memory clinic assessment. This information was communicated to the research team once the participant had expressed an interest in taking part in the ThinkingFit (2014) study. All assessments of the Op-Ft were conducted, recorded and analyzed by the author between 2010-2013. ThinkingFit (2014) research assistants helped with data storage and administration such as arranging appointments for participants to be reassessed.

All potential participants underwent a standard clinical assessment that included a physical examination and comprised of the following:

- Blood Pressure monitor
- Weight and Body Mass Indicator (BMI) calculation
- Hip waist ratio

Participants were referred for medical /cardio logical review and management prior to commencing exercise if indicated by the PAR-Q. Any further intervention was then guided by the PARmed-X.

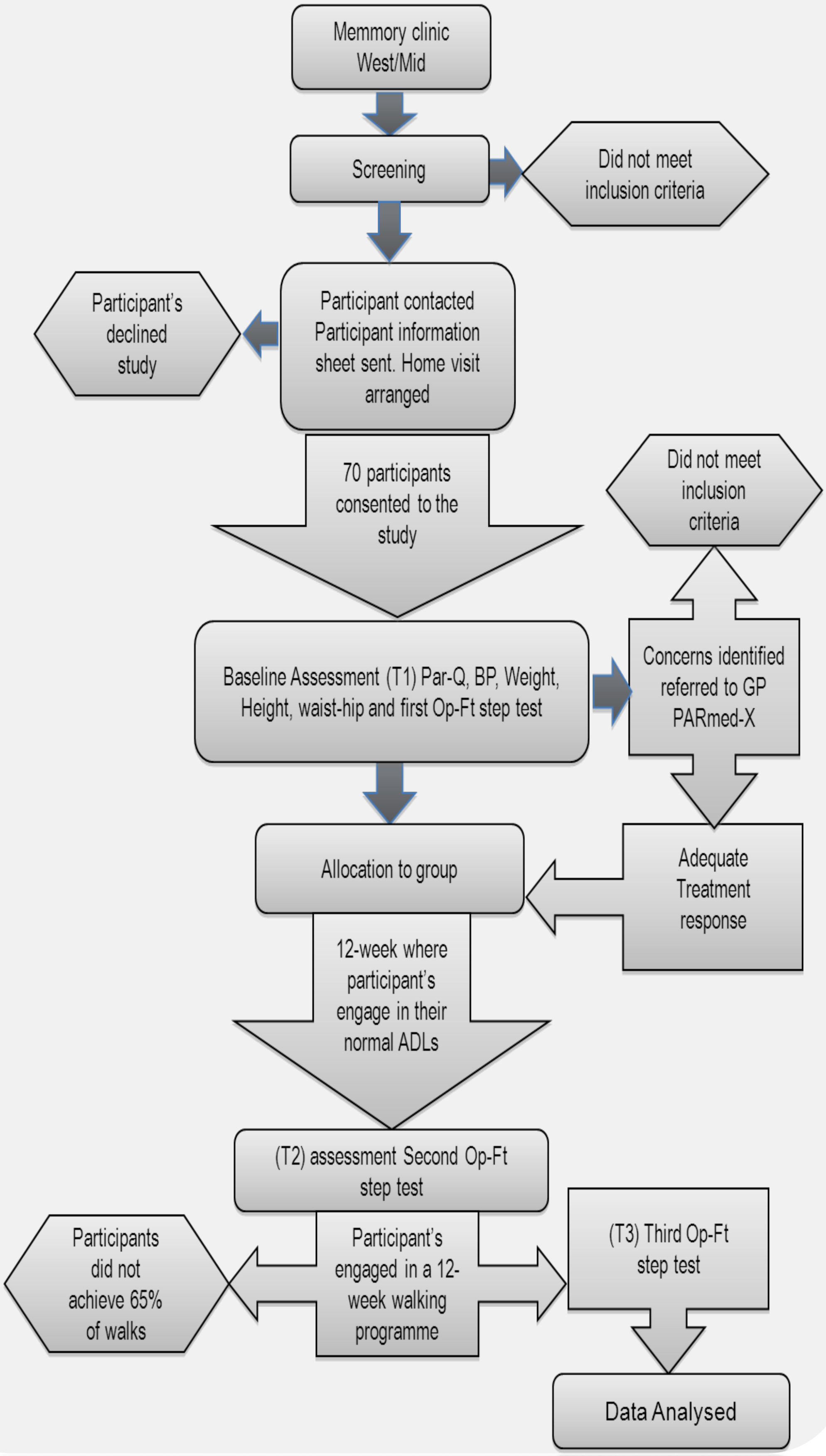
Participants taking medications affecting heart rate would have needed to be on a stable dosing régime for 3 months prior to commencing in order to control potential spurious results on fitness measures caused by these treatments. During the recruitment phase any potential participants who indicated they had recently been experiencing chest pains when exercising, recent and/or frequent falls, dizziness and/or short of breath when physically active as indicated by the PAR-Q were referred to their GP and a copy of the PARmed-X supplied for a medical review by the participants GP.

4.1.7 Participant confidentiality and consent

Favorable Ethical opinion form National Research Ethics Service, Essex 1 Research Ethics Committee (Ref 09/H0301/64) was obtained before the recruitment of possible participants (See Appendix). Ethical approval was also received from the University of Essex (Ref 11021). The study was conducted in liaison with the North Essex Mental Health Partnership NHS Trust. A letter of permission from the research and development department was provided (See Appendix).

Following ethical approval potential participants were screened using the memory clinical database and medical records. The selection process then commenced with the researcher (Author of the Op-Ft) contacting the potential participant via telephone. If the potential participant expressed an interest they were sent a participant information sheet (See Appendix page 142-148), clearly explaining what would be required of them. They were also encouraged to discuss the study with carers, loved ones and friends. Once the participant had been given a suitable amount of time to read the participant information sheet, they were again contacted by telephone (See Appendix screening form page 141). If the potential participant continued to show interest in the study, a home visit with the researcher was arranged so the potential participant could ask questions or/and clarify any concerns they may have had. During the interview the researcher explained that participation was entirely voluntary; participants could withdraw from the research at any time and confidentiality would be preserved throughout the project. If the participant decided to withdraw they did not need to inform the researcher of the reasons. Participants were reassured that if they did withdraw for any reason, there would be no ramifications regarding any treatment intervention they received from their NHS Trust. Permission was also sought to inform the participants GP of their decision to agree to the study (See Appendix GP Letter page 150-151). Participants were informed that confidentiality would be maintained throughout the study and any data collected would be anonymised. All information held and collected conformed with the 1998 Data Protection Act, which defines UK law on collecting, holding, using, processing, disclosure and protection of personal data. At the end of the home visit if the potential participant still wished to participate in the study they were given the opportunity to sign the consent form (See Appendix Consent Form page 149 and figure 3 recruitment procedure).

Figure 3. Recruitment procedure and study process



Method and Hypotheses

4.1.8 Feasibility pilot.

A feasibility pilot was initiated to determine if the study concept was viable before the procedure was finalised. Three subjects from the ThinkingFit (2014) cohort, two males and one female were tested to help finalise the Op-Ft modified step procedure. Subject One was a female-aged 64 and who had completed 29, 30 minute walks. Subject Two was a 65-year-old male who completed 33 walks of 30 minutes or more and subject three was a 77-year-old male who completed 36 walks of 30 minutes or more. Subjects' results were recorded and analysed via Microsoft Excel.

Subject One's recovery heart rate, was recorded twice, just prior to her 12-week walking programme and then on completion of the 12-week walking programme. Subject one maximum heart rate during the step test and then on completion of the step test was recorded. This exercise revealed that there was no significant difference in maximum heart rate during the step test or on completion of the step test. On this information it was decided that maximum heart rate would only need to be recorded at the end of the three-minute step test. The subject's 1-minute, 2-minute and 3-minute recovery was also recorded. This exercise revealed that the subject's heart rate recovery was significantly quicker during the last three-minute recovery phase the second time the subject was tested than the first time the subject was tested.

The two male subjects' resting pulse, maximum heart rate during step test and at the end of the step test and one, two and three minute recovery were recorded. Subjects Two and Three results were recorded 12-weeks before they embarked on a walking programme, then again before the start of the walking programme and then at the end of a 12-week walking programme. This process established a control period of 12-weeks prior to participants' 12-week participation in the walking programme and enabled the subjects to become their own control. See Table 10 the results of the feasibility pilot for subject one and two.

Table 10 results of the feasibility pilot for subject one and two

Subject two: 65-year-old male who completed 33 walks of 30 minutes			
	T1 12-week before start of walking	T2 immediately before walking	T3 after walking
Resting pulse	**77**	**75**	**71**
Maximum H/R	**148**	**127**	**108**
Max end test	**148**	**126**	**104**
One Min post	**101**	**97**	**78**
Two Min post	**85**	**87**	**75**
Three Min post	**83**	**81**	**71**

Subject three: 77-year-old male who completed 36 walks of 30 minutes or more			
	T1 12-week before start of walking	T2 immediately before walking	T3 after walking
Resting pulse	**78**	**77**	**70**
Maximum H/R	**98**	**101**	**93**
Max end test	**99**	**98**	**92**
One Min post	**88**	**82**	**76**
Two Min post	**75**	**79**	**74**
Three Min post	**76**	**76**	**73**

The data from this preliminary feasibility pilot assisted in establishing a viable procedure and provided proof of concept.

Chapter Five – Op-Ft Procedure

5.1.0 Walking Programme

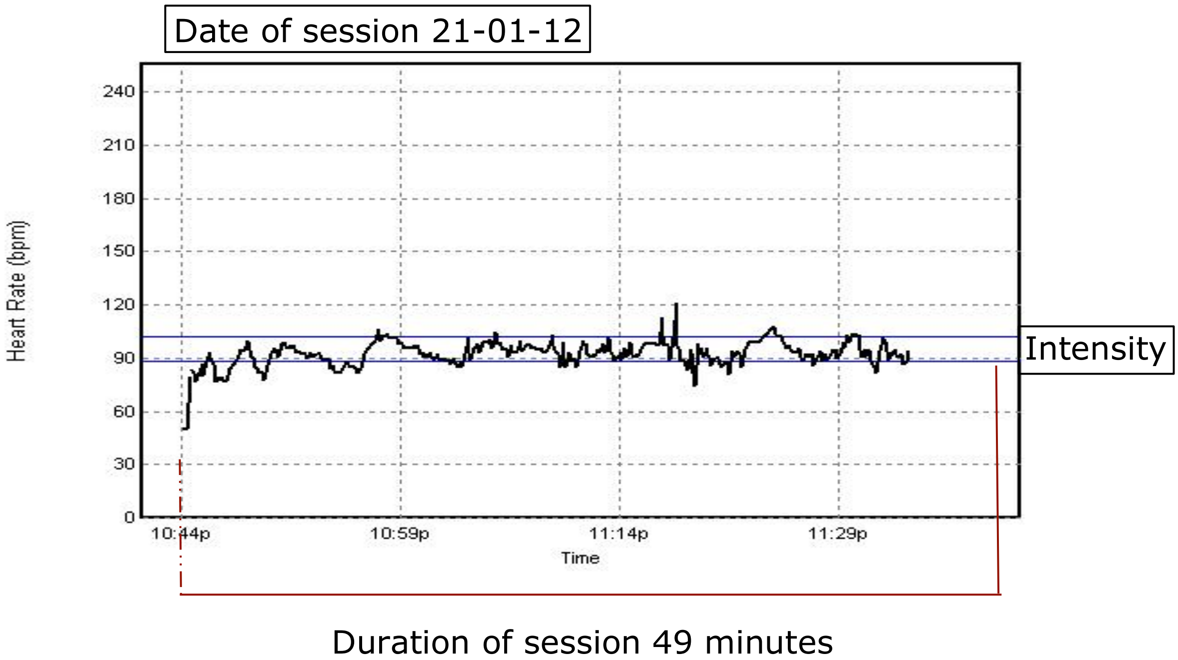
Participants were required to participate in a walking programme for 12 weeks completing 36 training sessions at a frequency of three per week. Walking is one or the easiest, safest and most inexpensive forms of exercise (Richardson et al 2005). It has the advantage of being available from the participant's home, can be incorporated into an older adult’s daily routine and does not need any specialist equipment (Richardson et al 2005; Department of Health 2011). There is increasing evidence that walking improves health, cognitive function and psychological wellbeing (McDevitt et al 2005; Richardson et al 2005; Dawson et al 2006; Mind 2007; Roe and Aspinall 2011). The *Walking the way to Health initiative* (WHI) and *Walk4Life* campaigns (DoH 2011) aimed to improve the health and well-being of the general public through walking. As previously stated, current guidelines advise 30 minutes of at least moderate intensity physical activity a day, five days a week which significantly reduces the risk of health problems (At least five a week 2004). However, for some older adults this amount of activity may be impossible to achieve because of pre-existing health problems. Specific guidelines for physical activity for older adults has not been established in the UK a. No consensus of opinion has been reached regarding the optimum modality, frequency, intensity and duration necessary to establish an exercise programme to maximise falls prevention and increase health and well-being for older adults. The Chief Medical Officer (2004) advises that older people who engage in low to moderate intensity activity will still produce a health benefit because of their relatively low levels of fitness. Furthermore, regular walking for older adults should be encouraged because it maintains independence and activities of daily living. Walking programmes should be designed to take into consideration older adult functional limitations and symptoms of disease.

The walking programme for this study required the participants to walk for the duration of 30 minutes at a moderate intensity, 65 - 75% of predicted heart rate maxima. Heart-rate monitors (Oregon Scientific SE102I) measure electrocardiographic signals via a chest strap. Heart rate zones were programmed into the monitors and auditory signals and vibration of the monitor attached to the arm provide feedback and alerted the participant when heart rate is outside the pre-set parameters. Heart rate monitors were programmed by the researcher. An electronic data logger (Oregon Scientific WM100) which collects continuous data from the chest strap activated during activity so that heart rate data during physical activity was captured for analysis. In addition, a poster was provided giving participants instructions on the practical application of equipment and illustrations of a warm-up and cool-down sequence the participant could follow before and after their walk. The 12-week 36 session exercise programme consisted of 6 supervised visits and 30 unsupervised sessions carried out independently by participants (see appendix E). In between supervised walking sessions regular telephone contact was maintained with participants to monitor progress and identify any problems.

5.1.1 Heart rate intensity

Heart rate intensity, walk duration and walk frequency of every walk was collected and analysed via the Oregon Scientific WM100 electronic data logger. Feedback was then given to participants, which enabled them to maintain their prescribed intensity zone (please see Fig 4). Participants taking beta blocker medication were excluded from this study as these medications lower heart rate (For further details of the walking programme see Appendix schedule for physical activity)

Fig 4 illustrates one participant's walking session.



