# Modelling Mobility Disability in Musculoskeletal Disorders: a Theory-Driven Evaluation of Self-Management and Disability Frameworks in Chronic Disease

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## Author's Declaration

This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.



Signed:
Date:

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**Abstract**

**Background:** Chronic disease is associated with aging and the average age of many Western populations is steadily increasing. The International Classification of Functioning, Disability, and Health (ICF) defines disability as behaviour, allowing for the application of behavioural models to the study of disability as well as interventions to affect behaviour change. Results of behavioural inerventions in chronic disease often produce heterogenous results and therefore, N-of-1 designs may be a useful way of testing such interventions in patients with chronic illness. Existing behavioural models must be tested on an individual level to allow for their application to intervention development on an individual level. The present thesis aimed to address these issues. **Methods:** Two studies were conducted. First, a systematic review and meta-analysis of self-management interventions for rheumatoid and osteoarthritis was carried out. Based on the findings that results from the reviewed group studies were heterogenous and that goal-setting and action planning were the most commonly applied self-management intervention techniques, the first study was a randomised, controlled series of N-of-1s testing the effect of a simple goal-setting and action planning intervention on physical activity (PA) within and between healthy individuals and those with chronic pain. The second study was a series of four N-of-1 trials testing a combined ICF/cognitions and a combined ICF/emotions model of disability in participants with arthritis. **Results:** Interventions employing self-management techniques positively affect outcomes in rheumatoid and osteoarthritis, but guidelines regarding core outcomes and measures are required along with clearer reporting of intervention content, potentially with the aid of taxonomies. A randomised, controlled series of N-of-1s was found to be a feasible method of testing a simple behavioural intervention. Goal-setting and action planning did not affect PA in healthy or chronic pain participants overall, but results varied between individuals. Longitudinal N-of-1s identified cognitions as the most effective predictors of PA behaviour in people with arthritis. Both combined models were feasibly and affectively applied at the individual level and were better at predicting behaviour than ICF constructs alone. **Discussion:** The findings of the present thesis have important implications for reporting methods and intervention design in health psychology and personalised behavioural medicine.

## Executive Summary

**Chapter 1:** Age-related musculoskeletal disease is now the most common cause of disability in the United Kingdom. Disease-related variables often do not predict mental or physical health related outcomes, but cognitive behavioural variables do. Self-management (SM) interventions have been developed to increase disease management skills on an individual level.

**Chapter 2:** The first part of this thesis is a systematic review and meta-analysis of SM interventions evaluating their effects on pain, disability, and mental health outcomes. Of 4,659 unique articles, 80 fit inclusion criteria (i.e. randomised controlled trial, adults aged 18 years or older with rheumatoid or osteoarthritis, include one or more SM intervention components, published in English) and were reviewed. Of the 80 studies reviewed, 59 were included in the meta-analysis. Results suggest that, while overall study quality was good, none defined an SM intervention and less than half (41.3%) used a theory-driven approach to intervention design. Studies included a wide range of outcomes and measures, with 31 different measures assessing pain, 95 different measures assessing disability, and 38 different measures assessing mental health across studies. Results of meta-analyses showed small, but significant positive effects on pain, disability, and mental health at posttreatment and up to six months follow-up, with effect on disability remaining beyond six months follow-up (up to 21 months after posttreatment).

**Chapter 3:** The second part of this thesis is a randomised controlled series of N-of-1 studies evaluating the utility of an N-of-1 design to test a goal-setting and action planning intervention on physical activity (PA) in healthy participants and participants with chronic pain. Thirty-five participants were recruited from the community and 13 were lost to withdrawal from the study, equipment malfunction, or misuse of equipment. This left 10 joint pain participants and 12 healthy participants. Participants were asked to wear an activity monitor daily for 60 days. Participants were individually randomised to complete the control (i.e. making a diet-related goal for the day) or the treatment condition (i.e. making an activity-related goal for the day) each day. They were also individually randomised to either report pain levels or not to report pain levels each day. Each morning, participants

received a text message directing them to either make a diet goal or to make an activity goal, depending on daily allocation. On pain report days, participants also received a text message asking for a numerical response indicating their current pain level once in the morning and in the evening. Data were analysed individually using autoregressive integrated moving average (ARIMA) models and between groups (i.e. chronic pain group, healthy group) using mixed analysis of variance (ANOVA). A positive effect of the intervention on PA was found in only one (healthy group) participant. Effects of reporting pain were found in five participants, four of whom engaged in less activity on pain report days and one of whom who engaged in more activity on pain report days. Effects of time were found in 12 participants, with two increasing PA over time and 10 decreasing PA over time.

**Chapter 4:** This thesis concludes with a series of longitudinal N-of-1s testing the utility of an integrated impairment / cognitions model and an integrated impairment / emotions model of disability behaviour in participants with rheumatoid or osteoarthritis. Six participants were recruited from the community. One withdrew from the study and one experienced an equipment malfunction that resulted in lost data, leaving four participants for the purposes of analyses. Participants were asked to wear an activity monitor daily for 60 days. They were also asked to complete a short questionnaire online each morning and each evening, measuring impairment, cognitions, emotions, and participation in social activities. Results showed that impairment, cognitions, and emotions did not predict objectively measured activity and activity did not predict participation behaviour. Impairment was a weak predictor of participation, while both cognitions and emotions were stronger predictors. Cognitions explained a greater amount of variance in participation than emotions did.

**Chapter 5:** The findings of this thesis suggest that SM interventions have small, but significant positive effects on pain, disability, and mental health. Personalising these interventions would require more research testing effects of SM components on an individual level using a theory-driven approach to intervention design. N-of-1 designs are efficacious in both intervention and model testing. Models of disability should include psychological factors known to affect behaviour using existing models to enable the identification of effect mechanisms and aid intervention design.

# Chapter 1: Introduction

## 1.1 Epidemiology of Arthritis

One in every 5 adults in the United Kingdom (UK) are affected by arthritis (McCormick, Fleming, and Charlton, 1995). It is the most common chronic disease (Office for National Statistics, 2011) and cause of disability (Arthritis Research UK, 2008) in both the UK and the United States (US; Centers for Disease Control and Protection, 2009). Of those between the ages of 18 and 44, approximately 8% suffer from arthritis (Centers for Disease Control and Prevention, 2010). However, this number increases to 30% between the ages of 45 and 64, and to 50% from the age of 65 years or more (Centers for Disease Control and Prevention, 2010). In 2011, the total cost of arthritis to the NHS was £5 billion (Arthritis Research UK, 2013), while the disease cost the US $128 billion the following year (Centers for Disease Control and Prevention, 2007). For patients, arthritis can be debilitating. Of those with osteoarthritis, 71% experience constant pain and 13% find the pain to be unbearable (Arthritis Research UK, 2013). The population in the UK is aging and, as the proportion of people over 65 is projected to increase by 7% by 2033 (Office for National Statistics, 2009), the number of people affected by arthritis and the cost of their care are both likely to rise.

### *1.1.1 Pathophysiology and Symptoms*

There are 200 different types of arthritis, including gout, lupus, and fibromyalgia (Arthritis Care, 2011). Osteoarthritis (OA) and rheumatoid arthritis (RA) are the first and second most common forms of arthritis, respectively, although they do not necessarily share the same symptoms or consequences. Due to the prevalence of RA and OA and the established body of research existing on these conditions, this thesis will focus on these two types of arthritis.

RA is a disease of the autoimmune system in which the body's defensive white blood cells target the synovial membrane of the joint as if it were a foreign body or disease

pathogen (McInnes and Schett, 2011). In particular, RA is characterised by the excess production of tumour necrosis factor (TNF), an inflammatory process that enacts large parts of the immune system (McInnes and Schett, 2011; Scott, Wolfe, and Huizinga, 2010). The result of this attack is a breaking down of the membrane that encases the joint and surrounding cartilage, eventually damaging the cartilage and bone itself (McInnes and Schett, 2011; Tak and Bresnihan, 2000). Joints in the hands, wrists, elbows, shoulders, knees, and ankles are most commonly affected and RA will usually present in joints symmetrically, affecting, for example, both wrists or both elbows (Firestein, 2003). Symptoms include pain, swelling and redness around affected joints, joint stiffness, and reduced mobility (Scott, Wolfe, and Huizinga, 2010). Because RA is a systemic disease, it can lead to a variety of complications affecting the eyes, cardiovascular system (Lindhardsen, Ahlehoff, Gislason, Madsen, Olesen, Hastrup, Torp-Pedersen, and Hansen, 2012), and respiratory system (Scott, Wolfe, and Huizinga, 2010). The secondary effects of RA also include fatigue (Hewlett, Cockshott, Byron, Kitchen, Tipler, Pope, and Hehir, 2005), depression, anxiety, and reduced quality of life (Murphy, Sacks, Brady, Hootman, and Chapman, 2012).