By undertaking this 12-week walking programme it would be expected that changes in recovery heart rate and maximal heart rate when given a specific level of exercise and resting heart rate would be observed. Identifying changes and measuring recovery rate, maximal rate and resting rate is an established way of determining the effectiveness of an exercise programme. The Op-Ft plans to measure these variations and identify if a predicted pattern that would be expected can be identified.

5.1.2 Expected results of a 12-week walking programme.

It would be expected that the heart rate would recover from the maximum reading at the end of the test to resting heart rate faster on 3T than either 1T or 2T, such as the speed in which the heart rate returned to resting heart rate. The maximal heart rate during the Op-Ft would be lower than before the 12-week walking programme and the resting heart rate would be lower after the 12-week walking programme.

Prior to the initiation of the exercise programme a screening process and fitness assessment was completed (Baseline data).

5.1.3 Op-Ft assessment

Stafford-Brown et al (2010), emphasise the importance of ensuring the health and safety of participants and that testing procedure meets certain considerations deemed necessary to minimise any risk to the participant. To ensure this, the test must adhere to strict procedures that are outlined in the testing protocol.

A comprehensive risk assessment will also need to be undertaken prior to any testing such as reading medical notes, taking blood pressure and asking the participant about their current health and lifestyle. Prior to any testing participants were screened; their medical notes were examined to identify any medical problems that may have excluded them from the study. Health history was also taken via the PAR-Q form (See Appendix PAR-Q page 140) to determine if there were any contraindications. Date of the assessment, participant's weight, height and blood pressure were recorded as well as resting heart rate.

The following health and screening tests were undertaken during all three assessments (please also see Op-Ft assessment form Appendix page 157):

- Par-Q health screening questionnaire
- Height
- Weight
- BMI
- Hip waist ratio
- Blood Pressure
- Resting heart rate
- Op-Ft

The Op-Ft step test was been designed to be portable and as such did not require a specific environment. The test was undertaken within the older person's home or in a specific location such as a clinical facility or gym. However, as far as possible the assessment environment was maintained throughout the 3 tests. It was critical that all the Op-Ft tests were standardised to increase internal reliability, therefore all participants were given clear instructions and guidance on the equipment being used and how the test was to proceed. An Apple Ipad2 with pre-recorded instructions was used, enabling consistency every time the test was carried out. Any medication taken before testing was noted and participants would have been asked to avoid a heavy meal, caffeine or nicotine within 2 to 3 hours of testing. If a participant had concerns regarding balance or timing, they were offered a short practice; they would then be given time to rest between the practice test and the real test. If at any time during the test they felt they could not continue for any reason, such as becoming out of breath, chest pain or balance problems, they were advised to inform the researcher and stop the test immediately. At the end of every test the participant was asked if their experienced had any adverse effects such as joint pain, muscle soreness, dizziness or chest pain.

5.1.4 Equipment required for Op-Ft

Reebok Step: Reebok aerobic step is a height adjustable, shock-absorbing low impact step that is commonly used in many health clubs. For the step test the height is set at 150 centimetres (6 inches). BP machine: Pharmaceuticals Upper Arm Blood Pressure/Pulse Monitor. Heart Rate Monitor: Oregon Scientific SE102I measure electrocardiographic signals via a chest strap. Electronic data logger: logger (Oregon Scientific WM100) that collected continuous data from the chest strap for later analysis.

Audible recording: An Apple iPad2 auditory recording guided the participant though the step sequence, commands such as: on the first beat the participant was asked to step one foot up onto the step, on the second beat the participant was asked to step the other foot up on to the step. Following the third beat the participant was required to step down off the step with one foot. The fourth beat the participant stepped the remaining foot down, collectively this is a known as the sequence of four. The recording also contained advice regarding safety. During the test the participant heard an audible soundtrack, which helped eliminate confusion for the participant, and enabled the participant to maintain the correct cadence per minute.

5.1.5 The Op-Ft procedure (Step 1-6)

Step 1: Medical notes screen and health history is taken via PAR-Q form, age, gender, weight, height, blood pressure, resting heart rate recorded (please see assessment form page 80).

Step 2: The heart rate transmitter belt is placed next to the skin of the participant, after applying contact gel on to the sensors. The belt must be fastened around the participant’s chest and the 2 sensors located under the pectoral muscles, one against each side of the chest. The chest strap senses the participant's heart rate and transmits a signal using wireless technology to the watch. The watch displays the heart rate in beats per minute. The participant’s age, weight and height are programmed into the watch and the auditory alarm set for 77% of the participant’s predicted heart rate maximum (this will ensure the participant does not exceed the 77%). The watch is then fixed to the participant’s wrist, displaying the heart pulse mode. The electronic data logger (Oregon Scientific WM100) will then be activated, which collects continuous data from the chest strap and will capture the participant’s heart rate throughout the assessment for later analysis.

Respect for the participant's privacy and dignity was maintained at all times; if the participant need help with fitting the chest belt they were asked for their permission before assistance was provided. Gender specific assistance was available at all Op-Ft. The chest belt was cleaned with a surgical disinfectant to eliminate any cross infection. The same watch and chest belt were used on all assessments to eliminate any product variations. No two heart rate monitors were used within close proximity to each other, as this may have cause the watch and logger to pick up signals from both chest belts resulting in incorrect data.

Step 3: Step bench: The step was set at the lowest possible platform height, which is 150 cm (6 inches). The participant is shown the step sequence which includes advice on the participant's safety; this states that if at any time the participant feels dizzy, unbalanced or unduly fatigued, they should stop and inform the test supervisor/instructor. The participant is then asked to practice stepping up on to the step. During this time the participant is given guidance on technique, postural alignment and proper foot positioning. The participant is asked to keep tempo with the bleeps that they will hear via the audio soundtrack on the iPad2. If the participant is finding this difficult the researcher steps with the participant, which helps keep time with the audible recording. When the participant and researcher were happy the test began, lasting 3 minutes. (Please see appendix H for details of step advice)

The researcher continually monitored the stepping sequence and advised the participant if they observed any deterioration in form that would either lead to injury or compromise safety.

Step 4: During the Op-Ft test, participants were asked not to talk as this has an upward effect on the heart rate. However, the test researcher did encourage the participant to maintain correct form or check with the participant if they see any undue signs of distress or fatigue. For standardisation purposes the test was administrated by the same test researcher and that the participant was given the same verbal encouragement as previous tests.

Step 5: The participant was monitored throughout the test for any indications of undue fatigue, dizziness, balance and coordination problems. If the participant appears to be in distress or in danger of falling, the test was be discontinued and recorded as incomplete on the Op-FT assessment form.

Step 6: Collecting data, participant's resting heart rate was recorded before the test. During the test, the test supervisor monitors the participant's heart rate via the wrist recorder and record maximum heart rate during test and heart rate on completion of the test. The participant was then asked to sit quietly for three minutes. Heart rate was recorded thereafter every minute until three minutes have elapsed. See below Op-FT assessment form.

The test was administered three times over a 24-week period the results were then compared. Baseline assessment T1 was undertaken 12 weeks before the walking programme commenced. Second assessment or T2 was undertaken one week before the start of the 12-week walking programme. The third assessment T3 took place no more than one week after the participant completed the 12-week walking programme.

5.1.6 Aim of the procedure

By an older person participating in a 12-week walking programme it was hypothesised that they would increase their cardiorespiratory fitness. Therefore, it would be expected that changes in recovery heart rate, maximum heart rate and resting heart rate would be observed. Identifying changes and measuring recovery rate, maximum rate and resting rate is an established way of determining the effectiveness of an exercise programme. The Op-Ft plans to measure these variations and identify if a predicted anomaly that would be expected can be identified.

The procedure requires the Op-Ft to be carried out three times on the same participant. It is hypothesised that the results between test one and test two would not show significant variations. However, due to the 12-week walking programme between T2 and T3 we would see a decrease in participants resting heart rate, maximum heart rate at the end of the test and a quicker recovery of the participant's resting heart rate within three minutes.

One of the predicted anomalies expected in the study would be that the resting heart rate would drop. As a person becomes physically fitter, the heart becomes more efficient and is able to circulate more blood each time it beats. Consequently, it would be expected that between T2 Op-Ft and T3 Op-Ft the resting heart beats should decrease, because as an increase in physical training occurs the heart adapts and becomes stronger. In turn this will show an improvement in the older person's cardiorespiratory ability. Studies have shown there is a marked difference between the resting heart rate (or pulse) of a trained athlete as opposed to an unfit person. The resting heart rate of an average adult is around 72 beats per minute, for a sedentary person, this can be as high as 80 to 90 beats per minute. The heart of an athlete may only need to be at 50 beats per minute to deliver the same amount of blood to the rest of the body (Stafford-Brown et al 2010, Banks 2011). Therefore, monitoring the resting heart rate and observing a reduction in resting heart rate would suggest improved cardiorespiratory fitness. The researcher could then compare the results of the older person's resting heart rate with other Op-Ft results and identify if other results are consistent.

The speed in which a person recovers from physical exertion has long been an established measure of cardiorespiratory fitness (Stafford-Brown et al 2010; Brukner & Khan 2012). Physically fit people will generally recover more rapidly from exertion because their cardiovascular systems are more efficient and adapt more quickly to an imposed demand. Recovery heart rate is measured by the speed in which the heart returns to its pre-exercise rate. By monitoring the recovery heart rate from the three Op-Ft's an increase in the speed of recovery is expected to be observed to pre-exercise levels. Consequently, it could be assumed that the ability of the study participants to recover from a specific measure of exertion would indicate an increased level of cardiorespiratory fitness.

5.1.7 Analysing Data

Five variables would be measured 3 times over a 24-week period.

1. Resting Heart Rate (RHR) as having a lower resting heart rate is a strong indicator of a person's cardiorespiratory fitness.
2. Maximum Heart Rate (MHR) as this determines the maximum effort needed to complete the Op-Ft.
3. Heart Rate Recovery (HRR) one minute post Op-Ft to indicate the speed the heart recovers from a standard measure of exercise.
4. HRR two minute post Op-Ft to determine continued recovery.
5. HRR three minute post Op-Ft to determine recovery.

The relationship between MHR and RHR was also correlated as they are both strong indicators of a person's cardiorespiratory fitness. The Statistical Package for Social Sciences Version, 19 (SPSS) was used to analyse data generated from the OpFt. SPSS is commercially available and used by government, business and academia and is one of the most widely used computer programs for data analysis in social science (Moule & Hek 2011; Bowling 2009). The Op-Ft participants were represented in rows. In the columns heart rate variations from test to test were entered. Descriptive variables (age and number of participants) were calculated. Distribution of gender was analysed to identify if any gender bias occurred.

The Op-Ft data for RHR, MHR and HRR were analysed using one-way repeated measures Analysis of Variance (ANOVA). An ANOVA was selected as it minimised the chance of a Type 1 error occurring when compared to conducting multiple t-tests and thus increased reliability of any significance found. One-way ANOVA is an *omnibus* test statistic and cannot identify which specific tests e.g., T1, T2, T3; were significantly different from each other only that there was a significant difference overall. Therefore, all significant ANOVAs (<0.5) will then be analysed using pair wise comparisons to identify where the significant difference(s) occurred between baseline (T1), pre-intervention (T2) and post-intervention (T3). Pair wise comparisons will identify where (if any) significant differences lie in heart rate recovery, 1 minute, 2 minute, and 3 minute across the three time points. Comparisons will be corrected using a Bonferroni adjustment. The comparison most of interest is the difference between the two pre-activity step tests (T1 & T2) and the one post-activity step test (T3).

To test the suggestion that a change can be identified in heart rate following the Op-Ft intervention RHR, MHR and HRR variations will be analysed. RHR is used as an indicator of a person's fitness. The generally accepted concept is, the lower the resting heart rate, the better the person's cardiorespiratory efficiency. MHR was measured because it has been associated with increased fitness outcomes. The assumption is that a repeated measured intervention would reveal a comparable MHR unless an increase in cardiorespiratory fitness had occurred. The speed at which the heart rate recovers post exercise has also been used as an indicator of improved cardiorespiratory fitness. Therefore, HRR will be analysed to identify if the speed of recovery after the Op-Ft repeated measured step test has improved after the 12-week walking programme. If this is so, it would imply that an increase in cardiorespiratory fitness had occurred. RHR and MHR have both been used as indicators of cardiorespiratory fitness. The expectation would be that the RHR decreases and a reduction in MHR would also be observed. A corresponding change between these two variables would support an increased reliability in the results, therefore, both variables will be correlated.

Chapter Six – Results

6.1.0. Descriptive statistics.

Table 11, summarizes the demographic characteristics of the 70 participants. The mean age was 73.7 years and the range was 51-89 years.

Table 11: Descriptive statistics for participant age

Minimum	Maximum	Mean	Std. Deviation
51	89	73.7	8.3

Table 12, identifies the gender distribution between the 70 participants. The sample size consisted of 41 females 58.6% and 29 males 41.4%.

Table 12: gender distribution for the sample.

	Frequency	Percent
Female	41	58.6
Male	29	41.4

Ethnicity and demographics of subjects are described in chapter 4 methodology.

Data on the participants' completion of the step test was recorded via the Op-Ft assessment from. Any identified problems observed of verbally stated by the participants during or after the Op-Ft were recorded.

Participant attrition, during data analysis, 17 participants' data was excluded due to low completion of the walking programme or incomplete data collection. Therefore, the following heart rate data is reported on a sample size of 53 participants. The gender distribution was 22 males and 31 females, (41.5% male; 58.5% female).

6.1.1 Resting Heart Rate across three time measures

Resting Heart Rate was recorded before the start of the Op-Ft at 3 time measures T1, T2 and T3. A repeated-measures ANOVA, identified a significant difference in RHR across these 3 time points, $F(2,110)=13.00$, $p<.001$ (see Table 13).

Table 13: RHR across 3 time points.

Repeated-measures ANOVA, across the 3 time points				
Error	Sphericity Assumed	3675.417	110	33.413

Due to the significance level of $p<.001$, pair wise comparisons were undertaken to reveal where the RHR differed. The pair wise comparisons revealed a significant difference between T2 and T3 ($p<.05$) but this was not observed between T1 and T2 ($p>.05$). Analysis implied that RHR decreased following the 12-week walking programme, results which are consistent with an increase in cardiorespiratory fitness. Results of pair wise comparisons are illustrated in Table 14.

Table 14: RHR across three time measures.

Pair wise Comparisons Resting Heart Rate						
Time RHR	Time RHR	Mean Difference	Std. Error	Sig.[a]	95% Confidence Interval for Differencea	
					Lower Bound	Upper Bound
T 1	T 3	3.73	0.96	.001,	1.36	6.11
T 1	T 2	-1.71	1.183	.459	-4.637	1.208
T 2	T 3	5.45	1.12	<.001*	2.68	8.21

Based on estimated marginal means
a. Adjustment for multiple comparisons: Bonferroni.
*. The mean difference is significant at time T2 to T3

Presented in Figure 5, is a whisker plot which displays a visual comparison between the 3 time points, the end of the whiskers denote the minimum and maximum of all the participants maximum heart rates with the centre point being the mean. *X,* Axis displays the three repeated time periods. *Y,* Axis displays heart rate in beats per minute. The graph clearly illustrates the mean resting heart rate from (T1) to (T2) of 68.85bpm. A mean RHR drop is then observed at T3 to 64.1bpm a drop in resting heart rate of 4.75bpm.

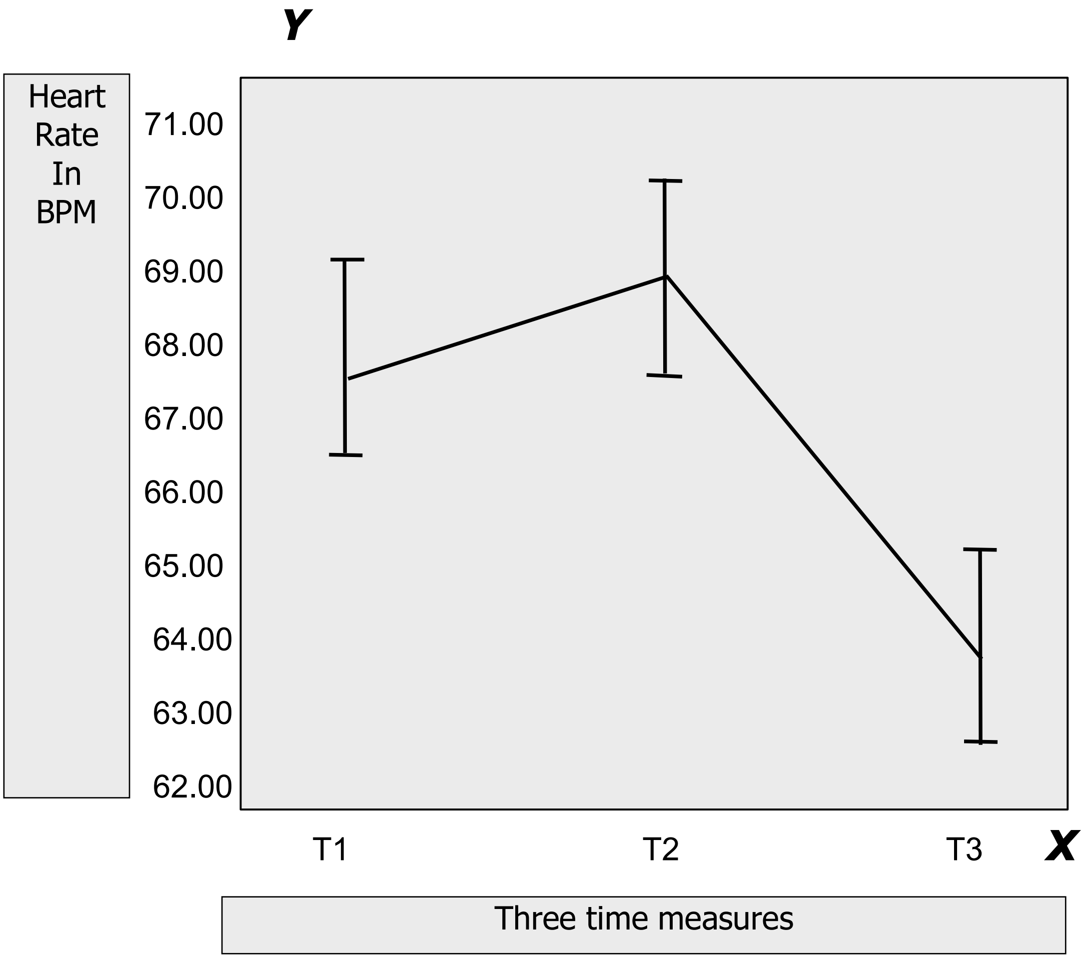


Fig: 5, displays mean RHR drop over the three repeated time periods.

6.1.2 Maximum Heart Rate, during Op-Ft across three time measures.

During the repeated-measures ANOVA for MHR a violation of sphericity occurred. Violation of sphericity occurs when variances are not all equal, which would result in an F-ratio that would be inflated. To determine whether statistically significant differences exist between the variances of the differences, Mauchly's test of sphericity was performed. Mauchly's test indicated that the assumption of sphericity had been violated $X^2(2)=13.57$, $p<.01$. In SPSS, three corrections are generated: the Greenhouse-Geisser (1959), the Huynh-Feldt (1976), and the lower-bound. Each of these corrections have been developed to alter the degrees of freedom and produce an F-ratio where the Type I error rate is reduced. The actual F-ratio does not change as a result of applying the corrections; only the degrees of freedom. Huynh-Feldt tests are reported over Greenhouse-Geisser because the epsilon value was greater than .75. The repeated-measures ANOVA, (see Table 15) revealed that the maximum heart rate was significantly different across time points, $F(1.675, 90.47)=22.73$, $p<.001$.

Table 15: One-way ANOVA of MHR

One-way ANOVA, across the 3 time points						
Source		Type III Sum of Squares	df	Mean Square	F	*P*
Model	Huynh-Feldt	1903.745	1.675	1136.319	22.729	<.001
Error	Huynh-Feldt	4522.921	90.470	49.994		

Due to the significance of $p<.001$, pair wise comparisons were performed to reveal where the MHR differed. Contrasts revealed that there was no difference between T1 and T2 ($p>.05$) but that maximum heart rates at T3 were significantly lower than at T1 or T2 (both $p<.05$) Results of pair wise comparisons are illustrated in Table 16.

Table 16: Mean Maximum Heart Rate over the 3 time measures

Pair wise Comparisons; Maximum Heart rate during Op-Ft						
Time MHR	Time MHR	Mean Difference	Std. Error	Sig.[a]	95% Confidence Interval for Differences	
					Lower Bound	Upper Bound
T 1	T 3	7.36	1.33	<.001,	4.08	10.65
T 1	T 2	0.33	1.41	1.00,	-3.82	3.82
T 2	T 3	7.04	0.9	<.001*,	4.81	9.26

Presented in Figure 6, is a whisker plot that displays visual comparison between the 3 time points, the end of the whiskers denote the minimum and maximum of all the participants maximum heart rates with the centre point being the mean. *X,* Axis displays the three repeated time periods. *Y,* Axis displays heart rate in beets per minute. The graph clearly illustrates the mean heart rate from (T1) to (T2) of 91.5bpm. A mean MHR drop is then observed in T3 to 85.5bpm.

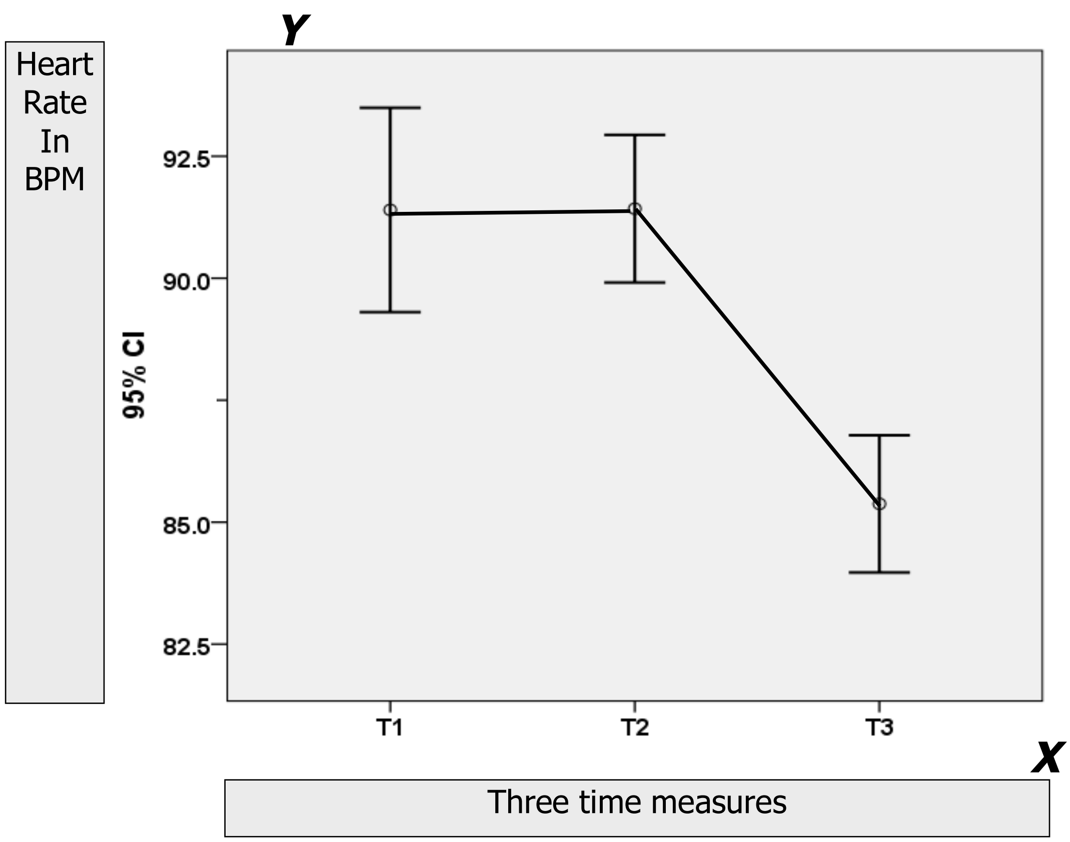


Fig: 6, displays mean MHR drop over the three repeated time periods.

Analysis implied that MHR at the end of the 3 minute Op-Ft decreased following the 12-week walking programme, results which are consistent with an increase in cardiorespiratory fitness.

6.1.3 Heart Rate Recovery post 1 minute across three time measures.

The repeated-measures ANOVA of 1 minute post Op-Ft identified a significant drop in heart rate recovery across the 3 time measures e.g. baseline (T1), and post-intervention (T3). $F(2,108.)=15.7$, $p<.001$. (see Table 17)

Table 17: RHR post one minute across 3 time points.

One-way ANOVA, across the 3 time points				
Error	Sphericity Assumed	5869.38	108	54.35

Table 18: displays the pair wise comparisons of heart rate recovery post one minute OpFt and revealed that there was no significant contrasts between (T1) and (T2) (both $p>.05$) however, speed of heart rates recovery post 1 minute at T3 were significantly quicker than at (T1) or (T2) ($p.<.05$).

Table 18: Heart Rate Recovery one minute post Op-Ft over the 3 time measures

Pair wise Comparisons; Heart Rate Recovery one minute post OpFt						
HRR 1min	HRR 1min	Mean Difference	Std. Error	Sig.[a]	95% Confidence Interval for Differencea	
					Lower Bound	Upper Bound
T 1	T 3	5.982*	1.34	<.001*	2.67	9.3
T 1	T 2	-1.46	1.54	1.00,	-5.25	2.34
T 2	T 3	7.436*	1.33	<.001*	4.15	10.73
Based on estimated marginal means a. Adjustment for multiple comparisons: Bonferroni. *. The mean difference is significant at time T2 to T3						

Presented in Figure 7 is a visual comparison between the 3 time points. The end of the whiskers denotes the minimum and maximum of all the 1 minute recovery heart rates with the centre point being the mean. *X,* Axis displays the three repeated time periods. *Y,* Axis displays heart beats per minute. No significant changes in heart rate recovery post 1 minute are observed from (T1) to (T2) a mean of 74.9bpm. However, a mean drop in heart rate is then discovered in T3 to 69bpm. These results are consistent with what would be expected from an increase in cardiorespiratory fitness.

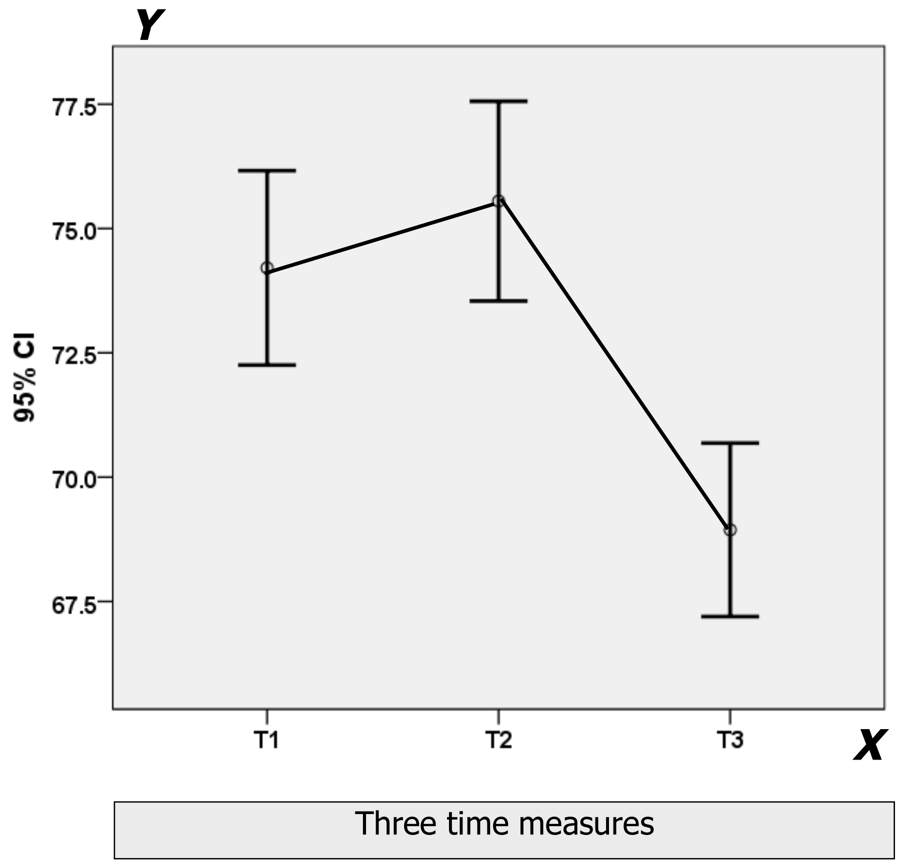


Fig 7 HRR at 1 minute post Op-Ft dropped quicker after the 12 week walking programme

6.1.4 Heart Rate Recovery 2 minute post Op-Ft across three time measures.

Presented in Table 19 is the repeated-measures ANOVA results of post 2 minute HRR which showed a significance across (T1) to (T3), $F(2,108.)=11.4$, $p<.001$.

Table 19: RHR two minute across 3 time points.

Repeated-measures ANOVA, across the 3 time points				
Error	Sphericity Assumed	5869.38	108	54.35

Contrasts revealed that there was no significant difference between (T1) and (T2)(both *p.>*05) but speed of heart rates recovery post 2 minute at (T3) were significantly quicker than at (T1) or (T2) (*p.>*.05). (see Table 20).