In contrast, OA is a disease of 'wear and tear', in which the cartilage wears away until the bones of a joint begin grinding together and deteriorating (Lane, 2007). Osteoarthritis is thought to result from a complex interaction of factors, including age, genetic predispositions, injury or overloading of the joints, and obesity (Dieppe and Lohmander, 2005). Although OA most often affects the joints that carry the majority of the body's weight (eg. hips, knees, spine) a link between obesity and increased risk of OA of the hand indicates that systemic risk factors for the disease are not entirely related to joint mechanics (Felson, et al., 2000). Due to the nature of the pain associated with OA and the involvement of peripheral nerves, the disease often leads to both psychological distress and physical limitations (Dieppe and Lohmander, 2005).

### *1.1.2 Treatment*

Although progression of RA can be slowed, stopped, or even sent into remission through the use of disease-modifying anti-rheumatic drugs these drugs are not always effective and can have serious side effects (Scott, Wolfe, and Huizinga, 2010). In cases of OA, joint replacement surgery may become an option if joints become damaged beyond repair by disease progression (Fox, et al., 2006). The procedure involves removing the damaged joint and replacing it with a plastic or metal prosthesis and whilst there are complications associated with this invasive, irreversible treatment, total joint replacement (TJR) can return patients to their original mobility levels, eliminate joint pain, and increase health-related quality of life (Ethgen, Bruyère, Richy, Dardennes, and Reginster, 2004). However, the link between disease severity and functional limitations is tenuous, whilst pain is a strong predictor of physical function (Summers, Haley, Reveille, and Alarcón, 1998). Therefore, the primary mechanism of action in TJR is the alleviation of pain, rather than the removal of diseased tissue (Orbell, Espley, Johnston, and Rowley, 1998). As psychological factors such as perceived control and specific illness cognitions are directly associated with health outcomes after TJR (Orbell, Johnston, Rowley, Espley, and Davey, 1998), it is possible that interventions that target psychological factors could improve functional limitation resulting from RA and OA.

Regardless of treatment, neither RA nor OA are curable diseases and thus, achieving optimal outcomes relies on the daily self-management of arthritis and its symptoms rather than on medical intervention and this rule applies to both patients and practitioners (Lorig and Fries, 2006). One of the main consequences of both RA and OA is functional limitation. Functional limitation restricts a person's ability to complete activities of daily living and, in turn, can impact quality of life related to work, home, and community involvement. Learning to effectively engage in self-management can enable a person living with arthritis-related pain to understand and control their pain whilst developing personalised methods of carrying out activities of daily living that limit pain (Conaghan, Dickson, and Grant, 2008).

## 1.2 Modelling Disability

Until 2001, disability was primarily defined as limitation caused by physical impairment (WHO, 1980). In 1980, the World Health Organisation (WHO) released the International Classification of Impairments, Disabilities and Handicaps (ICIDH; see Figure 1). This model expanded on the wholly medical model of disease by addressing the issue of disease outcomes on activities of daily living (Hemmingsson and Jonsson, 2005). The model (WHO, 1980) stated that disease, disorder, or injury leads to physical impairment, which leads to disability, which leads to handicap (Townsend, Ryan, and Law, 1990). Disability was defined as an inability to perform an activity that would otherwise be considered normal or routine (Townsend, Ryan, and Law, 1990). Handicap was described as an inability to fulfil a role that the person would otherwise be able to fill if it were not for the presence of the disability (Townsend, Ryan, and Law, 1990). There are a number of problems with this model, the main issue being the assumption that all disability and handicap occur as a direct result of physical impairment. For example, a wheelchair user may find that they are unable to enter a building – not due to their impairment, but due to the presence of stairs and the lack of a ramped entrance. A condition, such as facial disfigurement, often causes no physical impairment or loss of body function, but can lead to handicap due to social rejection or fear of social rejection (Rankin and Borah, 2003). Many people with facial disfigurements find themselves unable to secure employment or participate in society due to negative reactions and rejection based on their appearance (Rankin and Borah, 2003). Thus, a wheelchair user who suffers from a physical inability to walk may find it less difficult to find employment than someone who has normal physical function, but is facially disfigured. The ICIDH (1980) did not account for this. Oliver (1986) calls this model (WHO, 1980) "personal tragedy theory", stating that the only purpose that the mere medical model of disability has served is to allow society to place all the responsibility for functional limitations on the disabled themselves. This essentially enables society to remain the same, rather than make the universal changes that would be required should it be acknowledged that social and environmental factors contribute to and are often wholly responsible for the functional limitations of people with disabilities

(Oliver, 1986). Thus, while the medical model finds causal links between impairment, disability, and handicap, the social model of disability states that functional limitations are imposed on disabled people through social oppression, environmental obstacles, and politics (Oliver, 1986). Marks (1997) argued that, as every human being is likely to experience some disability in their lifetime, especially those who live to reach old age, people cannot be labelled as either 'disabled' or 'not disabled' because these discrete categories simply do not exist. Rather, we all fall somewhere within a spectrum of ability and a person's place within that spectrum is ever changing. Therefore, ability and disability are viewed to exist on a continuum, allowing for the fluctuations in ability that can occur by the minute, hour, day, or year in every individual (Marks, 1997).

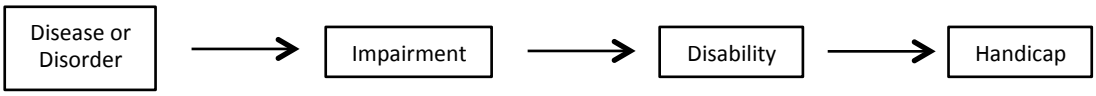


**Figure 1.1** ***The ICIDH model of disability (WHO, 1980)***

The WHO (2001) acknowledged the need for social and environmental factors to be included in the model of disability, but also asserted that the medical aspects of impairment could not be ignored, arguing that, should physical impairment be ignored, there could be negative impacts on prescription-related benefits, healthcare, and rehabilitation for disabled people (WHO, 2001). Thus, WHO's (2001) new International Classification of Functioning, Disability and Health (ICF; see Figure 2) model was formulated to take into account the effect of physical and mental abnormalities, while also acknowledging the arguments put forth by disability reform campaigners. The ICF describes disability as being determined by reciprocal influences from a disease or disorder, the structure and functions of the body, activity, participation, environmental factors, and personal factors, with activity at the centre of the framework (WHO, 2001). By showing all components as having reciprocal effects on each other, the ICF puts health on a continuum running between

ability and disability. Also, the model centres around activity itself. Activity is behaviour and therefore, activity limitations – which equate to disability - can also be considered, by definition, behaviour. By defining disability as behaviour, psychological theory can be applied to the study of disability and the factors that affect it. Where the ICIDH (WHO, 1980) merely allowed for interventions on impairment for disabled people, the ICF (WHO, 2001) allows for the development and implementation of cognitive and behavioural interventions to affect disability, therefore including people with disabilities for which medical interventions are not available or appropriate. This is particularly pertinent to chronic disease related disability, as the very nature of chronicity is that of incurability (Lorig and Fries, 2006).

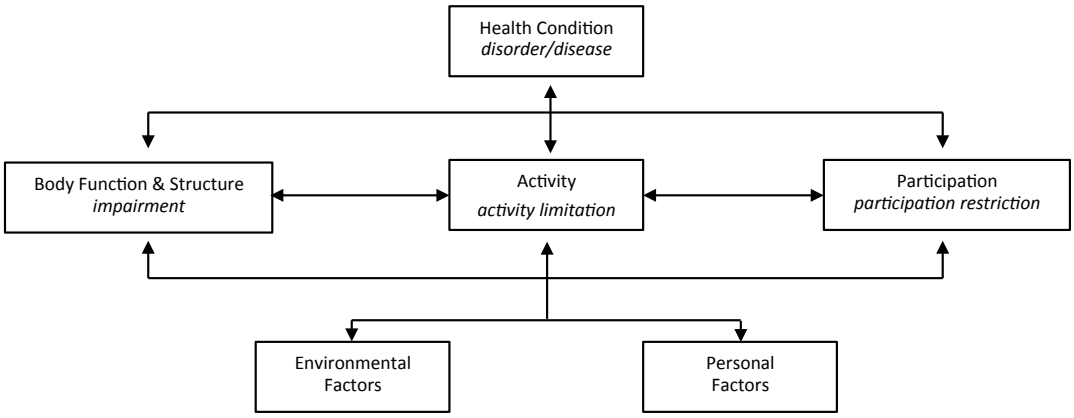


**Figure 1.2** ***The ICF model of health***

### *1.2.1 Psychological Models: Social Cognitive Theory*

Bandura's (1986) Social Cognitive Theory (SCT; see Figure 3) is a psychological model of human functioning that has been applied to the study health behaviour (Bandura, 1998), including disability as behaviour (Dixon and Johnston, 2008). It posits that human behaviour is determined by personal, behavioural, and environmental factors that influence one another concurrently (Bandura, 1986).

Personal determinants include affective, cognitive, and physical components (Bandura, 1986). In other words, how a person feels about performing a behaviour, what they believe about that behaviour, and whether they have the physical capability to carry it out will determine the personal influence on the execution of that activity. Environmental determinants are characterised by the outward context of a situation and its potential effect on behaviour. For example, a wheelchair user confronted with an entrance preceded by a set of stairs would be unable to enter via that entrance. However, a wheelchair user would be able to enter were the entrance preceded by a ramp. In this example, the wheelchair user's ability or inability to enter the establishment is dictated by an environmental determinant. Behavioural determinants are based on the effects a person's own actions could have on their carrying out a behaviour. For example, a person who believes themselves to be incapable of moving from a sitting to a standing position due to joint pain might avoid sitting altogether, thus becoming unable to sit. If the same person were practiced in the appropriate joint protection techniques, had access to aids such as railings or handles for support, and were able to correctly interpret the meaning of their joint pain, they would be less likely to perceive themselves as unable to sit. In this example, the person with joint pain's ability or inability to sit is dictated by behavioural determinants.

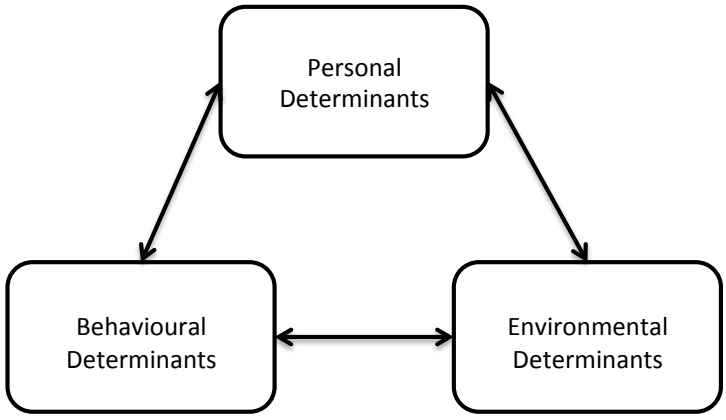


**Figure 1.3** ***Illustrative model of SCT (Bandura, 1986; Bandura, 2001)***

### *1.2.2 Self-Efficacy*

Self-efficacy (SE) is the primary casual theoretical construct within SCT. SE is defined by Bandura (1997) as "beliefs in one's own capabilities to organise and execute the courses of action required to produce given attainments" (p. 3).

Self-efficacy is of utmost importance to behavior and behaviour change. A person with high self-efficacy can be expected to approach more challenging tasks and treat them as such, applying more perseverance and more focus due to their strong belief in their ability to achieve their goal (Wentzel and Wigfield, 2009). Conversely, a person with low self-efficacy is likely to avoid challenges and set more basic goals, while approaching difficult tasks with negative emotions such as fear, anxiety, and self-doubt (Wentzel and Wigfield, 2009). Thus, high levels of self-efficacy will not only influence the kinds of goals that people set for themselves, but will also determine the likelihood that they will achieve them.

Bandura (1997) posits that there are 4 main sources from which individuals derive self-efficacy. Performance accomplishments (termed mastery experiences) occur when a person actually achieves something and through that experience are able to conclude that they are capable of producing the same outcome again in future (Bandura, 1997). Vicarious experience can take place when one witnesses another person carrying out a task and essentially concludes that, 'if they can do it, I can do it' (Bandura, 1997). Verbal persuasion involves conversation, encouragement from others, and a general change in attitude towards a task through self-talk or influence from a knowledgeable source (Bandura, 1997). The fourth and last source of self-efficacy is emotional arousal, which can be induced during relaxation exercises, biofeedback training, or other anxiety-reducing experiences of goal-related tasks (Bandura, 1997). However, performing a behaviour could never be based purely on a person's belief system. For example, a man may fully believe that he can flap his arms and fly, but he will still fail. Of course, an individual must also be equipped with the proficiency required to complete the task (Schunk, 1995).

Through rigorous testing, it has been shown that self-efficacy is the main mechanism through which chronic disease self-management programmes (CDSMP) produce positive health outcomes (Lorig and Holman, 2003). Within a chronic disease self-management context, it is often described as patient empowerment (Nolte, Elsworth, Sinclair, and Osborne, 2007). An individual's level of self-efficacy has been shown to predict health status up to one year following participation in a CDSMP, with higher self-efficacy predicting significantly more positive health outcomes (Lorig, Gonzalez, and Ritter, 1999). CDSMPs aim to generate mastery experience by asking participants to set achievable, yet challenging goals (Lorig and Holman, 2003), thus, each time a goal is met, self-efficacy for completing that task increases as well as the proficiency to act on it. These are the two factors that Bandura (1977) posits are needed to increase the likelihood that a behavior will be performed.

## 1.3 Behavioural Interventions for Arthritis

Patients who receive a diagnosis of arthritis face lifestyle changes that require them to accommodate new daily tasks, responsibilities, and lines of communication with care providers (Lorig and Fries, 2006). They must make their own decisions about their disease and its consequences on a daily basis rather than relying on specific medical direction. They must also work together with health care professionals to monitor disease patterns, drug side-effects, diet, and exercise. To achieve this requires behaviour change on the part of the patient in many aspects of their life, as well as behaviour change on the part of the health care provider in the form of a move from the traditional medical model of treatment to a collaborative model of care (Lorig and Holman, 2003).

A range of interventions have been applied to a variety of behaviours important for the management of arthritis. For example, interventions have targeted diet (Hagen, Byfuglien, Falzon, Olsen, and Smedslund, 2009), weight management (Christensen, Bartels, Astrup, and Bliddal, 2007), exercise (Fransen, McConnell, and Bell, 2002), medication adherence (Haynes, Ackloo, Sahota, McDonald, Yao, 2008), and joint protection (Hammond and Freeman, 2001). However, physical activity can

exacerbate arthritis pain in the short-term, despite its long-term benefits (Lane, 2007). Thus, patients can be faced with two important goals that are in conflict; they might want to be more active because it is good for their general and joint health but they also may wish to control their pain, which is exacerbated in the short term by movement.

## 1.4 Thesis Rationale

This thesis employs the theoretical frameworks of the ICF and SCT to understand outcomes in arthritis with a particular focus on activity limitations and walking as PA. •One aim of this thesis was to determine whether it is possible to identify the effective components of SM interventions. SM interventions include multiple components in various combinations. Quantifying the effects of SM intervention components individually and in combination could facilitate the development of more effective, focussed SM interventions in arthritis. This aim is addressed in Chapter 2. •Another aim of this thesis was to evaluate a commonly applied self-management technique on both the group and individual level. Also, pain control and engagement in PA are often conflicting behaviours for an individual with arthritis. Determining the factors involved in the decision making process of daily goal prioritisation could help to improve behavioural interventions where the target behaviour is in conflict with one or more of an individual's personal goals. This aim is addressed in Chapter 3. •A final aim of this thesis was to test the validity of integrated ICF/SCT and ICF/emotion models of disability *within* individuals with chronic joint pain. Psychological models are most often tested using group study designs – a methodology specifically designed to treat individual variability as error. However, patient care is now trending towards the individualisation of treatment and it is therefore important to understand the drivers of daily disability behaviour within individuals. Doing so could facilitate the use of an integrated theoretical model for the design of individualised interventions on behaviour. This aim is addressed in Chapter 4. This thesis presents studies with a focus on individuals, but without the scope of their personal or environmental circumstances that the 'participation' component of the ICF models includes in its conceptualisation.

# Chapter 2: Systematic Review and Meta-Analysis of SM Interventions for RA and OA

## 2.1 Background

Arthritis is the most common chronic disease in both the UK and the US (Arthritis Research UK, 2008; Centers for Disease Control and Protection, 2009). Its prevalence increases dramatically with age, occurring in 50% of those aged 65 or over (Centers for Disease Control and Prevention, 2010). OA and RA are the most common types of arthritis, occurring in 14% and 1.6%, respectively, of the UK population (Arthritis Care, 2011; Arthritis Research UK, 2013; Symmons, Turner, Webb, Asten, Barrett, Lunt, Scott, and Silman, 2002). The most widely reported symptoms are joint pain, stiffness, and reduced mobility, but RA is also associated with inflammation of the joints and fatigue (Hewlett, et al., 2005; Scott, Wolfe, and Huizinga, 1010). People who have arthritis often experience depression, anxiety, and reduced health-related quality of life (Kosinski, Kujawski, Martin, Wanke, Buatti, Ware, and Perfetto, 2002; Murphy, et al., 2012). The resulting outcomes are often physical disability, poor mental health, and reduced health-related quality of life (Pincus, Callahan, Sale, Brooks, Payne, and Vaughn, 1984).

Due to the chronic nature of arthritis, it is essential for both patients and healthcare providers to have an effective method of long-term disease management. Self-management (SM) has become an integral part of the treatment of a variety of chronic health conditions, including RA and OA, heart disease, diabetes, and HIV / AIDS (Gifford, Laurent, Gonzales, Chesney, and Lorig, 1998; Holman and Lorig, 2004; Lorig, Ritter, Stewart, Sobel, Brown, Bandura, Gonzalez, Laurent, and Holman, 2001a; Lorig, Ritter, Villa, and Armas, 2009). SM is described as occurring when patients are able to make decisions about their disease on a daily basis while working together with their health care provider to monitor disease patterns, drug side-effects, diet, exercise, and daily health management (Lorig and Holman, 2003). One of the first self-management (SM) programmes was developed as an intervention targeting patient management behaviours. The original programme

developed by Lorig (1982) at Stanford University and variations implemented around the world have been shown to significantly reduce pain levels, disability, healthcare utilization and healthcare costs for a variety of chronic conditions (Gordon and Galloway, 2008; Newman, Steed, and Mulligan, 2004; Warsi, et al., 2003).