Table 20: Heart Rate Recovery 2 minute post OpFt over the 3 time measures

Pairwise Comparisons; Heart Rate Recovery two minute post Op-Ft						
HRR 2min	HRR 2min	Mean Difference	Std. Error	Sig.[a]	95% Confidence Interval for Differencea	
					Lower Bound	Upper Bound
T 1	T 3	5.036*	0.13	.001*	1.79	8.29
T 1	T 2	-.945	1.515	1.000	-4.690	2.799
T 2	T 3	-5.982*	1.172	<.001*	3.09	8.88
a. Adjustment for multiple comparisons: Bonferroni. *. The mean difference is significant at time T2 to T3						

Presented in Table 21, the one-way ANOVA of HRR post 3 minute which reproduced similar comparisons to one and two minute results. Significant difference across time points $F(2,106.)=8.3$, $p<.001$.

6.1.5 Heart Rate Recovery 3 minute post Op-Ft across three time measures.

Table 21: RHR post three minute across 3 time points.

One-way ANOVA, across the 3 time points				
Error	Sphericity Assumed	5869.38	108	54.35

Contrasts revealed that there was no significant difference between (T1) and (T2)(both *p*>.05) but speed of heart rates recovery post 3 minute at T3 were significantly quicker than at (T1) or (T2) (*p.*<.05). (see Table 22).

Table 22: Heart Rate Recovery three minute post Op-Ft over the 3 time measures

Pair wise Comparisons; Heart Rate Recovery three minute post Op-Ft						
HRR 2min	HRR 2min	Mean Difference	Std. Error	Sig.[a]	95% Confidence Interval for Differences	
					Lower Bound	Upper Bound
T 1	T 3	3.278*	1.14	0.02	0.47	6.09
T 1	T 2	-1.667	1.384	.702	-5.089	1.756
T 2	T 3	-4.944*	1.168	<.001*	2.06	7.83

a. Adjustment for multiple comparisons: Bonferroni.
*. The mean difference is significant at time T2 to T3

Summary of all three Op-Ft heart rate recovery results

Figure, 8 is a summary of all heart rate recovery data over the three post-recovery time measures. The three time points are viewed in the *X,* Axis, the *Y,* Axis displays heart beats per minute (bpm). The top line (blue line) displays the test results from the one-minute post-recovery test and as previously identified shows there was no significant change in the participants' recovery from T1 to T2 however, there is then a significant drop in heart rate post-one minute in T3. This drop in heart rate would indicate the participant was able to recover from the exertion of the repeated measured effort Op-Ft quicker after they completed the 12-week walking programme. The middle line (red) shows the two-minute post-recovery test and identifies a similar result with an increased speed of recovery in T3. The bottom line (green) displays the three-minute post recovery test and again identifies the participants' heart rate recovered quicker in the T3 tested. Figure 8, highlights a consistent and symmetrical illustration of the three post 1, 2 and 3 minute recovery tests.

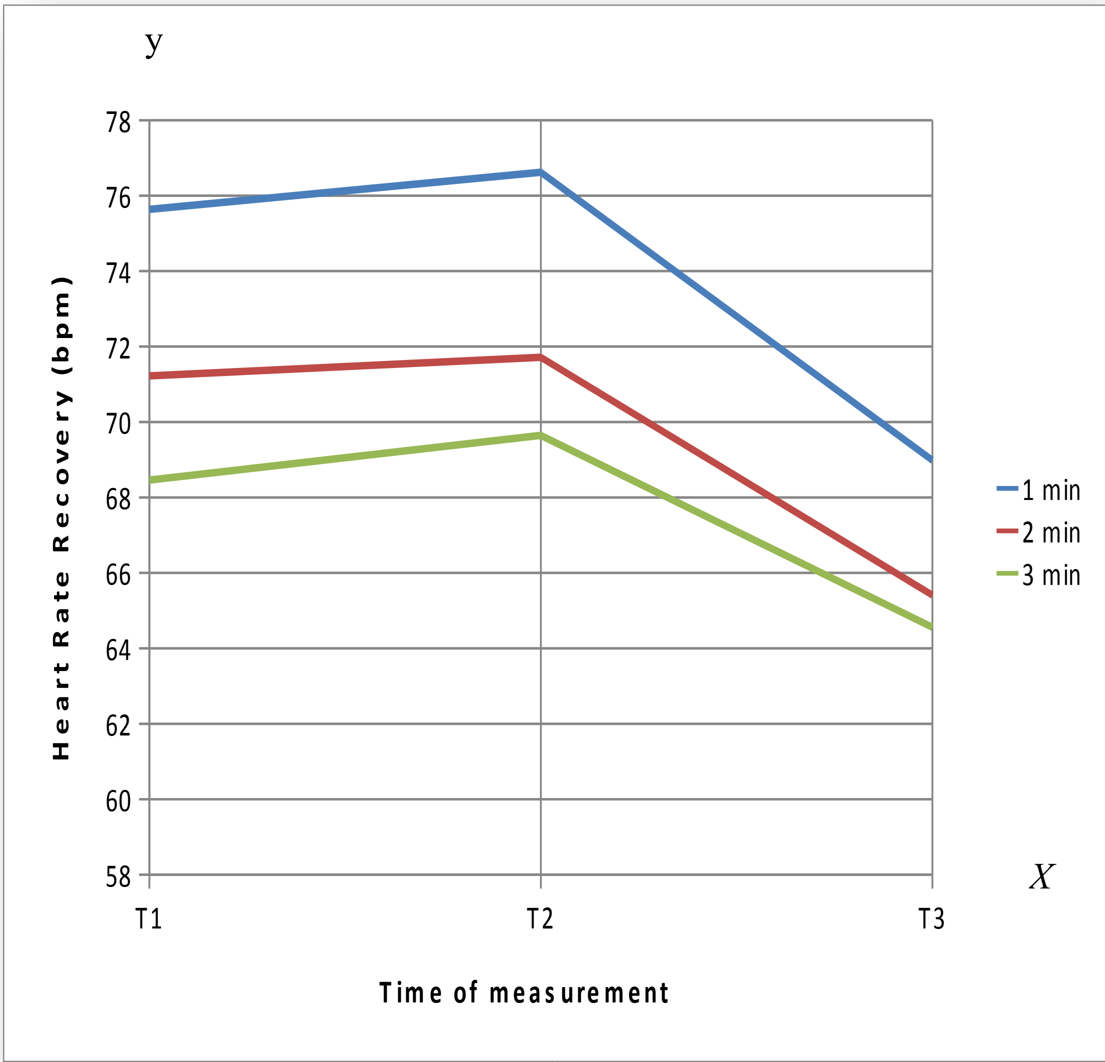


Fig 8: Axis Y, bpm, Axis X Op-Ft test times, top line (blue) 1 minute recovery, middle line (red) 2 minute recovery, bottom line (green) 3 minute recovery.

6.1.6 Relationship between RHR and MHR

RHR and MHR have both been used as indicators of increased cardiorespiratory fitness. The assumption would be that the RHR decreases and a reduction in MHR would also be observed at the end of the Op-Ft following the programme as the participants' cardiorespiratory fitness increases. A corresponding change between these variables could support previous findings in this study and increase the reliability of the results.

Previous results indicated there was no significant difference in RHR between T1 and T2. Therefore a change score was created by subtracting the pre-mean from the post mean. This procedure was repeated with MHR. A correlation between these two variables was performed to identify if there was a relationship between changes in participants' RHR and changes in their MHR following the programme. Results identified a significant correlation between variables r=.733, p<.001.

Figure 9 shows the results in a scatter plot graph. The Y Axis is the decrease in MHR following the 12-week walking programme. X Axis is the decrease in RHR following the 12-week walking programme. The results are consistent with what would be expected from older people who had improved their cardiorespiratory fitness. The findings also suggest that a change in one of these variables is associated with a change in the other.

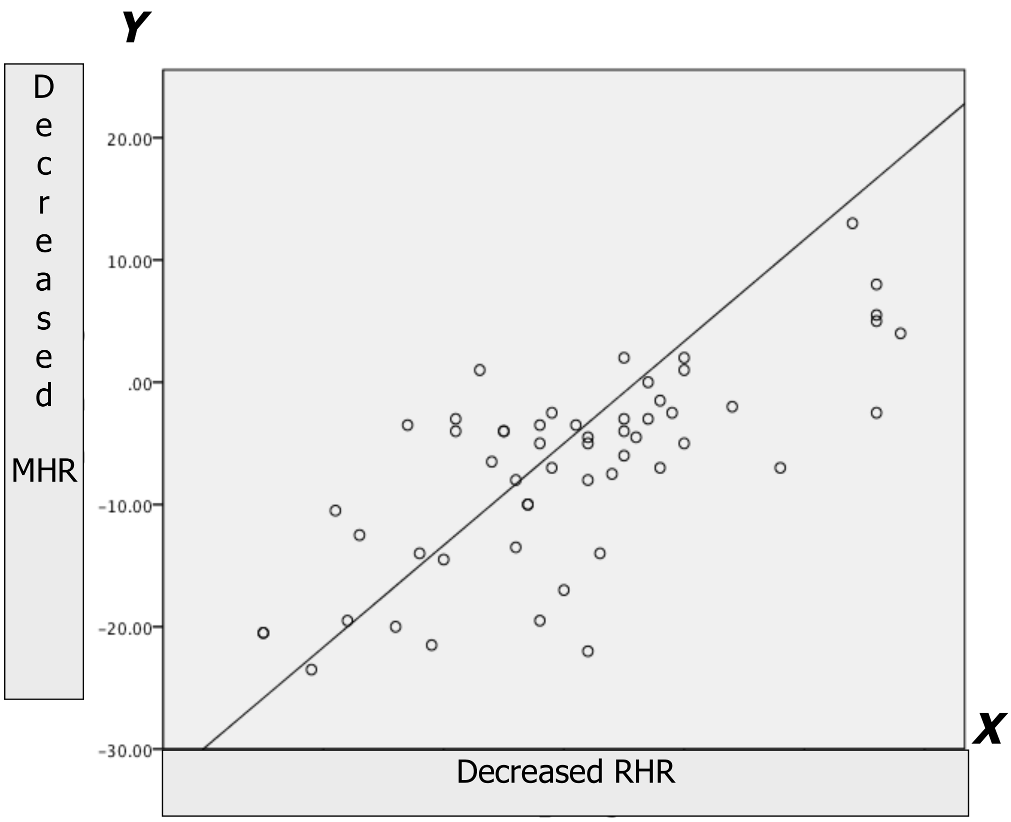


Fig 9: Axis *Y,* displays decease in HRM, *X,* Axis displays a decrease in RHR over the last 12 weeks of participants' walking programme.

Chapter Seven – Discussion

7.1.0 Introduction

The Op-Ft study sought to develop and design a sub maximal step test that is safe and attainable for older people. Additionally, it needed to be easily administered, inexpensive and have the ability to measure variations in cardiorespiratory outcomes. The literature review identified methods of testing fitness but none of the procedures met the needs of the ThinkingFit (2014) study. Those that had been developed in the literature were tests that required expensive equipment and were not mobile such as the Maximal Direct test. Maximal tests such as Multi-stage 'bleep test', Incremental Shuttle Walking Test, Rockport Fitness Walking Test and Six Minute Walk Test all carried a risk of injury because they required the participant to work until they can no longer keep up with the beeps. Step tests such as the Harvard step test and the Queen's College step test were found to have a step height that was difficult to achieve by an older adult or there was no mechanism to monitor safe heart rate. The subjective method test 'Borg Scales' had high inter-individual variability, which meant it was not a reliable repeat measure test. The following chapter presents the findings arising from the data collected via the testing of the Op-Ft. As discussed in the methodology, the data that emerged from the Op-Ft were generated through quantitative research methods in an inter-subject, repeated measure design. This process provided substantial data, with the potential for analysis on many different levels. However, for the purposes of this discussion the research findings will be limited to discussing participant safety and attainability of the Op-Ft and the quantitative data on six outcomes: Table 23 shows the codes that have been applied to identify the themes within this chapter.

Participant safety and attainability	PSA
Resting heart rate of participants before undertaking the Op-Ft	RHR
• Maximum heart rate during the Op-Ft	MHR
• Heart rate recovery taken one minute post Op-Ft	HRR-1
• Heart rate recovery taken two minutes post Op-Ft	HRR-2
• Heart rate recovery taken three minutes post Op-Ft	HRR-3
• Correlation between resting heart rate and maximum heart rate	RHR-MHR

Table 23: Identifying themes

7.1.1 Participants Safety and Attainability

The Op-Ft was carried out on 159 occasions by 53 participants. The attrition rate for non-completion was zero. No participants failed to complete the test or refused to be retested. According to Chodzko-Zajko (2009) and Costello et al (2011) one of the barriers for older people to engagement in exercise is the fear of injury. The Op-Ft is a dynamic test and involves lower body strength, flexibility, agility, balance and cardiorespiratory fitness. Therefore the test had the potential to cause distress, discomfort or injury to the older person if too arduous. No injuries to participants were reported and all the participants were able to complete the test without excessive fatigue; no muscular-skeletal problems occurred as a consequence of performing the Op-Ft. This result would suggest that Op-Ft could be conducted without causing injury or undue discomfort to the participant. Wilcox et al (2003); Forbes et al (2015a) and NICE (2008) all describe the importance of providing physical activity that does not cause injury or discomfort when trying to encourage older people to engage in physical activity programmes. As no participant described or displayed any injury or discomfort it would suggest the Op-Ft did meet one of its aims, that of designing a sub-maximal step test for older people that can be used without causing undue discomfort to the participant.

All Op-Ft testing was conducted in the participant's home or in the gym at the participant's local mental health unit. One of the barriers for older people described by Belza et al (2004) Costello et al (2011) Lees et al (2005) and Age Concern (2006) is older people find it difficult to engage in exercise where it is provided in unfamiliar settings or environments. Ashworth et al (2005) support this view, advocating that older people should have fitness activity programmes that can be undertaken from the older person's home because it increases longer-term adherence to physical activity programmes. The Op-Ft showed it could be administered in a variety of settings and be transported to the person's home; this would suggest the Op-Ft could be beneficial in reducing this recognised potential barrier described by Belza et al (2004) Costello et al (2011) Lees et al (2005) and Age Concern (2006). In addition administering the Op-Ft in the participant's home may remove the problem of the older person being self-conscious (Dergance et al 2003). A study by Stathi et al (2002) suggested older people can feel out of place and uncomfortable in health clubs or sports centres. Therefore, the convenience of a test such as the Op-Ft could be beneficial to professionals in encouraging older people to become more active by enabling the test to be conducted in the privacy of the individual's home. One of the aims of the Op-Ft was that it could be administered in various settings and did not require expensive equipment. It appears from the findings of this study that the Op-Ft has the potential to do this.