SM programmes based on the Stanford model have targeted an increasingly long list of outcomes, including, but not limited to health behaviour, self-efficacy, health status, health care utilisation (Lorig, et al., 2001a), disability, pain (Lorig, Ritter, Laurent, and Fries, 2004), health distress, fatigue (Lorig, Ritter, and Plant, 2005), illness intrusiveness (Lorig, Ritter, Dost, Plant, Laurent, and Mcneil, 2008), stiffness, grip strength, joint count (Bell, Lineker, Wilkins, Goldsmith, and Badley, 1998), articular index, plasma viscosity, and c-reactive protein (Hill, Bird, and Johnson, 2001). This wide spread of target outcome variables, from basic biological processes to health behaviours (i.e. walking), has served to show that SM can have positive effects on most every aspect of a person's overall health and quality of life. However, a lack of an agreed set of core outcomes matched with core measures across studies has made it difficult to integrate the evidence base or evaluate the effectiveness of SM interventions as a whole.

Following the widely reported success of chronic disease self-management programmes (CDSMP) in the United States (US) (Center for the Advancement of Health, 1996; Riemsma, Kirwan, Taal, and Rasker, 2003; Warsi, et al., 2004), similar programmes have been implemented in countries throughout the world (Newman, Steed, and Mulligan, 2004). This included the United Kingdom's (UK) Expert Patient Programme (Department of Health, 2001), which was backed by government policy when the Department of Health (1999) committed to "…address the needs of the very many people in this country with a chronic disease or disability... [and] look at the role which those affected can themselves play as experts in managing their chronic disease… to improve their self-esteem and their quality of life." (paragraph number 3.50).

Even in the infancy of the Stanford SM programme, it was estimated that only 1% of rheumatoid or osteoarthritis patients would need to take part in the program to produce tens of millions of dollars in healthcare costs (Lorig, Mazonson, and Holman, 1993) with effects on outcomes lasting at least two years (Lorig, et al., 2001a).

Delivering the Expert Patient Programme costs the National Health Service (NHS) an estimated £289 per person (Curtis, 2011), representing an average cost reduction of £27 per patient when compared to standard care (Richardson, Kennedy, Reeves, Bower, Lee, Middleton, Gardner, Gately, and Rogers, 2008). It also leads to a significant increase in quality adjusted life years in participants – a positive outcome that could lead to further healthcare savings over time (Richardson, et al., 2008).

However, SM interventions are poorly defined in the literature. In fact, reviews and scientific trials of SM for chronic disease almost never include a full definition of what an SM intervention consists of. Furthermore, an SM programme as defined in the literature should include a number of specific components (Lorig and Holman, 2003). The Stanford SM programme includes 5 core self-management skills: problem-solving, decision making, communicating with healthcare providers, resource utilisation, and taking action. Problem-solving entails identifying problem activities, brainstorming solutions, and choosing the best strategy for implementing the best solution. Decision making skills are built by equipping people with the knowledge that they might need when faced with various treatment options, assessing their own need for physical aids, exercising joint protection techniques, and any other choice that a person might face in relation to their health. Learning to communicate more effectively with healthcare providers can empower a patient, as they will know which symptoms are important to report, which treatments to enquire about, and how to choose between the treatment options that they are offered. Resource utilisation skills can be developed simply by teaching people to use a telephone book, the internet, or how to obtain a library card. Finally, taking action is based on setting goals, creating short term action plans, and assessing the outcomes of those action plans (Lorig and Holman, 2003). However, even though the

Consolidated Standards for Reporting Trials (CONSORT) statement calls for intervention studies to include a "description of the different components of the interventions and, when applicable, descriptions of the procedure for tailoring the interventions to individual participants" (Boutron, Moher, Altman, Schulz, and Ravaud, 2008, p. 296), it is currently unclear as to how consistently or reliably these five components of SM are included in SM interventions or which components are crucial to intervention effectiveness. Therefore, if a standard SM program is to include only a choice few of the components from the intervention as it was originally devised, it is important to quantify the effect that each component may have on different outcomes.

Further, if SM programmes are to be delivered in a cost effective way whilst producing optimal benefits for patients, it is essential to define SM and determine which intervention components are necessary for producing positive effects on particular outcomes (Michie, et al., 2013). Doing so is vital to the development of a cumulative evidence base that enables personalised care to improve outcomes of relevance and importance to individual patients.

### *2.1.1 Aims*

Previous reviews have shown that the effects of SM programmes are variable (Newman, Steed, and Mulligan, 2004). This review aimed to evaluate the impact of SM interventions on physical and mental health outcomes in people with a confirmed diagnosis of rheumatoid or osteoarthritis. The review is in two parts. The first provides a systematic, narrative review of the literature. The second reports meta-analytic analyses of the overall effectiveness of self-management interventions for arthritis and the effectiveness of individual components of those interventions.

## 2.2 Methods

Searches were performed from November 9, 2010 until February 8, 2011 on PsycNET, Excerpta Medica database (Embase), ISI Web of Knowledge, Cochrane Library, the Cumulated Index to Nursing and Allied Health Literature (CINAHL), the Allied and Complementary Medicine Database (AMED), and the Health Management Information Consortium (HMIC) databases. The search terms employed were taken from Newman, Steed, and Mulligan (2004) and entered as:

(arthritis OR osteoarthritis OR musculoskeletal OR rheum*) AND (self-management OR self-care OR education* OR behav* OR psych* OR cognitive) AND (intervention OR program* OR trial) AND (random* OR RCT).

No data restrictions were applied. The searches returned 12,076 articles in total, with 4,659 remaining after duplicates were removed (see Figure 2.1).

Inclusion criteria were that studies must be randomised controlled trials (RCT) of adults 18 years or over with a diagnosis of osteoarthritis (OA) or rheumatoid arthritis (RA) and published in English. Studies must have screened participants for an existing physician diagnosis, examined radiographic evidence, or should have performed an examination themselves to formally determine the presence of RA or OA. Studies including participants with other chronic health conditions, as well as RA or OA, that did not report results separately according to disease were excluded unless the participants without RA or OA made up 10% or less of the overall sample. Also, only trials that compared self-management with usual care were included. In the case that the control group was not explicitly described as receiving usual care, authors were contacted for clarification.

All studies including any one or more of the five SM components described by Lorig and Holman (2003) were included in the narrative review (see Table 2.1). To control for heterogeneity of treatments received by the control groups, the content of usual care was coded in the same way as the intervention groups (i.e. labelling them for the

number and types of self-management techniques that were used; see below for details of content coding). To ensure adequate power for meta-analyses, only studies including one or more measure of mental health, disability, or pain were included in the meta-analysis.

Each of the 4,659 unique studies was screened for inclusion in the review. This involved screening titles, abstracts, and the full article when necessary. During this process, excluded studies were coded with the reasons for their exclusion (i.e. not an RCT, not RA or OA, not a self-management intervention, not printed in English). Twenty percent of studies were reviewed independently by two reviewers ($K = 0.91$; Gwet, 2002; Cohen, 1960) and any discrepancies were discussed until a consensus was reached.

After screening, 85 studies were judged as including one or more SM components. The content of each of these interventions was independently coded for the presence of each SM component by two authors ($K = 0.97$; Gwet, 2002; Cohen, 1960). These authors were both trained to identify behaviour change techniques within interventions using a rigorously developed taxonomy of behaviour change techniques (Michie, et al., 2013). There is no such taxonomy of SM components, however, the method of coding the content of behaviour change interventions described by Michie, et al. (2013) was used in this review; Lorig and Holman's (2003) definitions of SM components were used to code intervention content.

Risk of bias of included studies was reviewed using the recommendations from the Cochrane Collaboration (2011), but no other quality scale was used in this review as the validity of such scales has been called into question following empirical review (Emerson, Burdick, Hoaglin, Mosteller, and Chalmers, 1990). The use of quality scales and checklists has been criticised for being too simplistic, disallowing any subjective judgement, and scales and checklists often do not include vital aspects of quality assessment, such as allocation concealment (Schulz, Chalmers, Hayes, and Altman, 1995)

Table 2.1 *Descriptions of the 5 self-management components (Lorig and Holman, 2003)*

| SM Component | Definition |
|---|---|
| Problem-Solving (PS) | includes problem definition, generation of possible solutions including solicitation of advice, solution implementation, and evaluation of results |
| Decision Making (DM) | the formation of key messages to foster appropriate decision making - based on having enough appropriate information |
| Communication with Healthcare Professionals (CHCP) | how to accurately report trends and tempo of disease, make informed treatment choices, and discuss with health care providers |
| Resource Utilization (RU) | teaching people how to use resources and helping them to seek resources from many sources |
| Taking Action (TA) | solution implementation and skill mastery - making a short-term, specific action-plan that is realistic and the person is confident in carrying it out (must include action plan or goal) |

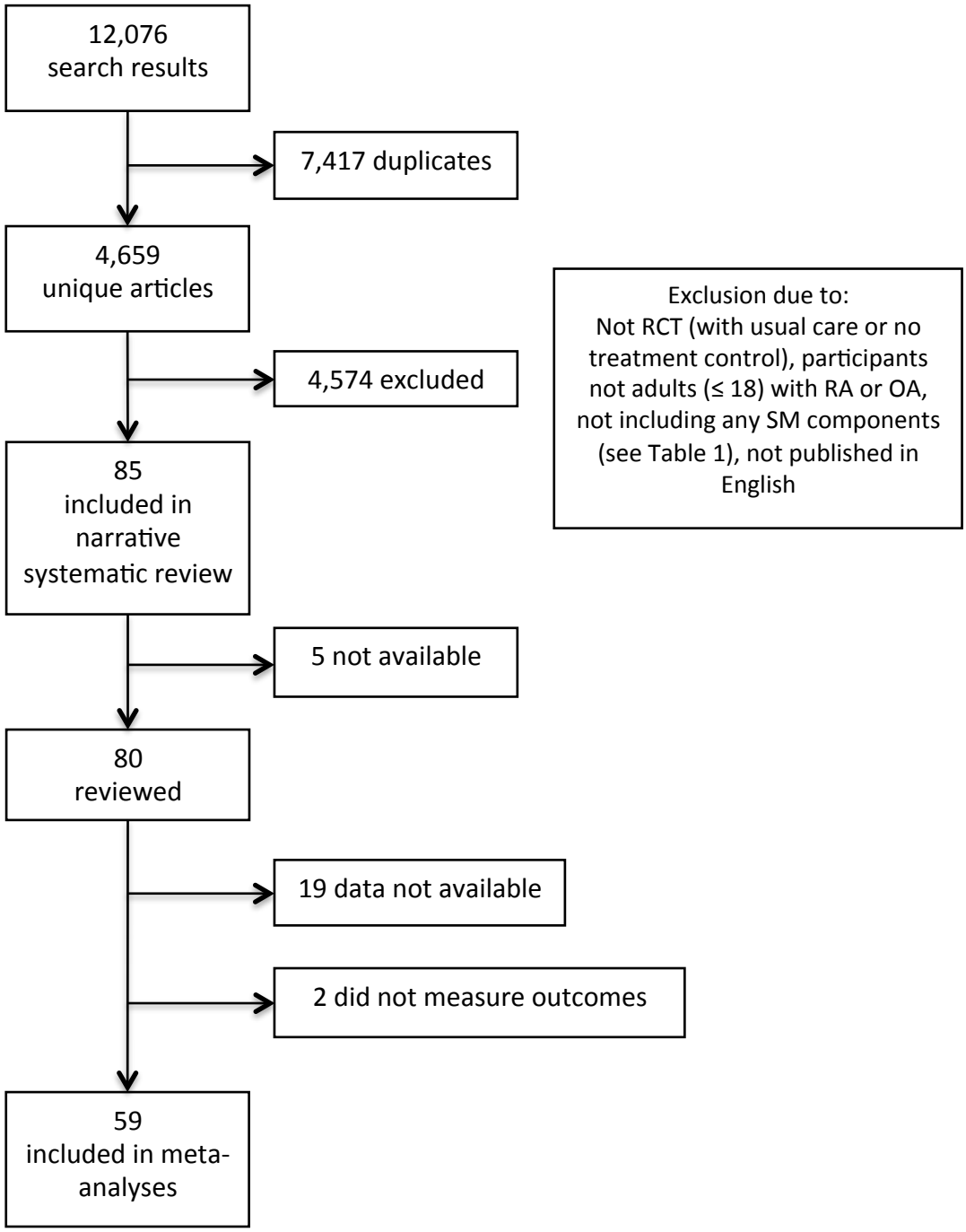


**Figure 2.1** ***Inclusion and exclusion of articles in the review and meta-analysis***

Eighty-five studies were identified for inclusion in the systematic review, but five were excluded as the full reports could not be located. This left 80 studies for review. The following data were extracted from each study: country of origin; target behaviour (e.g. physical activity, adherence to treatment, etc.); participant demographic information (age, gender, socioeconomic status, education level, ethnicity); clinical information (diagnostic criteria, joint involvement, disease duration, disease severity, and co-morbid conditions); sample size; methodology (recruitment methods, method of randomisation, attrition rates, outcomes, outcome measures, outcome validation methods, and follow-up length(s)); intervention provided [group vs. individual sessions, SM techniques used, group size, number of sessions, duration of sessions, duration of intervention, co-interventions, delivery format (eg. face-to-face meetings, mail-delivered intervention, online intervention), delivery source (eg. health professional, lay-person, exercise instructor, psychologist), and theoretical framework]; outcome effects (mean, standard deviation, statistic type, *p* value, effect direction, and number of responders); and number and type of self-management techniques included (i.e. PS, DM, CHCP, RU, or TA).

Effect size information (outcome, sample size, mean or mean change or effect size, standard deviation, and direction of effect) was extracted for meta-analytic review. Of the 80 studies included in the narrative review (marked with * in reference list), data for meta-analyses were available from 61 studies; data were taken from the published reports, requested from the authors, or from a previously published meta-analysis (Riemsma, et al., 2003). A further two studies did not measure pain, disability, or mental health, bringing the number of studies included in the meta-analysis to 59 (marked with ** in reference list).

### *2.2.1 Data Analysis*

Data were analysed using the Comprehensive Meta-Analysis 2.0 software package (Borenstein, Hedges, Higgins, and Rothstein, 2005) and the R version 2.14.1 software package (R Development Core Team, 2011). Meta-analyses were

conducted on 3 outcomes: pain, disability, and mental health at 3 time points – immediately post-treatment (PT), ≤ 6 month follow-up (range = 0.25 – 6 months), and > 6 months follow-up (range = 7.5 – 12.75 months for pain and mental health; up to 21 months for disability) using random effects models. Random effects models were employed due to the known heterogeneity between the studies included in analyses. This model takes study differences into account by estimating both within study error and differences in effects between studies. Study weights are then assigned accordingly to minimise the risk of any one study biasing the results. Multiple measures were used for each outcome and multiple outcomes were measured across studies (see Tables 2.2, 2.3 and 2.4). Different measures of the same outcome were combined by standardising scores and calculating standardised mean differences for effect sizes. Nine separate meta-analyses were run to give overall results on each outcome and each time point to ensure that the assumption of independence was met. When multiple measures of the same outcome were included within a study, standardised scores were combined and the average was used in analyses.

Positive effect sizes demonstrate more positive outcomes in the treatment group in comparison to the control group. When baseline and follow-up sample sizes were not equal, the smaller sample size was used. As study weights are applied based on sample size, this was a method of limiting the weight applied to studies for which the sample size varied between baseline and follow-up.

Restricted maximum likelihood (REML) estimates were used for meta-regression analyses. Using univariable models, each of the five SM components were regressed individually onto each outcome (pain, disability, mental health) at each time point (post-treatment, ≤ 6 months, > 6 months). Potential confounding variables (intervention duration, delivery source, group vs. individual delivery, number of sessions, co-interventions, country of delivery, use of block randomisation, and gender) were also regressed individually onto each outcome and time point in this way. Any confounding variables found to have a significant effect were entered into all multivariable models of that outcome/time point to control for the effect.

Multivariable models including all possible combinations of the five SM components were also regressed onto each outcome at each time point using a forced entry method. The number of components included in interventions (1, 2, 3, 4, or 5) was also regressed onto each outcome at each time point.

## 2.3 Narrative Review

### *2.3.1 Description of Studies*

All data extracted from studies included in narrative review is included in Appendix 1. The mean age across studies ranged from 44.6 (sd = 2.6) to 78.7 years (sd = 10.2). Aside from 8 studies that included only females and 4 studies that included only males, studies ranged from a 6% : 94% female to male ratio to 92% : 8% female to male ratio. Overall, female participants were in the majority in most interventions. Of the 170 different groups across all 80 studies, only 16 groups had a population made up of less than 50% female participants. Group sample sizes ranged from 9 to 568. About a quarter of the study groups were sized 100 participants or more (27.5%). Most studies only included 2 groups – an intervention and a control (81.3%), but some included 3 (13.8%) or 4 (6.3%) groups.

The majority of studies recruited participants from medical centres (80.0%), but some also recruited from the community using public service announcements, word-of-mouth, newspapers, or fliers (20.0%). A few recruited from joint replacement waiting lists (5.0%) or health maintenance organisations (3.8%).

Block randomisation was used in only 18.8% of studies. Participants were matched or stratified based on certain variables in 20.0% of studies. These variables included age, sex, education, ethnicity, functional class, time since diagnosis, surgical history, prescription medications, stress level, and pain index.

Intervention length varied greatly across studies, with some lasting only 30 minutes while others ran monthly for a full year. The most common intervention length

(22.5% of studies) was 6 weeks. Nearly all interventions were delivered by health professionals (83.8% of studies), although some were delivered by trained lay-people (10.0%) or by both health professionals and lay-people (2.5%).