Wilcox et al (2003) also suggested that one of the obstacles in engaging older people to participate in regular physical activity is a lack of time. The relatively short length of time that the Op-Ft took to administer, and its simplicity, may have had a positive effect and supported continued compliance for participants when being retested.

Motivating older people to engage in physical activities can be one of the greatest challenges for the public health agenda and health professionals (Costello et al 2011; Philips et al 2004). Informal feedback after the Op-Ft suggested that participants wished to know three things: what the results were; what the results meant; how the results could be improved. The Op-Ft was able to provide periodic individualized feedback that may have increased motivation to continue with the retesting over the three time points and during the ThinkingFit (2014) walking programme. Rikli and Jones (2013) suggest evaluation is the most powerful motivator for getting older people to improve their level of fitness and maintain a physical activity programme. The National Academy of Sports Medicine (2012) also maintains that providing people with measurable repeated assessments can be motivating. Philips et al (2004) found that self-belief is a strong determinant in older people engaging and adhering to physical activity programmes and that furthermore, older people's perceived capability and confidence to participate in physical activity programmes is less than in other age groups. It is possible that the Op-Ft was able to engage participants as through evaluation they had some control over their ability to improve their level of physical fitness.

MCI is often prodromal for the most prevalent form of dementia and has the potential to affect a vast number of people worldwide (WHO Statistics 2012; The Alzheimer's Disease International report 'The Global Impact of Dementia' 2013; Dannhouse et al 2014). Studies have supported the likelihood that engaging in regular physical activity may reduce the risk of cognitive decline and dementia in older people (Baker et al 2010; Lautenschlager et al 2010; Elwood 2013). Chronic conditions were identified as both a barrier and motivation in older people's populations (Wilcox et al 2003; Belza et al 2004). Hui et al (2001) and Dergance et al (2003) suggest older people should be better informed about the positive benefits of engaging in physical activity. The information shared prior to the start of the study, about better cognitive health and the potential reduction in risk of developing dementia if older people engaged in regular physical activity, might have contributed to the levels of compliance of the Op-Ft. A person's internal locus of control is a sense of how much control a person feels they have over their external environment. Empowering older people can profoundly affect their motivation

(Philips et al 2004). The study participants who engaged in the Op-Ft and the ThinkingFit (2014) programme may have been imbued with a perceived sense of control over their own health, which may have contributed to a high level of adherence. This could be researched further through a qualitative follow-up study.

Interest in developing occupational therapy interventions to address 'active and healthy ageing' is increasing (Iwarsson 2013; Mountain et al 2008; Orrell & Wenborn 2014; NICE/SCIE 2006; NICE 2008). Occupational therapists can provide motivation and safe exercise instruction tailored to individual needs, adapting physical abilities to functional goals, and motivate older people to take charge of their own health and well-being (NICE 2008; Philips et al 2004; Blair et al 2001). Boyette, et al (2001) affirmed that 85% of adults stated that if a physician or health care professional recommended an increase in their physical fitness activities it would help them get more involved in regular physical activities. NICE (2008) recommend occupational therapists should increase older people's knowledge and awareness by providing information directly on topics such as staying active and increasing daily mobility (NICE 2008 p7). However, to do this occupational therapists may need to look outside of occupational therapy's own field of expertise by adapting existing knowledge and techniques (Iwarsson 2013). The Op-Ft was adapted and developed from pre-existing tests within the field of sport and exercise to meet the needs of a population cohort in the hope it may help in reducing some of the barriers experienced by older people.

During the administration of the Op-Ft no problems were recorded regarding misunderstanding or incorrect techniques over the 159 times it was performed. Furthermore, the test administrator witnessed no procedure violations that could not be corrected by following the Op-Ft procedure step 3 described in chapter three. This would suggest that the Op-Ft is a simple procedure that could have potential for encouraging older people to engage in physical activity programmes. This is in line with recommendations from

NICE public health guidance (2008) '*Occupational therapy interventions and physical activity interventions to promote the mental wellbeing of older people in primary care and residential care'.* The health benefits of physical activity for elderly persons are well established (Herholz & Zatorre 2012; Angevaren et al 2008; Schroll 2003, Crombie et al 2004; Mernitz & McDermott, 2004; Baker et al 2010; Lautenschlager et al 2010; Elwood 2013) however exercise is an underused form of health promotion, especially in the elderly population (Philips et al 2004; Belza et al 2004; Dannhauser et al 2014). Having a test that requires the minimum of equipment, is relatively simple to administer and is safe to use will assist in reducing some of the barriers to exercise experienced by older people (Jones & Rikli 2002).

The results of the participant safety and attainability data suggest the Op-Ft may be a safe and appropriate test for older people. Having no reported adverse instances over the course of the study implies the level of exertion required by the Op-Ft is manageable and safe for older people. These findings do suggest that the Op-Ft is a safe and manageable procedure for older people.

7.1.2 Resting Heart Rate

The assessment of RHR is a sensitive indicator of an older person's overall cardiorespiratory health and fitness status and it can help in the design, monitoring, and progression of a person's exercise programme (Nation Academy of Sports Medicine 2012). In the Op-Ft RHR was measured while the participant was at rest and prior to the beginning of the step component. The results of the RHR repeated over the three time points revealed that the mean participants' resting heart rate had dropped between T2 and time T3 but no difference was observed between T1 and T2. This finding suggests that an improvement in cardiorespiratory fitness had occurred between T2 and T3.

One of the main adaptations that occur through participating in endurance fitness activities such as walking is that the cardiorespiratory system becomes more efficient at delivering oxygen to working muscles (Brukner & Khan 2012; Nation Academy of Sports Medicine 2012; The Swedish National Institute of Public health 2010). The hypertrophy of heart muscle increases stroke volume, enabling the heart to pump greater volumes of blood per beat. The heart adapts by decreasing beats per minute as the heart can deliver the same amount of blood volume using less beats per minute (Nation Academy of Sports Medicine 2012). This results in a decreased heart rate that is often referred to as bradycardia (Staffored-Brown et al 2010).

A lower resting heart rate may also predict better health outcomes for older people; studies have suggested higher resting heart rate can be a low tech predictor of cardiovascular risk (Hsia et al 2009; Thayer et al 2007). As discussed in the literature review one of the three leading causes of death in developed countries is heart disease (Sattelmair et al 2011, McKechnie et al 2002, Sandercock 2013). In the UK the cost of heart disease to the NHS was estimated to be £16 billion in 2004 (WHO 2012 HERC 2004). Therefore, if health care professionals were going to promote the health benefits of exercise to older people, a test such as Op-Ft could identify a high or low resting heart rate and this data could then be used to monitor and predict health outcomes.

Measuring resting heart rate is a non-invasive procedure, which only requires minimal equipment (Nation Academy of Sports Medicine 2012). There are several ways of recording resting heart rate. The Op-Ft repeated resting heart rate measures used Boots pharmaceuticals upper arm blood pressure and pulse monitor. Blood pressure can be an indicator of an older person's overall cardiorespiratory health as well as fitness status (Nation Academy of Sports Medicine 2012). The advantage of using a blood pressure machine as well as a heart rate monitor is that the participant's blood pressure can be recorded. Furthermore, the majority of health professionals will be familiar with taking blood pressure and therefore would not require additional training. Participants' blood pressure was measured as part of the health screening process prior to the step component of the Op-Ft in an attempt to identify any health risks to the participant in the forthcoming fitness test or during the fitness programme. The Op-Ft used the same blood pressure machine to record all resting heart rates, as this provided consistency and increased internal validity. By using a blood pressure machine to record resting heart rate the test administrator was also able to identify hypertension (high blood pressure) or hypotension (low blood pressure).

Hypertension can increase older people's risks of heart disease and stroke (Blood Pressure Association 2008). Persistently high blood pressure is a major cause of premature death and disability in the UK (Blood Pressure Association 2008). Hypertension risk factors include obesity, excessive alcohol consumption, smoking and family history. Across the UK, 1 in 3 adults (around 16 million) has high blood pressure (a reading of 140/90 or higher) and this rises to at least 1 in 2 over-65s. Furthermore, 5 million people don't know that they suffer from hypertension (Blood pressure report 2007). If high blood pressure is left untreated it can increase the risk of heart disease, kidney disease and dementia. Fitness activities can significantly impact on keeping blood pressure healthy (HNS choices 2013). Regular monitoring and recording of older people's blood pressure during Op-Ft can identify hypertension and encourage fitness activities that have been shown to reduce high blood pressure (Blood Pressure Association 2009).

The RHR provides measurable data that can track change in an individual (Nation Academy of Sports Medicine 2012). The results of the Op-Ft indicated a mean heart rate dropped between T2 and T3 however, this procedure did not require the participant to engage in stepping. Data was collected prior to the step procedure and therefore it could be suggested that in itself collecting resting heart rate would be a sufficient method of identifying cardiorespiratory change. However, monitoring heart rate alone has its limitations because of changing variables. Many factors such as physical activity, anxiety or simply the time of day can influence heart rate (National Academy of Sports Medicine 2012). Drinking caffeine (in tea or coffee) can also temporarily raise heart rate as can nicotine in cigarettes (Krucilk 2014). Common colds and infections can also increase an older persons heart rate. Considering the many factors that may change resting heart rate the test of resting heart rate by itself would be a poor indicator of improved cardiorespiratory fitness. However, in conjunction with other procedures it could provide supporting evidence of cardiorespiratory variations and change.

7.1.3 Maximum Heart Rate

The participants' heart rate was monitored via the visual display on the Oregon Scientific heart rate monitor watch, throughout the three-minute test; the maximum heart rate was then recorded at the end. Monitoring HR during exercise provides a good estimate of the amount of work the heart is doing at any given time (National Academy of Sports Medicine 2012). The results of the MHR repeated over the three time points revealed that the participants' maximum heart rate did not differ significantly between T1 and time T2 but a significant difference in a lower MHR occurred between T2 and T3. These findings revealed that a possible improvement in cardiorespiratory fitness had occurred between T2 and T3.

The understanding of the physiological changes that occur as older people's cardiorespiratory fitness improves may support an explanation of this phenomenon. A physiological adaptation to a fitness activity programme is that the heart muscle becomes stronger and more efficient at delivering oxygen to working muscles this is often referred to as the '*training effect*' (Brukner & Khan 2012; National Academy of Sports Medicine 2012). The hypertrophy of the heart muscle enables the heart to pump greater volumes of blood to the muscles that are demanding oxygen (oxygen uptake) to create energy to continue stepping (National Academy of Sports Medicine

2012). This adaptation to the cardiorespiratory fitness of the older person that may have occurred is similar to that of the resting heart rate in that bradycardia enabled the participant's heart to function more efficiently. As a consequence the expectation would be that the participant heart would not need to beat as fast to do the same level of work and therefore a reduction in maximum beats per minute would be observed. These findings are consistent with The Swedish National Institute of Public Health's (2010) description of how during physical exertion, the pulse rises and cardiac output increases with the workload placed on the muscles of the body and the greater the cardiorespiratory fitness the less MHR will elevate during physical activity.

The finding suggest the Op-Ft has the ability to identify maximum heart rate variations in repeated measures over three time points which in turn could identify an improvement in an older person's fitness. Alternatively, if an older person did not show a reduction in maximum heart rate it could identify that the fitness activity has not been adhered to or the fitness activity was not sufficient to improve cardiorespiratory fitness (National Academy of Sports Medicine 2012).

As identified in the literature review, no dose response for older people has been established, recommendations for the modality, frequency, duration and intensity of physical fitness activities appears to be dependent upon what guidelines you read (Forbes et al 2015b). The Swedish National Institute of Public Health (2010) recommend training for older people should be undertaken at least 2-3 times a week, for at least 20 minutes at a time depending on intensity. The findings of the Op-Ft may suggest that walking for 30 minutes three times a week at 65 to 75% of predicted heart rate maximum may be sufficient to improve cardiorespiratory fitness. These findings would support the Renaud et al (2010) study suggesting a cardiorespiratory change can occur in older people within a three-month training programme. Although, it needs to be recognised the Renaud et al (2010) study asked participants to engage in three 60-minute sessions per week. A possible explanation for this improved heart rate response in the Op-Ft is progressive overload. The human body adapts to training overload and its fitness capacity will increase to meet this new level demand (Carnell et al 2009; Brukner & Khan 2012; National Academy of Sports Medicine 2012). The greater difference between the amount of exercise prescribed and the existing level of physical activity the more improvement would be seen. It is therefore plausible that the participants who showed the most improvement would have been the participants who were the most sedentary before the beginning of the 12-week walking programme. However, physiological and perceptual responses to exercise are highly variable, even among individuals of similar age, fitness and health (National Academy of Sports Medicine 2012).

It would also need to be acknowledged that if the walking programme remained 30 minutes three times a week at 65 to 75% heart rate intensity the improvements suggested in the Op-Ft results would remain static. The Op-Ft, although not conclusive in its evidence does support the Chief Medical Officers report 2004 that suggests that older adults who participate in relatively modest amounts of fitness activities can improve their health outcomes.

A reduction in an older person's maximum heart rate can provide evidence of improved cardiorespiratory fitness (National Academy of Sports Medicine 2012). However, collecting data on maximum heart rate during the step procedure on its own may not be as reliable as a combination of evidence. Maximum heart rate is subject to variations because of factors such as the older person becoming familiar with the procedure (motor learning) and as a consequence needing less effort to perform the same task (National Academy of Sports Medicine 2012). This theory would suggest that the Op-Ft would identify a reduction in maximum heart rate over the course of the three time points as each time the participant performed the test they would become more skilled at repeating the movements. However, what it would not explain is that a significant MHR drop was only observed in T3 and not a gradual drop over all three time points. The theory of motor learning and mastery of a movement may also suggest that as participants repeat the test it would become safer to use as older people's motor control would become more efficient.

The findings of the MHR repeated, suggests the Op-Ft was able to identify a change in participant's cardiorespiratory fitness. This supports Renaud et al (2010) findings and the Chief Medical Officer's report (2004) report that older people's cardiorespiratory health may benefit from just three 30 minute walks a week. Although this finding by itself is not definitive, it does suggest, taken with other results, that it may be a consistent indicator of change in older people's cardiorespiratory fitness.

7.1.4. Heart Rate Recovery 1-2-3

The heart rate post one minute was recorded via the visual display on the Oregon Scientific heart rate monitor watch. The results of the HRR-1 repeated over the three time points revealed that the participants' heart rate did not differ significantly between T1 and T2 but a significant difference was observed between T2 and T3. The results revealed that the participants' heart rate recovered quicker post one minute in T3 than in T1 or T2. These findings are consistent with what was found in the MHR and RHR analysis, that is, a cardiorespiratory change had occurred during the ThinkingFit (2014) 12 week walking programme.

Comparable results were also indicated in HRR-2 and HRR-3. The data from all three post time points, post one minute, post two minutes and post three minutes tests revealed that there was no significant differences between T1 and T2 however, a significant different was observed between T2 and T3. Participant's heart rate recovered significantly quicker from the three-minute modified step test element of Op-Ft after they had completed a 12-week walking programme. These finding are consistent across all the three time points an average of 3 beats per minute. Although, the test – retest reliability of heart rate is high, small day-to-day variations exist (National Academy of Sports Medicine 2012). Even under controlled conditions, changes of 2-4 beats per minute are likely to occur when individuals are measured on different days (Achten and Jeukendrup 2003). However, Op-Ft results showed a significant difference between T2 to T3 and no difference was observed between T1 and T2. Furthermore, data on HRR was also collected on 53 participants, which in turn would minimise individual day-to-day variations.

The speed in which people recover from physical exertion has long been an established measure of testing, cardiorespiratory fitness (Stafford-Brown et al 2010). Post-exercise heart rate recovery is a readily obtainable parameter and a powerful and independent predictor of cardiorespiratory fitness (Dimkpa 2009). The heart rate of people who are physically fit recovers more rapidly because their cardiorespiratory systems are more efficient and adapt more quickly to an imposed demand (Carnell et al 2009). Recovery heart rate has two decreasing phases: the first minute after a physical fitness activity, during which the heart rate drops sharply, and the resting plateau, during which the heart rate gradually decreases. The resting plateau may last as much as one hour after exercise. The finding from Op-Ft revealed a consistent decrease in heart rate through all three recovery time points. A significant quicker reduction in the first minute after the step phase of Op-Ft was not indicated as illustrated in figure 8 Chapter 7. However, this phenomenon may be the result of the Op-Ft being a submaximal test and not requiring the participant to reach their maximal heart rate. Alternatively, if no or very little drop was identified in the one-minute heart rate measure but then a heart rate drop was observed in two minutes and three minutes recovery phase, this could indicate that the Op-Ft could be too strenuous. The consequences being the heart rate would then take longer to recuperate and no significant drop would be observed until the two minute and three minute recovery phase.

However, a delayed decrease of heart rate has also been associated with increased risk of cardiovascular mortality (Dimkpa 2009). Cole et al (2000) study confirmed the results of previous studies that showed that a slow heart rate recovery after submaximal exercise was a powerful predictor of mortality in adults who had not been previously diagnosed with cardiovascular disease. The study demonstrated the prognostic importance of heart rate recovery in healthy persons undergoing submaximal, as opposed to symptom-limited, exercise testing such as the Borg test. Furthermore, the study was able to identify a correlation between abnormal heart rate recovery and participants who were less likely to exercise regularly. The study concludes by stating heart rate recovery may be a clinically relevant predictor of risk among patients undergoing screening exercise testing. The Op-Ft could provide a mechanism of identifying arrested heart-rate recovery post one minute and therefore assist the healthcare professional in screening for potential cardiovascular health risks.

An anomaly not consistent with expected outcomes occurred when the amount of walks participants completed was viewed together with the participant's heart rate recovery from the Op-Ft step test. The numbers appeared to indicate that older people who walked for a shorter duration showed greater fitness gains. Older people that walked 30 minutes showed a greater increase in recovery from T2 to T3 than those older people who walked for longer. This anomaly may be explained by the principle of training response discussed in maximum heart rate 8.1.3. Cardiorespiratory fitness of participants in the ThinkingFit (2014) study would have shown improvement if the dose of physical activity exceeded that to which the older person was already accustomed (National Academy of Sports Medicine 2012). This may explain why the more sedentary people may have shown greater initial fitness gains because their starting point was much lower, and as a consequence they responded more quickly to the new demands on them.

This possibility was considered in the study inclusion criteria when possible participant were excluded if they exceeded 20 minutes of exercise more than two/three days a week. The theory is that more active older people will already have more tolerance to exercise and therefore need higher levels of intensity within their exercise regime to show additional increases in their fitness level.

Healthcare professionals, who become involved in promoting fitness activities as a general primary prevention intervention, will need to evidence that their involvement is cost-effective (Mountain et al 2008; NICE 2008). By identifying older people that are at risk of dementia, could be an important aim in reducing demand on the health care services. Early treatment intervention and educating older people about healthy lifestyles may reduce the prevalence of some dementias (Dannhauser et al 2014; Baker et al 2010; Lautenschlager et al 2010; Elwood 2013; Eriksson et al 2012). Dementia will affect 76 million people worldwide by 2030 (The Alzheimer's Disease International report 'The Global Impact of Dementia' 2013). The potential cost of dementia on healthcare economies will be substantial (Marcell 2003). Therefore, activities that can help engage and motivate older people must be explored. An increasing physical activity may be one of the best preventative activities to reduce cognitive deterioration (Eriksson et al 2012; Baker et al 2010; Lautenschlager et al 2010; Elwood 2013) However, older people find it hard to engage in physical activity programmes because of fear of injury (Chodzko-Zajko 2009; Costello et al 2011; Forbes 2015a; Wilcox et al 2003) and lack of knowledge regarding the positive benefits of physical activity (Hui et al 2001, Dergance et al 2003). The Op-Ft may have some potential in increasing engagement of older people however only when in conjunction with a healthcare professional that can reinforce the positive aspects of physical activity. NICE guidelines (2008) recommend occupational therapists should ensure that exercise programmes reflect the preferences of older people and advise them and their carers of how to exercise safely. The cost effectiveness of the Op-Ft will be in its ability to be use as a tool for healthcare professionals in promoting fitness activities. However, the economic argument for more occupational therapists to promote physical activities will need to take into account all aspects and the impact of multiple lifestyle interventions to establish the true clinical cost effectiveness of promoting healthy ageing.

7.1.5. Resting Heart Rate –Maximum Heart Rate Correlation

RHR and MHR have both been used as indicators of increased cardiorespiratory fitness (Hsia et al 2009, Thayer et al 2007, Stafford-Brown et al 2010, Clark et al 2012). Therefore, a correlation between these two variables would indicate a consistency within the findings that would increase the reliability of the results. If a correlation did not exist between the two variables the postulation would be that the reliability of the results was inconsistent and therefore less reliable. The assumption is that as RHR decreases a reduction in MHR would also be observed at the end of the Op-Ft. The correlation between these two variables was performed to identify if there was a relationship between changes in a participant's RHR and changes in their MHR. Results identified a significant correlation between variables r=.733, p<.001. The findings showed that a change in one of these variables was associated with a change in the other. The results are consistent with what would be expected from older people who had improved their cardiorespiratory fitness. The corresponding change between these variables supports previous findings in this study.

7.1.6 Conclusion of discussion

Results from the participants' safety and attainability indicated Op-Ft had the potential to deliver a safe systematic assessment tool that was manageable and did not present unacceptable risks for the older person. The Op-Ft when combined with an understanding of an older person's goals, needs and abilities may also help to motivate older people as they engage in physical activities. The lack of motivation can be the best determiner between those older people who adhere to a fitness activity programme and those who withdrew. Individual feedback can increase engagement (Rikli and Jones 2013). The value of the Op-Ft test may not be in its ability to determine cardiorespiratory fitness against normative values but its ability to give individual feedback on an older person's progression. The Op-Ft may have helped with adherence to the ThinkingFit (2014) programme because it provided people with measurable repeated assessments, which in turn would have increased older people's motivation (National Academy of Sports Medicine 2012).

Physical activity assessments and fitness activity advice is not yet routine practice by occupational therapists for most primary care providers although there are mounting calls for them to become more involved (NICE 2008). If occupational therapists are to become more proactive in promoting health related fitness activities they will need to become more familiar with fitness activity programmes and the positive health benefits they can produce, they will also need convenient tools to help them. The Op-Ft is easy to administer, does not require expensive equipment or specialist skills and is not overly time-consuming. Since the Op-Ft was straightforward to use and easily transportable occupational therapists may also be more willing to employ it in the older person's home. Utilizing easy to use tests such as the Op-Ft could offer a potential opportunity for making a significant impact on patients' adherence and motivation to participate in fitness activities. The Op-Ft may also have the potential of establishing a baseline of the older person's cardiorespiratory fitness that could show improvement in their fitness and help to guide the appropriate intensity and duration of any fitness programme. This could ensure fitness capacity increases at an appropriate level, gradually increasing to keep the body adapting (Carnell et al 2009).

The results of this study suggested that older people who participated in the Op-Ft and undertook the ThinkingFit (2014) 12-week walking programme showed evidence of an increase in cardiorespiratory fitness. The results pertaining to the Op-Ft were able to reveal that variations in participants' cardiorespiratory fitness had occurred such as speedier recovery from the step test and a decreased maximum heart rate at the end of the repeated measures modified step test. The participants' RHR was lower after the 12-week walking programme. The MHR of participants at the end of the modified step test was lower after the 12-week walking programme and both RHR and MHR improved in accordance with expectations of both variables. Recovery heart rate results across the three time points (post 1-2-3 minutes) also showed a quicker drop in heart rate recovery after the participants had completed the 12-week walking programme. The results of the six quantitative data outcomes have all suggested that an improvement in cardiorespiratory fitness had occurred. However, these results should be viewed with some caution as not only is there no strong evidence that that the amount of walking participants achieved would have caused an improvement in cardiorespiratory fitness but also the Op-Ft was not measured against a validated cardiorespiratory assessment tool therefore it had no external validity.

Fitness activity programmes for older people will need to be based on the individual's capacity, which would require a baseline assessment of their current physical ability as well as their medical conditions and level of motivation. The Op-Ft may provide the solution to some of these questions. It has the potential to add to the dose response knowledge base by identifying current levels of fitness and monitor what may be required to improve health outcomes. National Academy of Sports Medicine (2012) describe how cardiorespiratory tests help in recognizing safe and effective starting exercise intensities as well as identifying the appropriate physical activity modality to improve cardiorespiratory fitness. The Op-Ft may provide a mechanism of screening possible health problems, such as elevated resting heart rate, and monitoring older people's progression through a walking programme. Op-Ft may also help the healthcare professional and non-healthcare professional to modify and adapt the fitness activity to the capacity and needs of the older person.

Chapter Eight – LIMITATIONS AND RECOMMENDATIONS

8.1.0 Limitations

The secondary aim of the Op-Ft study sought to develop and design a sub maximal step test that could identify variations in cardiorespiratory outcomes. Heart rate measures were chosen as a means of identifying these variations. The heart rate measures in this study did indicate that change had occurred in participants. However, these results should be viewed with some caution as not only is there no strong evidence that that amount of walking participants achieved would have caused a change in heart rate measures but also the Op-Ft was not measured against a validated cardiorespiratory assessment tool and therefore has no external validity. Further investigation would be needed to establish the external validity of the Op-Ft. This would require the Op-Ft results to be compared agenised a '*gold standard*' test such as maximal oxygen uptake test.

This study benefited from using a convenience group that may have confounded the results due to unidentified basis in selection. A limitation identified with this study was the age rage of the convenience cohort. NICE guidance report 2008 defines 'older people' as aged 65 years and over (NICE 2008). This research did not establish a defined age range and due to a non-discrimination ethos, that led to the inclusion of data from a participant whose age at 51 was notably younger than the mean age of 73.7. The data of this outlier could have been excluded from the analysis, which would have increased the internal validity.

The sample size of the cohort at 53 participants was too small to produce meaningful interpretations of the results across populations and limits generalisation. Gender, height and weight were not identified as possible confounds in this study so inter-reliability between participants could not be distinguished. No interpretation of the learning effect was considered in the methodology, which could limit the reliability of the data.

The study examined 53 older people who completed modified step test the Op-Ft. Although the study achieved its aims, some systematic bias may have arisen through the selection method that recruited participants from a convenience sample the ThinkingFit study. All participants in the Op-Ft study had a diagnosis of Mild Cognitive Impairment (amnestic and non-amnestic) that may have produce a confounding variable. It is not possible to be sure that older people with MCI would produce the same result as older people without MCI. One way to avoid this type of confound is to repeat the study on older people who do not have a diagnosis of MCI.

A further possible confound is the theory of learnt behaviour that suggests as people repeat tests they become more efficient at doing them. People learn to react differently based on the natural consequences of their previous actions. Therefore, participants may have become better at performing the Op-Ft and consequently used less effort, which would result in the heart rate not increasing as much during subsequent tests.

Unintentional bias may also be a factor in the results. In an attempt to inform participants of the purpose of the study and what would be required of them unintended bias may have been suggested. This was acknowledged in the study protocol, to limit any unintentional bias, participants were played a recording of the step instructions. However, the researchers expectations may have still influence the participants, causing the participants to respond as they think they are expected to respond. An example would be if the participant were more relaxed their heart rate would decrease. This unintentional bias could be diminished by the Op-Ft test being administered by an impartial tester.

Another limitation of this study was that it was not gender specific. Physiological differences between genders can occur such as men have greater lung capacity and can therefore sustain endurance activities for longer (National Academy of Sports Medicine (2012). Other cardiorespiratory fitness tests such as the Harvard Step Test and Queen's College step test have developed gender specific formula based on HRR post-exercise to predict VO_2max in recognition of these gender differences (Gladwell et al 2010; Stafford-Brown et al 2010; Mackenzie 2001). As the methodology chosen for the Op-Ft was and inter-subject repeated measure the variations between genders was not as significant as a methodology that used comparison groups. Any future study would need to contain the same gender distribution so an analysis of the result could identify any gender differences. Weight and height of participants could also be analysed for variations in results between participants. The sample size for this study was relatively small. As sample size increases, the margin of error decreases and validity increases. Sample size is an important factor when making inferences about populations (Bowling 2009). The relative small sample size of the Op-Ft, means that conclusions made can only be tentative and may not be generalised.

In conclusion, due to the limitations of this study it is not possible to conclusively evidence that the Op-Ft can identify variations in cardiorespiratory fitness and is a safe and appropriate assessment test for older people. However, what this study has indicated is that there are relevant issues within this research that are worthy of further investigation, not only for older people but for the health care professionals and fitness industry.

8.1.1 Recommendations

As the older population is set to increase in the UK because people are living for longer (Ball 2007; Age UK 2015, Public Health England 2015), it is becoming increasingly important to encourage older people to maintain active lifestyles (Orrell and Wenborn 2014; Dannhauser et al 2014; Mountain et al 2008; Atwal & Mcintyre 2013). Considering the current financial climate in health and social care, fitness activities that have demonstrated effectiveness in reducing ill-health and maintaining good health (Forbes 2015b; Swedish National Institute of Public health 2010; Brunkner & Khan's 2009; Herholz & Zatorre 2012; Cochrane 2008; Rowe & Kahn 1997; Schroll 2003; Crombie et al 2004 Herholz & Zatorre 2012; Angevaren et al 2008; Schroll 2003, Crombie et al 2004; Mernitz & McDermott, 2004). Physical activity should be promoted, in an attempt to reduce the huge demands placed on health and social care budgets (Cochrane 2008; Marcell 2003). The investment in prevention is an economical argument for reducing future health and social care costs and improving the quality and productivity of life for older people (Windle et al 2008).