Attrition was reported according to each treatment group by 77.5% of studies. Aside from 12.2% of treatment and 8.5% of control groups that reported losing no participants, the rate of attrition ranged from 3.1% to 44.4% for treatment groups and 2.2% to 55.6% for control groups. This resulted in a similar average rate of attrition between treatment (15.8%) and control (15.1%) groups overall.

Outcomes were measured at follow-up points beyond immediate post-treatment in 78.8% of studies. The longest follow-up period was 2 years after treatment, but the most common were 6 months (28.8%), 3 months (12.5%), and 12 months (11.3%) after treatment.

Usual care control groups received some form of SM in 5.0% of studies. In all of these cases, didactic information was given, but in 2 studies (2.5%) an element of 'taking action' was included alongside this and in 2 others (2.5%) an element of 'resource utilisation' was included. In all studies where a component of SM was included in the control group, the treatment group received at least one additional component of SM and it was delivered in considerably more detail and intensity.

Only 33 studies (41.3%) made any mention of using a theory-driven approach in the design of the interventions that were being tested. Of those that did, the most commonly applied theories were Social Cognitive or Social Learning Theory (69.7%), Health Belief Model (12.1%), and Gate Control Theory (9.1%), although some used more obscure models (Crotty, Prendergast, Battersby, Rowett, Graves, Leach, and Giles, 2009; Frost, 2005; Gerber, Furst, Shulman, Smith, Thornton, Liang, Cullen, Stevens, and Gilbert, 1987) or simply alluded to 'self-management theories' (Nunez, Nunez, Segur, Macule, Quinto, Hernandez, and Vilalta, 2006a; Nunez, Nunez, Yoldi, Quinto, Hernandez, and Munoz-Gomez, 2006b).

Similarly, none of the studies reviewed gave a clear definition of SM. Many simply called the intervention a "self-management programme" or referred to the "self-management model".

### *2.3.2 Outcomes Assessed and Measured Used*

A number of different outcomes were measured across the studies and a wide variety of measures were used to assess those outcomes. The same health outcome was often assessed by different measures both within the same study and between different studies (Tables 2.2, 2.3 and 2.4).

#### *2.3.2.1 Pain Outcomes*

Pain was assessed in 63 studies. Most of these studies (90.3%) reported measuring 'pain' in general (Table 2.2). Studies that looked at pain in greater detail included measures of peak pain (Appelbaum, Blanchard, Hickling, and Alfonso, 1988), pain intensity (Nunez, et al., 2006b) or pain unpleasantness (Bradley, Young, Anderson, Turner, Agudelo, McDaniel, Pisko, Semble, and Morgan, 1987). Thirty-one different measures were used to assess pain. Pain was most frequently measured on a visual analogue scale (44.4%), but many also used the pain items in multi-dimensional measures such as AIMS / AIMS2 (20.6%), or the WOMAC (14.3%). Others used numerical rating scales (7.9%), or the McGill Pain Questionnaire (6.3%).

Table 2.2 *Measures used to assess pain*

| Study | Pain Outcomes | Pain Measures |
|---|---|---|
| Allen, et al. (2010) | • Pain<br>• Pain | • Pain Subscale AIMS2<br>• VAS |
| *Appelbaum, et al. (1988) | • Pain Total<br>• Weekly Pain Index<br>• Weekly Pain Rating | • McGill Pain Questionnaire<br>• Pain Diary (mean daily pain)<br>• Pain Diary (single highest rating) |
| *Barlow, et al. (2000) | • Pain | • VAS |
| *Beaupre, et al. (2004) | • Pain | • Pain Subscale WOMAC |
| *Bell, et al. (1998) | • Pain | • VAS |
| *Berge, et al. (2004) | • Pain Disruption<br>• Pain Distress<br>• Pain Intensity | • Numerical Scale<br>• Numerical Scale<br>• Numerical Scale |
| *Blixen, et al. (2004) | • Duration of Pain | • Duration of Pain Question from Arthritis Pain AIMS2 Subscale |
| Bradley, et al. (1987) | • Pain Intensity<br>• Pain Unpleasantness | • VAS<br>• VAS |
| Brus, et al. (1998) | • Pain | • AIMS (Dutch) |
| *Buszewicz, et al. (2006) | • Pain | • Pain Subscale WOMAC |
| Cohen, et al. (1986) | • Pain | • Numerical Scale |
| *Crotty, et al. (2009) | • Pain | • Pain Subscale WOMAC |
| DeVellis, et al. (1988) | • Pain<br>• Pain | • Numerical Scale<br>• AIMS |
| *Evers, et al. (2002) | • Pain | • IRGL |
| Freeman, et al. (2002) | • Pain | • VAS |
| *Fries, et al. (1997) | • Pain | • VAS |
| *Frost (2005) | • Pain | • Pain Subscale WOMAC |
| Germond, et al. (1993) | • Pain | • McGill Pain Questionnaire |
| Goeppinger, et al. (1989) | • Pain | • Pain index |
| *Goeppinger, et al. (2009) | • Pain | • VAS |
| *Hammond & Freeman (2001) | • Hand Pain<br>• Lower Limb<br>• Pain | • VAS<br>• AIMS2<br>• VAS |
| *Hammond, et al. (1999) | • Pain | • HAQ |
| *Hammond, et al. (2001) | • Pain<br>• Pain | • VAS<br>• ASES |
| Hammond, et al. (2004) | • Pain | • VAS |
| *Hansson, et al. (2010) | • Pain | • ASES |
| *Helliwell, et al. (1999) | • Pain | • Bodily Pain Subscale SF-36 |
| *Heuts, et al. (2005) | • Hip Pain<br>• Knee Pain | • VAS<br>• VAS |

*Note: * denotes studies included in meta-analyses; AIMS = arthritis impact measurement scale; AIMS2 = arthritis impact measurement scale 2; ASES = arthritis self-efficacy scale; sec. = seconds; BDI = Beck depression inventory; HAQ = health assessment questionnaire; IRGL = Invloed Reuma op Gezondheid en Leefwijze; MPQ = McGill pain questionnaire; SF-36 = short form 36; vas = visual analogue scale; WOMAC = Western Ontario and McMaster Universities arthritis index*

Table 2.2, Continued. *Measures used to assess pain*

| **Study** | • **Pain Outcomes** | • **Pain Measures** |
|---|---|---|
| Hewlett, et al. (2011) | • Pain | • VAS |
| *Hill, et al. (2001) | • Pain | • unreported |
| *Hopman-Rock, et al. (2000) | • Pain Intolerance<br>• Pain | • VAS<br>• IRGL |
| *Hughes, et al. (2004) | • Pain | • Pain Subscale WOMAC |
| Hurley, et al. (2007) | • Pain | • Pain Subscale WOMAC |
| *Keefe, et al. (2004) | • Pain | • AIMS |
| *Keefe, et al. (1990) | • Pain | • AIMS |
| *Kirwan, et al. (2005) | • Pain | • unreported |
| *Kraaimaat, et al. (1995) | • Pain | • IRGL |
| *Laforest, et al. (2008) | • Pain | • VAS |
| *Lindroth, et al. (1997) | • Pain | • VAS |
| *Lorig, et al. (1986) | • Pain | • VAS |
| *Lorig, et al. (1985) | • Pain<br>• Pain | • Ordinal Scale<br>• VAS |
| *Lorig, et al. (1989) | • Pain | • VAS |
| *Lorig, et al. (2004) | • Pain | • VAS |
| *Lorig, et al. (1999) | • Pain / Physical Discomfort | • Medical Outcomes Study |
| Lundgren, et al. (1999) | • Pain<br>• Pain | • AIMS2<br>• Sickness Impact Profile |
| *Martire, et al. (2007) | • Pain | • Pain Subscale WOMAC |
| *Masiero, et al. (2007) | • Pain | • VAS |
| *Mazzuca, et al. (2004) | • Pain | • Pain Subscale WOMAC |
| Multon, et al. (2001) | • Pain<br>• Pain<br>• Pain Symptoms | • McGill Pain Questionnaire<br>• VAS<br>• AIMS |
| *Neuberger, et al. (1993) | • Pain | • VAS |
| *Nunez, et al. (2006a) | • Pain | • Pain Subscale WOMAC |
| *Nunez, et al. (2006b) | • Pain | • VAS |
| *Parker, et al. (1988) | • Pain | • VAS |
| Parker, et al. (1984) | • Pain | • AIMS |
| *Parker, et al. (1995) | • Pain | • VAS |
| Radojevic, et al. (1992) | • Pain | • AIMS |
| *Ravaud, et al. (2009) | • Pain | • Numerical Scale |
| *Riemsma, et al. (1997) | • Pain | • AIMS (Dutch) |
| Rogers & Wilder (2009) | • Pain | • AUSCAN |
| *Sharpe, et al. (2001) | • Pain | • Self-Monitored (Intensity x Duration) |
| *Stamm, et al. (2002) | • Pain | • VAS |