The primary aim of this study was to investigate the feasibility of designing a sub-maximal fitness test for older people that can be used without causing undue discomfort to the participant, is appropriate in multi-settings and does not require expensive equipment. The initial finding would suggest the Op-Ft was manageable for older people and did not cause undue soreness to joints and muscles. However, no qualitative data was collected regarding how participants felt about the test. Further testing of the Op-Ft regarding the participants' thoughts, perceptions and experiences could be gathered which may help identify why the attrition rate for non-completion was so low.

The Op-Ft may have potential to provide primary healthcare practitioners with a tool that can assess older people's cardiorespiratory fitness. However, further research is needed to determine the efficiency, effectiveness of the

Op-Ft to assess cardiorespiratory fitness. The Op-Ft's secondary aim is to evaluate the sub-maximal test to identify if it can distinguish change in participants' cardiorespiratory capacity.

This study recognised the significant role occupational therapists can play in promoting wellbeing physical activity in older people living in the community. One area of lifestyle occupations that is of interest to occupational therapists is physically active leisure pursuits because of the potential they may have in maintaining older people's health (Ball et al 200&; Mountain et al 2008). This potential role for occupational therapists has already been identified (NICE 2008; Hynes et al 2008; Mountain et al 2008; Wensley & Slade). However, further occupational therapy research such as '*Lifestyle Matters*' Sprange and Mountain et al (2013) and '*Valuing Active Life in Dementia*' (VALID) (Orrell and Wenborn 20140) is needed to determine the long term sustainability and cost effectiveness of wellbeing physical activity programmes.

The profession of occupational therapy may be well placed to do this since they are highly trusted by the general public and often work with older people who might be thought of as being 'hard to reach' regarding engaging in health related activities (Jewell, et al 2006; Karp et al 2006; Balde et al 2003; Yardley et al 2005).

Although it was not in the scope of this study to analyse this phenomenon, in further studies a correlation could be performed between the number of walks participants completed and the speed of HRR. This data would help in establishing a dose response for older people and health professional that wish to identify an appropriate amount of physical activity to improve overall health for sedentary older people.

In addition, research on exercise and a dose response specific for older populations is needed to identify the amount of fitness activity required to elicit better health outcomes. Further research using Op-Ft would help to increase the body of knowledge regarding what is required to maintain older people's health and what is required to increase their quality of life. The cost of healthcare for older people is set to increase considerably as people live for longer and they need to access health services because of the health concerns associated with older age. Literature suggests that prescribing fitness activities for older people will enhance their quality of life and reduce the cost to the public sector because they will require less health and social care. Having an assessment tool that can help deliver this target would appear to be a creditable objective.

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Appendix

Appendix A

National Research Ethics Service
Essex 1 Research Ethics Committee, Favourable ethical opinion.
REC reference number: 09/H0301/64
October 2009

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NHS

National Research Ethics Service

Essex 1 Research Ethics Committee

CM20 1XA

12 October 2009

Dr B Mougey
The Mental Health Unit
St Margaret's Hospital
The Plain, Epping
CM16 6TN

Dear Dr Mougey

Study Title:	**Piloting a complex intervention involving physical exercise, cognitive training and socialising to delay the onset of dementia in mild cognitive impairment.**
REC reference number:	**09/H0301/64**
Protocol number:	**1**

Thank you for your letter of 05 October 2009, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Ethical review of research sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

The Committee has not yet been notified of the outcome of any site-specific assessment (SSA) for the non-NHS research site(s) taking part in this study. The favourable opinion does not therefore apply to any non-NHS site at present. I will write to you again as soon as one Research Ethics Committee has notified the outcome of a SSA. In the meantime no study procedures should be initiated at non-NHS sites.

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

This Research Ethics Committee is an advisory committee to East of England Strategic Health Authority
The National Research Ethics Service (NRES) represents the NRES Directorate within
the National Patient Safety Agency and Research Ethics Committees in England

Essex County Council

North Essex Mental Health Partnership NHS Trust

Appendix B

Martin Cleverley

Clinical Research Fellow & Principal Investigator,
ThinkingFit Study,
North Essex Partnership NHS Trust,
Room 9, Lea suit, Derwent Centre,
Princess Alexandra Hospital,
Harlow,
Essex,
CM20 1OX

The Chairman Essex 1 REC
Essex 1 Research Ethics Committee,
Victoria House
Capital Park
Fulbourn
Cambridge
CB21 5XB

14/11/2011

Dear Dr Lamont,

Re Study title: Piloting a complex intervention involving physical exercise, cognitive training and socialising to delay the onset of dementia in mild cognitive impairment.

REC reference number: 09/H0301/64

Documents attached: 1. Protocol, version 1.1 February 2010
2. Participant Information Sheet, version 2 October 2009

In the original approval for this study, we included an MSc for Dr B Mougey, and this has now been completed. I would now like to initiate a further MSc project on the data that we have collected. I will be undertaking the MSc at the University of Essex, under the supervision of Dr P. Martin and Dr T Dannhauser. It would not involve any additional methods and I do not think it requires an amendment to the existing approval; however, I thought it courteous to inform you of our intention.

For this MSc project I would like to analyse data collected on the step test to investigate the validity of the modification for older adults. The fitness measures are described on page 11 version 1.1 February 2010 ThinkingFit protocol (see attached document).

I hope this meets with your approval, and if there is any further information you require then please do not hesitate to contact me.

Yours sincerely

Martin Cleverley
Clinical Research Fellow & Principal Investigator,
ThinkingFit Study,
North Essex Partnership NHS Trust,
Room 9, Lea suit, Derwent Centre,
Princess Alexandra Hospital,
Harlow,
Essex,
CM20 1OX

Telephone: 01279 444455/Ext 2831/**Mobile** 07554334728/email: thinkingfit@btconnect.com

Essex County Council

North Essex NHS
Mental Health Partnership
NHS Trust

Appendix C
Headquarters **Trust**

Stapleford House
103 Stapleford Close
Chelmsford-Essex-CM2 0QX
Telephone: 01245 546400
Facsimile: 01245 546401
www.nemhpt.nhs.uk

Ref MF/CE/L09096

17th November 2009

Martin Cleverley
Research Fellow for the ThinkingFit Project
C/O Ruth Collins
Medical Secretary / PA
Dr T Dannhouser
Taymar Suite
Derwent Centre
Harlow
CM21 QX

Dear Martin

R&D "ThinkingFit Study"

Thank you for submitting for Trust approval the study protocol "Piloting a complex intervention involving physical exercise, cognitive training and socialising to delay the onset of dementia in mild cognitive impairment", in short the "ThinkingFit Study".

You have received approval by the Research Ethics Committee, and I am pleased to confirm approval in the name of the Trust for research on the basis described in the submitted protocol.

Any data collected in course of the study must be stored securely ans in accordance with the data Protection Act. Research assistance or support staff who are not employees of the North Essex Partnership Foundation NHS Trust need a letter of access or honorary contract. The inclusion criteria state that all subjects will be able to give informed consent so the arrangements for capacity assessments under the Mental Capacity Act are not necessary.

Could you please forward to me the IRAS on line application form and the REC approved patient information sheet and consent form? Could you please also confirm the name of the principal investigator. Could you also forward the approval letter by Essex County Council with the detailed funding plan and project plan with anticipated start and end date.

I wish you all the best with the progress of study.

Yours sincerely

Dr Malte Flechtner
Medical Director

Appendixes D

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

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 (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME ______________________________

SIGNATURE ______________________________ DATE ______________________________

SIGNATURE OF PARENT ______________________________ WITNESS ______________________________
or GUARDIAN (for participants under the age of majority)

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

continued on other side...

Screening Number					Study ID Number					Participant initials		
0	0											

Screening

Screening date: ...../........./......... Screener ID: ....

Appropriate for study: **No**: Why? ....
Yes: Diag: **AMCI / AMCI+ / NonAMCI / NonAMCI+**

If Yes, allocate Study number:

Participant's initials

Telephone contact /date: ..../......../..........Time: ......h..........Tel nr:................................

Interested **Yes / No / Unsure,** wants info

Patient information sheet sent **Yes /No**

Telephone Contact

Wants to discuss study further/consent **Yes/No**

If Yes, Home visit arranged : Date ....../......./.........Time: ......h.........

Name of researcher who will visit: ....

Home visit information **entered on research calendar** **Yes/No**

Home visit

Exclusion criteria

Type 1 insulin dependent **diabetes** **Yes/No**

Blood pressure Systolic > 160mmHg or Diastolic > 100 mmHg **Yes/No**

if BP elevated repeat after 15 minutes of rest

Body Weight > 140% of ideal: Ideal Weight (from table) :_____kg; Current weight _____Kg. Percentage:_______ Overweight? **Yes/No**

Patient on **Beta-blocker medication** (see list on the back) **Yes/No**

if Yes then indicate on Fitness monitoring form

Resting heart rate > 100bpm **Yes/No**

PAR-Q completed and fit for increased activities **Yes/No**

If No, has PARMed-X been completed? **Yes/No**

Informed consent signed: **Yes/No**

GP letter sent with/without PARMed-X **Yes/No**

Start date given: ..../............/.........

Essex County Council

North Essex Mental Health Partnership NHS Trust

Version 1 August 2009

Participant Information Sheet

Title of Research Study: **ThinkingFit - Combining physical, cognitive and social treatment in Mild Cognitive Impairment.**

Thank you for your interest in this research study in which we are inviting you to take part in. This sheet provides more information about the study. It is important that you understand why the research is being done and what it will involve when you make your decision. We suggest you read this carefully and discuss it with others if you wish. We will explain anything that is not clear. Please take your time to decide and keep in mind that your participation is voluntary. You are free to withdraw at any time without giving a reason.

Who are we?

We are researchers working with people with memory and related problems at Princess Alexandra Hospital, Harlow. The main specialists involved in the study are Dr Thomas Dannhauser, Dr Zuzana Walker and Mr Martin Cleverley.

What is the purpose of the study?

We want to see if we can involve people with memory or related problems in activities that may reduce their risk of further deterioration and dementia. Dementia is a progressive brain problem which impairs the ability of sufferers to maintain their lifestyle, relationships, independence and it shortens life. People diagnosed with ***Mild Cognitive Impairment*** (MCI) have existing memory or related problems. They have a high risk of developing dementia and studies show that 8 out of 10 diagnosed with MCI will have progressed to dementia after 6 years. Research studies have shown that healthy people who regularly take part in physical and mental activities are less likely to develop dementia. However, most adults are not active enough to reduce their risk of dementia. We want to see if we can get people with MCI involved in a program that combines physical, mental and social activities that may reduce their risk of developing dementia. These activities will be guided by trained instructors and tailored to each person's own needs. We also plan to measure blood flow in the brain to see how it is affected by the activities.

Who would we like to investigate?

We would like to investigate individuals who have been given a diagnosis of ***Mild Cognitive Impairment*** which means they have memory difficulties and/or problems with their thinking.

What will happen to me if I take part?

If you agree to take part we will meet you in person to get your permission in writing. We will then look at your existing activity levels and decide if it is safe for you to take part. For this you will be asked to do a 3-minute step-test, similar to climbing easy stairs, to measure your current fitness level. You will then answer a series of questions to measure your current well-being and also do a test on a computer to assess your current thinking abilities. During the computer tests we will measure brain blood flow using a special monitor that uses ordinary light and which requires no special preparation. For this you will be asked to wear a tight fitting cap on your head for about 5 minutes. All the tests will take 1.5 hours. These tests may indicate that some people may not be able to take part any further or may require some medical treatment before the can proceed. We will arrange any necessary treatment for you.

If you can take part in our study you will be asked to complete the 14-week ***ThinkingFit*** program of activities. You may have to wait before starting as places are limited. During this time we will ask you to do something different from your normal routine. You can pick activities from a list of possibilities and they can take as long as you wish. This will help get you ready for the 14 week ***ThinkingFit*** program. The program will be designed to specifically suit your needs and will include physical, mental and social activities. During the first two weeks you will have a weekly two hour-long session. During these you will meet 7 other people who will take part with you as well as the researchers who will help you during the study. You will be shown how to use the equipment and we will explain the activities in more detail.

The physical activities will involve walking 3 times a week, from home, for up to 30 minutes. You will be shown how fast to walk or be given an electronic device which will tell you how fast to walk. Qualified fitness instructors will visit and call you regularly to look at your progress, provide support and adapt your program to maximise your physical well-being.

You will be asked to complete a weekly brain training activity lasting 1.5 hours. This will involve playing games and puzzles on a computer. The games are designed to be fun and to improve your abilities. You do not need to have worked with computers before and all the help you require will be provided by trained staff. You will be allocated to one of two groups based on your circumstances.

The ***Centre-group*** participants will train on computers provided by the Adult Community Learning (ACL) service for Essex at a centre close to them.

The Online-group participants will train at home using a computer and internet facility provided by us. Through using the computer they will communicate with other people and be able to both see and hear them whilst also being seen and heard at the same time, this is called *teleconferencing*. The research team will be able to help them with the brain activities by using *teleconferencing.* We will provide all the computer equipment for as long as they take part, at no cost to them, however they need to have a home telephone from British Telecom (BT).

Social activities will take place on a weekly basis with the assistance of trained staff. Centre-group participants will meet at their local ACL centre. The meetings are designed to be enjoyed and will last up to 2.5 hours. It will involve group discussion, participation in a variety of new leisure activities and will finish with a gentle relaxation session. Online-group participants will have similar sessions where they interact socially with other group members and staff via *teleconferencing*.

The activities have been developed to promote brain training, physical health and social activity in your community. The social sessions will give you the opportunity to try new activities which we hope will be fun and enjoyable.

At the end of the 14 weeks we will repeat the tests we did at the beginning to see how well people did on the program. We will collect all the equipment from your home after your participation for further use in the study. The equipment remains the property of the ***ThinkingFit*** project but we can assist people who would like to get their own equipment after the study.

Do I need to prepare for the tests and activities?

There is no specific preparation required by you for the tests however we advise that you have a good nights sleep and wear comfortable clothes and shoes.

What if I am taking tablets or other drugs? Should I stop these before the scan?

There is no requirement for you to change your medication regime. You should not stop taking any of your medication without discussing it with a doctor first.

What if I have a problem with getting there?

If necessary, we can help you to arrange transport and cover the cost.

Will my taking part in this study be kept confidential?