*Note: * denotes studies included in meta-analyses; AIMS = arthritis impact measurement scale; AIMS2 = arthritis impact measurement scale 2; ASES = arthritis self-efficacy scale; sec. = seconds; BDI = Beck depression inventory; HAQ = health assessment questionnaire; IRGL = Invloed Reuma op Gezondheid en Leefwijze; MPQ = McGill pain questionnaire; SF-36 = short form 36; vas = visual analogue scale; WOMAC = Western Ontario and McMaster Universities arthritis index*

Table 2.2, Continued. *Measures used to assess pain*

| Study | Pain Outcomes | Pain Measures |
|---|---|---|
| *Taal, et al. (1993) | • Pain | • AIMS (Dutch) |
| *Victor, et al. (2005) | • Arthritis Pain<br>• General Pain | • Pain Subscale WOMAC<br>• Bodily Pain Subscale SF-36 |
| *Yip, et al. (2007) | • Pain | • VAS |

*Note: * denotes studies included in meta-analyses; AIMS = arthritis impact measurement scale; AIMS2 = arthritis impact measurement scale 2; ASES = arthritis self-efficacy scale; sec. = seconds; BDI = Beck depression inventory; HAQ = health assessment questionnaire; IRGL = Invloed Reuma op Gezondheid en Leefwijze; MPQ = McGill pain questionnaire; SF-36 = short form 36; vas = visual analogue scale; WOMAC = Western Ontario and McMaster Universities arthritis index*

#### *2.3.2.2 Disability Outcomes*

Disability was assessed in 62 studies. Twenty different disability related outcomes were measured, including functional limitations, mobility, activities of daily living, physical activity, and range of motion (Table 2.3). However, a few studies targeted more specific outcomes, such as hand (Stamm, Machold, Smolen, Fischer, Relich, Graninger, Ebner, and Erlacher, 2002), hamstring, or quadricep strength (Yip, Sit, Fung, Wong, Chong, Chung, and Ng, 2007). Thus, disability was measured in a variety of different ways, with some studies employing physiological measures and others measuring the ability to perform more complex activities of daily living, such as walking and climbing stairs. Moreover, disability related outcomes were assessed using 95 different measures. However, some measures were frequently used, namely the Health Assessment Questionnaire (HAQ; 37.1%), the Arthritis Impact Measurement Scale (AIMS, AIMS2; 33.9%), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC; 21.0%), and the Short Form Health Survey (SF-36; 12.9%).

Table 2.3 *Measures used to assess disability*

| Study | Disability Outcomes | Disability Measures |
|---|---|---|
| Allen, et al. (2010) | • Mobility<br>• Function<br>• Walking and Bending | • AIMS2<br>• AIMS2<br>• AIMS2 |
| *Appelbaum, et al. (1988) | • Daily Activities | • Total DAQ |
| *Arnold & Faulkner (2010) | • Balance BBS<br>• Dual Task Function<br>• Functional Performance<br>• Walking Performance | • BBS<br>• Time Up and Go<br>• 30 sec. Chair Stand<br>• 6 min. Walk |
| *Barlow, et al. (2000) | • Physical Functioning | • HAQ |
| *Beaupre, et al. (2004) | • Function<br>• Range of motion<br>• Quadriceps strength<br>• Hamstring strength<br>• Physical Component | • Function Subscale WOMAC<br>• Goniometer<br>• Dynamometer<br>• Dynamometer<br>• Composite Score of Physical Function, Role Physical, Bodily Pain, and General Healthy SF-36 Subscales |
| *Bell, et al. (1998) | • Grip strength | • Therapy Assessment |
| *Berge, et al. (2004) | • Minutes Walked | • 4 min. Walk |
| *Blixen, et al. (2004) | • Functional Status | • Physical Component Score AIMS2 |
| Brus, et al. (1998) | • | • M-HAQ (Dutch) |
| *Buszewicz, et al. (2006) | • Physical Function<br>• Physical Health | • Function Subscale WOMAC<br>• SF-36 |
| Cohen, et al. (1986) | • | • HAQ |
| *Cronan, et al. (1997) | • Health Status | • QWB |
| *Crotty, et al. (2009) | • Physical Fitness | • Function Subscale WOMAC |
| DeVellis, et al. (1988) | • Dexterity<br>• Activities of Daily Living<br>• Mobility<br>• Physical Activity | • AIMS<br>• AIMS<br>• AIMS<br>• AIMS |
| *Evers, et al. (2002) | • Functional Disability | • IRGL |
| Freeman, et al. (2002) | • Physical Function | • Physical Component Score AIMS2 |
| *Fries, et al. (1997) | • Function | • HAQ modified |

*Note: * denotes studies included in meta-analyses; AIMS = arthritis impact measurement scale; AIMS2 = arthritis impact measurement scale 2; BBS = Berg balance scale; sec. = seconds; BPI = brief pain inventory; DAQ = daily activities questionnaire; EMIR = Echelle de Mesure de l'Impact de la polyarthrite Rhumatoïde; EQ-5D = EuroQoL 5 dimensions; HAQ = health assessment questionnaire; IRGL = Invloed Reuma op Gezondheid en Leefwijze; M = metres; min. = minutes; mod. = modified; MOS-SF-12 = medical outcomes study short form 12; PSFS = patient-specific functional status; QoL = quality of life; QWB = quality of wellbeing scale; SF-36 = short form 36; SOLEC = seconds standing on one leg eyes closed; SOLEO = seconds standing on one leg eyes open; vas = visual analogue scale; WOMAC = Western Ontario and McMaster Universities arthritis index*

Table 2.3, Continued *Measures used to assess disability*

| Study | Disability Outcomes | Disability Measures |
|---|---|---|
| *Frost (2005) | • Bodily Pain<br>• General Health<br>• Mobility<br>• Muscle Force & Balance<br>• Physical Function<br>• Physical Health Status<br>• Role Physical | • SF-36<br>• SF-36<br>• 6 min. Walk<br>• Timed Chair Rise<br>• Function Subscale WOMAC<br>• SF-36<br>• SF-36 |
| *Gallagher, et al. (1997) | • Health Status | • QWB |
| *Gerber, et al. (1987) | • | • HAQ |
| *Giraudet-Le Quintrec, et al. (2007) | • Physical Functioning<br>• QoL Physical | • HAQ<br>• EMIR |
| Goeppinger, et al. (1989) | • Function | • HAQ |
| *Goeppinger, et al. (2009) | • Activity Limitation<br>• Disability<br>• General Health | • Activities Limitation Scale<br>• HAQ<br>• National Health Survey |
| *Hammond & Freeman (2001) | • Activities of Daily Living<br>• Current Health Status<br>• Grip Strength<br>• Upper Limb | • AIMS2<br>• AIMS2<br>• Jamar Dynamometer<br>• AIMS2 |
| *Hammond, et al. (1999) | • Disability | • HAQ |
| Hammond, et al. (2004) | • Physical Function<br>• Health<br>• Hand Function | • Physical Component Score AIMS2<br>• HAQ<br>• Jebsen Test |
| *Hansson, et al. (2010) | • Balance SOLEC<br>• Balance SOLEO<br>• Bipedal Raising (#)<br>• Grip Ability<br>• One Legged Jump<br>• Perceived Health<br>• Perceived Health | • sec. standing on 1 leg, eyes closed<br>• sec. standing on 1 leg, eyes open<br>• number raises<br>• Grip Ability Test<br>• cm Jumped<br>• EQ-5D<br>• Visual Analogue Scale |
| *Helliwell, et al. (1999) | • Disability | • HAQ |

*Note: * denotes studies included in meta-analyses; AIMS = arthritis impact measurement scale; AIMS2 = arthritis impact measurement scale 2; BBS = Berg balance scale; sec. = seconds; BPI = brief pain inventory; DAQ = daily activities questionnaire; EMIR = Echelle de Mesure de l'Impact de la polyarthrite Rhumatoïde; EQ-5D = EuroQoL 5 dimensions; HAQ = health assessment questionnaire; IRGL = Invloed Reuma op Gezondheid en Leefwijze; M = metres; min. = minutes; mod. = modified; MOS-SF-12 = medical outcomes study short form 12; PSFS = patient-specific functional status; QoL = quality of life; QWB = quality of wellbeing scale; SF-36 = short form 36; SOLEC = seconds standing on one leg eyes closed; SOLEO = seconds standing on one leg eyes open; vas = visual analogue scale; WOMAC = Western Ontario and McMaster Universities arthritis index*