Yes, all information collected about you will be kept strictly confidential. Data collected during your participation in this research project will be stored electronically on a research database. All such data will have the names removed so that you will not be able to be identified on the database. All data so stored will comply with the provisions of the Data Protection Act and will only be accessible via written permission of the principal investigator of this study. We plan to publish the results of the study locally and internationally but no personal details will be included. A summary of the main findings will be made available to all those who took part when it has been published. Your GP will be informed of your participation in the study.

Do I have to take part?

No, your participation is voluntary. Even if you decide to take part you may change your mind later at any time and withdraw without giving a reason. The study is completely separate from your clinical care, so your treatment will be the same whether or not you choose to take part.

What are the benefits of participating?

We cannot guarantee that the study will be of any direct benefit to you. You may however experience improved health and general wellbeing if you continue with the activities as this has been shown in other studies. Your participation will be of help to us to design future studies to reduce the risk of dementia. The total cost of your participation (£4,000) will be provided at no cost to you through sponsorship from Essex County Council, The North Essex Partnership NHS Foundation Trust and University College London.

What are the possible disadvantages and demands of taking part?

You should be aware that there is a possibility that the tests involved in the study may produce an unexpected result that is relevant to your health. In the unlikely event of this happening, we will discuss this with you and, if necessary, provide any support that you may require, as well as informing your GP. Taking part will require up to 6 hours a week of your time. You may experience some aches and pains due to increased physical activities, however this is normal. Anyone who increases their physical activities are at a greater risk of falling however, we plan to reduce this risk by showing you how to safely do the physical activities, by making sure you have the correct clothing, and by closely monitoring your progress.

What if something goes wrong?

If you have any concerns about your participation or any aspect of the program then we advise you get in contact with us on the numbers provided at the end of this information sheet. If you have any concerns about how you have been approached or treated during the course of this study and wish to complain, you should contact the National Health Service complaints service. On 01245318440 and 01245318433.

Who has approved this study?

The Essex 1 Research Ethics Committee has approved the proposal for this study.

Who do I contact if I want to take part in the study or need further information?

One of the research team will contact you by telephone within the next week to find out if you wish to take part in the study. Alternatively, you can contact the team on 01279 827260 with your decision or to find out further information.

Thank you for your help.

Mr Martin Cleverley, Dr Thomas Dannhauser and Dr Zuzana Walker.

Our telephone number: 01279 827260 or 0707554334728

Essex County Council

North Essex **NHS**
Mental Health Partnership
NHS Trust

CONSENT FORM VERSION 2 OCTOBER 2009

Title of Research: Combining supervised physical, cognitive and social activities in mild cognitive impairment. A feasibility study.

Researchers**: Dr Thomas Dannhauser, Martin Cleverley and Dr Zuzana Walker**

To be completed by participant: **please confirm your answer below by initialling** Yes **or** No **in the applicable box's:**

I confirm that I have read and understand the *Information sheet* ***Version 2. October 2009*** **about this study.**	**Y**
I have had the opportunity to ask questions and discuss the study.	
I have received satisfactory answers to all my questions.	**Y**
I understand what participation in the study will require from me.	**Y**

Which doctor/research workers have you spoken to about this study?

Name Martin Cleverley……………………………

I understand that I am free to withdraw from this study:

1. at any time	**Y**
2. without giving any reason	**Y**
3. without it affecting my medical care or legal rights	**Y**

I understand that my general practitioner (GP) will be informed of my participation in the above study.

I agree to take part in the above study. **Y**

This consent form will be retained by the participant and a second copy will be kept on your medical notes.

Name of the participant (block capitals):………………………………..

Signature of Participant: Electronically submitted hard copy signed Date: 5/3/2010

Signature of Researcher: Electronically submitted hard copy signed Date: 5/3/2010

Essex County Council

North Essex NHS
Mental Health Partnership
NHS Trust

GP Information letter Version 1 August 2009

Closed and Confidential Dr	**The '*Thinkingfit*' office** **Room 9, Lea suite** **Derwent Centre** **Princess Alexandra Hospital** **Hamstel Road,** **Harlow,** **Essex.** **MC20 7QX** **Tele: 01279 444455 Ext 2831**

Date:

Dear Dr

RE:

The above-named patient has agreed to be involved in the following research project:

A pilot study to develop a complex intervention involving combined physical, cognitive and social training to delay the onset of dementia in mild cognitive impairment.

Mild cognitive impairment (MCI) is the most prevalent high risk state for the development of dementia. It has been estimated that 80% of patients presenting with MCI will develop some form of dementia within six years of diagnoses. Multimodal intervention programmes which include physical exercise, cognitive training and which promote social and psychological well-being is thought to be the most likely to reduce the need for care and delay conversion in those at risk. Studies have reported improvements in physical status, functional abilities, mood and engagement in physical activity following multimodal multi-sensory interventions.

Based on the available findings and indicated beneficial effects, the study primary aim is to pilot treatment affects of a multimodal intervention programme in MCI. We planned to design, develop and assess cognitive, physical fitness and social interventions suitable for group and individual participation. Participation within this study will involve attending a cognitive/social group once a week for 90 minutes for 12 weeks where they will be given individual and group tasks to stimulate cognitive function and social engagement.

Participants will be expected to participate in a moderate exercise programme requiring 20 minutes of moderate intensity (65-77% of peak treadmill heart rate) three times a week for 12 weeks. Participants with modifiable exclusion criteria will be reconsidered after successful management and/or activity modification. Participants will also be invited to participate in a cognitive training programme accessed through computer technology. This will require the participant to engage in 12 cognitive training sessions lasting no more than 60 minutes.

This study will take place over two years and it is expected that 128 patients will contribute and benefit from the research. All participants will be screened prior their engagement within the research, this will include the completion of a PAR-Q form (Physical Activity Readiness Questionnaire). For a minority of participants this screening tool may indicate further investigation regarding the participants physical fitness, therefore you may be asked to supply further information concerning your patient if this occurs.

If you would like to receive a copy of the study protocol or any other information about the study, please do not hesitate to contact us using the phone number or address above.

Yours sincerely

Martin Cleverley

Clinical Research Fellow for the *ThinkingFit'* project.

Dr T Dannhauser,

Consultant in Psychiatry of the Elderly

Screening Number					Study ID Number					Participant initials		
0	0											

Contact. Box 1 to be complete for every contact.

Reasons for contact	**DSD program** **Exercise program** **IT program** **social program**	**Telephone** **In person** Teleconferencing
Greeting and Response:	**Response given from client:**	**Advice given:**
Positive: Negative:		

Walking Session Box 2 to be completed when client participation in walking session

Are you ready to do your exercise today?	**Have you all the equipment you need?**	**Advice**
	Reflective Arm Bands Trainers/clothing Door key Heart Rate Logger Heart Rate Monitor - Check it is working - Check settings - Check strap location	
Logger data collected	Date:	

Contact IT session. Box 3 to be completed on completion of IT session.

How was your session?	**Response given from client**	**Advice given**
Positive:		
Negative:		

Date: **Form completed by:**

Time date

Contact social activity. Box 4 to be completed on completion of social activity session.

How was your session?	Response given from client	Advice given
Activity:......................... Positive: ☐		
Negative: ☐		

Box to be completed if client dose not want to participate in the agreed activity

Reasons for not participating in exercise.	Explanation	Advice / Positive Encouragement
Physical ill health		
Low motivation		
Environmental		
Did not remember		
Other		

Additional information such as if the participant experienced any problems?

Arrange next contact with participant:
time:..................Date:...................................
From completed by:...

Executive Schedule for Physical Activity

Initial contact:

Orientation day

First home visit to be arranged with participant, this visit may not require the presents of the research fellow, because the participant and the instructor have already met.

Joint home Visit

Telephone contact to be confirm for next walking session

Second contact (supervised visits) will be arranged by the instructor with the participant.

Telephone Contact:

First telephone contact on the participants first unsupervised walk.
(telephone contact form to be completed by instructor)

Second telephone contact on the participants third unsupervised walk
(telephone contact form to be completed by instructor)

Home Visit:

Second home visit on or around session 5
(activity contact form to be completed by instructor)

Telephone Contact:

Third telephone contact on session seven
(telephone contact form to be competes by instructor)

Forth telephone contact on session nine
(telephone contact form to be completed by instructor)

Home Visit:

Third home visit on or around session eleven
(activity contact form to be completed by instructor)

Telephone Contact:

Firth telephone contact on session fourteen
(telephone contact form to be completed by instructor)

Sixth telephone contact on session seventeen
(telephone contact form to be completed by instructor)

Home Visit:

Forth home visit on or around session twenty
(activity contact form to be completed by instructor)

Telephone Contact:

Seventh telephone contact on session twenty-three
(telephone contact form to be completed by instructor)

eighth telephone contact on session twenty-sixth
(telephone contact form to be completed by instructor)

Home Visit:

Firth home visit on or around session twenty-nine
(activity contact form to be completed by instructor)

Last Telephone Contact:

Ninth telephone contact on session thirty-two
(telephone contact form to be completed by instructor)

Last Home Visit:

last home visit on session thirty-six
(activity contact form completed and all data on participant handed over to the research fellow)

Time allocated to the instructors to complete this program is 12 hours 6 hours of face to face contact and 6 hour for telephone contact and travelling to and from participates homes.

For full details of this program please refer to the standard operating procedure for physical activity programs.

The start date will be next baseline assessment week, the participant DI should then be entered onto the research calendar. If the participant cannot make the orientation sessions a home assessment may need to be arranged.

Screening and Consent:

All the information must be recorded in each section before the next section can be initiated. Failure to do so will result in delays and possible inadequate data.

Section 1

Screening date to be entered in the sector provided: day, month and year.

The person undertaking the screening (the screener) will need to be clearly identified in the screener's ID section.

Outcome of screening: circle the appropriate result.

Positive result: allocate a study number with the subject's initials in the boxes provided.

Date and time the subject is contacted by telephone. Details of date and time must be entered onto the research database and calendar.

Outcome of telephone contact: circle the appropriate result.

Has the subject been supplied with a patient information sheet? Circle the appropriate result.

Section 2 Home visit

Home visits must adhere to the lone working policy and procedure of the North Essex Partnership NHS Foundation Trust and/or Essex County Council guidelines.

Date of home visit must be entered in the sector provided: day, month and year. This date must also be entered on the research database and calendar.

Section 3 Outcome of home visit

Outcome of home visit: tick the appropriate box.
If the outcome was positive the subject will need to sign the informed consent form and the PAR-Q: it is the responsibility the person undertaking the home visit to check if the PAR-Q form has been fully completed and returned to the cohort information file. However, if the participant has answered YES to one or more questions on the PAR-Q the Physical Activity Readiness Medical Examination (PARmed-X) is to be sent to the participant's GP.

Tick the appropriate box. Both consent forms will need to be kept by the research team and copy supplied to the patient's notes. Letter to be sent to GP informing them that their patient wishes to participate in the research: tick and date when this has been completed. Allocate a start date for participant: record this date on the research database and research calendar

Op-FT assessment form

Op-FT assessment from	Screening Number					Study ID Number					Participant initials		
	0	**0**											

Baseline data T1 T2 T3

Date of assessment ……/……/………	Staff ID:………………………..	
DOB: …………/…………../…………….	Male:	Female:
Assessment	Gym:	Home:

Fitness Test: PAR-Q completed and inspection:

HT/CM	KG	Percentage % of body fat

Blood Pressure /	Resting Pulse

Step test completed	Yes	No

During the step test the participant should be continually monitored for any signs of distress. *If the participant exceeds the maximal heart rate (77%) the test should be stopped immediately* *The participant should be seated at the end of the step test and heart rate collected every minute.* *Please refer to the research protocol if unsure.*	Max Heart Rate during the test	
	Heart Rate at the end of the test	
	Heart Rate after one minute	
	Heart Rate after Two minutes	
	Heart Rate after Three minutes	

Comments:

Appendix H (Step advice)

Posture. *Participants were advised to keep their head up, shoulders down and back straight, chest up and out, abdominals lightly contracted, tail bone (Coccyx) gently tucked under the hips. They were advised not to hyperextend the knees or the back at any time. When stepping they were informed to, lean from the ankles and not the waist to avoid excessive stress on the lumbar spine.*
Stepping up. *Participants were advised to make full contact with the sole of the foot onto the step, they were asked to step up softly on to the platform to avoid unnecessary impact and informed to watch the platform periodically to ensure correct foot placement.*
Stepping Down. *Participants were advised to step close to the platform (no more than 8 inches away) and allow the heels to contact the floor to help absorb shock*
Propulsion. *Participants were advised not to perform propulsion steps (in which both feet are off the floor or platform at the same time).*
Arms *Participants were advised to keep their arms relaxed and let them swing in a natural movement. They were advised to avoid using their arms at or above shoulder level, as this places significant stress on the shoulder girdle.*
Tempo *The tempo for the Op-Ft was 10 steps per minute timed via a four-beat sequence. If the participant could not manage this tempo or the correct techniques and safety were compromised the researcher stopped the test and it was recorded as incomplete.*

Date	Impact of Research
2010	ERBOAT presentation: '*How Occupational Therapists can play a role in research*'
2011	OT Regional New Letter: '*The impotence of OT research*' ThinkingFit.
2012	ECC: Task and Finishing Group (TFG) presentation, subsequent report highlighted the need for activity well-being groups to be supported in Essex.
2012	Initial Findings presented in Vancouver Alzheimer's Association AAIC 2012
2014	ThinkingFit findings, promoted, Essex wide during EEC campaign about dementia awareness.
2014	NIHR application, proposed 5 year RCT funding for wider study
2014	Research article published: BMC psychiatry '*A complex multi-model activity intervention to reduce the risk of dementia in Moll cognitive impairment-ThinkingFit: pilot and feasibility study for a randomized controlled trial'*.
2014	Invitation to India (Bangalore), where the study protocol was adopted by the Nightingale Medical Trust. Two centers have now adopted the study protocols
2015	Feature article in OT news, '*The important role OT's can play in research*' April 2015.

Recommendations: removed to Appendices.

- With the current pressures on health services, activities that have been shown to prevent ill health and maintain good health must be promoted. Health professionals need to become more proactive in endorsing physical activities as part of a general primary prevention programme. The Op-Ft could enable more health professional to achieve this goal.

- Further studies will be required to validate the present study findings. The Op-Ft should be validated against another established method of assessing cardiorespiratory capacity. Correlating results from Op-Ft against recognised and more established cardiorespiratory fitness tests would help to validate the initial results of this study.

- The Op-Ft has the potential to contribute to the knowledge base regarding developing a dose response for older people and therefore further exploration is required to correlate Op-Ft results with health outcomes.

- A cardiorespiratory fitness assessment tool such as Op-Ft has the potential to guide healthcare professionals in establishing appropriate and safe levels of physical activity for older people. Continued investigation to identify if Op-Ft can identify risk factors and provide additional motivation for older people to engage in fitness activities need to be explored.