Table 2.3, Continued *Measures used to assess disability*

| Study | Disability Outcomes | Disability Measures |
|---|---|---|
| *Heuts, et al. (2005) | • Functional Status<br>• Health Change<br>• Health Status<br>• Physical Functioning | • PSFS<br>• SF-36<br>• Total WOMAC<br>• SF-36 |
| Hewlett, et al. (2011) | • Disability | • HAQ |
| *Hopman-Rock, et al. (2000) | • Walking<br>• Knee Extension/Strength Left<br>• Knee Extension/Strength Right<br>• Stair Climbing Down<br>• Stair Climbing Up<br>• Time Up & Go<br>• Toe Reaching Left<br>• Toe Reaching Right | • 20 min. Walk<br>• Goniometer<br>• Goniometer<br>• Time<br>• Time<br>• Time<br>• Time<br>• Time |
| *Hughes, et al. (2004) | • Walking<br>• Physical Function<br>• Timed Sit-Stand | • 6 min. Walk<br>• Function Subscale WOMAC<br>• Timed Stands Test |
| Hurley, et al. (2007) | • Physical Function | • Function Subscale WOMAC |
| *Keefe, et al. (1990) | • Physical Disability | • AIMS |
| *Kirwan, et al. (2005) | • Disability | • HAQ |
| *Kovar, et al. (1992) | • Arthritis Impact<br>• Arthritis Pain<br>• Functional Status<br>• Physical Activity | • AIMS<br>• AIMS<br>• 6 min. Walk<br>• AIMS |
| *Kraaimaat, et al. (1995) | • Mobility | • IRGL |
| *Laforest, et al. (2008) | • Functional Limitations | • Function Subscale WOMAC |
| *Lindroth, et al. (1997) | • Disability | • HAQ |
| *Lorig, et al. (1986) | • Disability | • HAQ |
| *Lorig, et al. (1985) | • Disability | • HAQ |
| *Lorig, et al. (1989) | • Disability | • HAQ |
| *Lorig, et al. (2004) | • Disability | • HAQ |
| *Lorig, et al. (1999) | • Disability HAQ<br>• Health | • HAQ – modified<br>• National Health Interview Survey |

*Note: * denotes studies included in meta-analyses; AIMS = arthritis impact measurement scale; AIMS2 = arthritis impact measurement scale 2; BBS = Berg balance scale; sec. = seconds; BPI = brief pain inventory; DAQ = daily activities questionnaire; EMIR = Echelle de Mesure de l'Impact de la polyarthrite Rhumatoïde; EQ-5D = EuroQoL 5 dimensions; HAQ = health assessment questionnaire; IRGL = Invloed Reuma op Gezondheid en Leefwijze; M = metres; min. = minutes; mod. = modified; MOS-SF-12 = medical outcomes study short form 12; PSFS = patient-specific functional status; QoL = quality of life; QWB = quality of wellbeing scale; SF-36 = short form 36; SOLEC = seconds standing on one leg eyes closed; SOLEO = seconds standing on one leg eyes open; vas = visual analogue scale; WOMAC = Western Ontario and McMaster Universities arthritis index*

Table 2.3, Continued *Measures used to assess disability*

| Study | Disability Outcomes | Disability Measures |
|---|---|---|
| Lundgren, et al. (1999) | • Mobility<br>• Walking / Bending<br>• Hands / Fingers<br>• Arm Function<br>• Physical<br>• Strength<br>• Endurance<br>• Balance | • AIMS2<br>• AIMS2<br>• AIMS2<br>• AIMS2<br>• Sickness Impact Profile<br>• Index of Muscle Function<br>• Index of Muscle Function<br>• Index of Muscle Function |
| *Martire, et al. (2007) | • Function | • Function Subscale WOMAC |
| *Masiero, et al. (2007) | • Health<br>• Physical | • HAQ<br>• AIMS2 |
| *Mazzuca, et al. (2004) | • Function | • Function Subscale WOMAC |
| *Neuberger, et al. (1993) | • Disability | • Visual Analogue Scale |
| *Nunez, et al. (2006a) | • Bodily Pain<br>• Function<br>• General Health<br>• Physical Function<br>• Physical Role | • SF-36<br>• Function Subscale WOMAC<br>• SF-36<br>• SF-36<br>• SF-36 |
| *Nunez, et al. (2006b) | • Physical Function | • HAQ |
| O'Brien, et al. (2006) | • Upper Limb Function<br>• Hand and Finger Function<br>• Right Hand Function<br>• Right Index Finger Flexion<br>• Dominant Gross Grip<br>• Dominant Key Grip | • AIMS2<br>• AIMS2<br>• Jebsen-Taylor<br>• Flexion Goniometry<br>• Jamar Dynamometer<br>• Pinch Gauge in Pounds |
| Oermann, et al. (1986) | • Health Status | • AIMS |
| *Parker, et al. (1988) | • Disability | • AIMS |
| Parker, et al. (1984) | • Physical Activity | • AIMS |
| *Parker, et al. (1995) | • Mobility<br>• Impact | • AIMS<br>• AIMS |
| *Peterson, et al. (1993) | • Walking<br>• Fast Cadence<br>• Fast Stride<br>• Fast Velocity<br>• Free Cadence<br>• Free Stride<br>• Free Velocity | • 6 min. Walk<br>• VA-Rancho Footswitch Stride Analyser Mark II<br>• VA-RFSA Mark II<br>• VA-RFSA Mark II<br>• VA-RFSA Mark II<br>• VA-RFSA Mark II<br>• VA-RFSA Mark II |

*Note: * denotes studies included in meta-analyses; AIMS = arthritis impact measurement scale; AIMS2 = arthritis impact measurement scale 2; BBS = Berg balance scale; sec. = seconds; BPI = brief pain inventory; DAQ = daily activities questionnaire; EMIR = Echelle de Mesure de l'Impact de la polyarthrite Rhumatoïde; EQ-5D = EuroQoL 5 dimensions; HAQ = health assessment questionnaire; IRGL = Invloed Reuma op Gezondheid en Leefwijze; M = metres; min. = minutes; mod. = modified; MOS-SF-12 = medical outcomes study short form 12; PSFS = patient-specific functional status; QoL = quality of life; QWB = quality of wellbeing scale; SF-36 = short form 36; SOLEC = seconds standing on one leg eyes closed; SOLEO = seconds standing on one leg eyes open; vas = visual analogue scale; WOMAC = Western Ontario and McMaster Universities arthritis index*

Table 2.3, Continued *Measures used to assess disability*

| Study | Disability Outcomes | Disability Measures |
|---|---|---|
| *Petkova (2009) | • Walking Ability<br>• General Activity | • BPI<br>• BPI |
| Radojevic, et al. (1992) | • Physical Functioning | • AIMS |
| *Ravaud, et al. (2009) | • Physical Function<br>• Physical | • Function SubscaleWOMAC (French-Canadian)<br>• MOS-SF-12 |
| Rogers & Wilder (2009) | • Physical<br>• Right Maximum Grip<br>• Right Average Grip<br>• Left Maximum Grip<br>• Left Average Grip<br>• Right Maximum Key Pinch<br>• Right Average Key Pinch<br>• Left Maximum Key Pinch<br>• Left Average Key Pinch<br>• Right Max 3-Point Pinch<br>• Right Ave 3-Point Pinch<br>• Left Max 3-Point Pinch<br>• Left Ave 3-Point Pinch<br>• Right Peg Board<br>• Left Peg Board<br>• Both Hands Peg Board | • AUSCAN<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard<br>• Purdue Pegboard |
| *Scholten, et al. (1999) | • Disability | • HAQ |
| *Sharpe & Schrieber (2012) | • Disability | • HAQ |
| *Sharpe, et al. (2001) | • Disability | • HAQ |
| *Stamm, et al. (2002) | • Grip Strength Left Hand<br>• Grip Strength Right Hand | • Martin Vigorimeter<br>• Martin Vigorimeter |
| *Taal, et al. (1993) | • Disability | • HAQ (Dutch) |
| *Victor, et al. (2005) | • Disability<br>• General Health<br>• Physical<br>• Role Physical | • Function Subscale WOMAC<br>• SF-36<br>• SF-36<br>• SF-36 |
| *Wetzels, et al. (2008) | • Physical | • AIMS2 (Dutch) |
| *Yip, et al. (2007) | • Disability<br>• Right Hamstring Strength<br>• Right Knee Flexion<br>• Right Quadriceps Strength | • HAQ – modified<br>• NR<br>• Goniometer<br>• NR |

*Note: * denotes studies included in meta-analyses; AIMS = arthritis impact measurement scale; AIMS2 = arthritis impact measurement scale 2; BBS = Berg balance scale; sec. = seconds; BPI = brief pain inventory; DAQ = daily activities questionnaire; EMIR = Echelle de Mesure de l'Impact de la polyarthrite Rhumatoïde; EQ-5D = EuroQoL 5 dimensions; HAQ = health assessment questionnaire; IRGL = Invloed Reuma op Gezondheid en Leefwijze; M = metres; min. = minutes; mod. = modified; MOS-SF-12 = medical outcomes study short form 12; PSFS = patient-specific functional status; QoL = quality of life; QWB = quality of wellbeing scale; SF-36 = short form 36; SOLEC = seconds standing on one leg eyes closed; SOLEO = seconds standing on one leg eyes open; vas = visual analogue scale; WOMAC = Western Ontario and McMaster Universities arthritis index; NR = not reported*

#### *2.3.2.3 Mental Health Outcomes*

Mental health was assessed in 44 studies. There were 12 different mental health related outcomes included across the studies reviewed. These outcomes were assessed using 38 different measures (Table 2.4). The most common outcomes were depression (61.4%) and anxiety (31.8%); 34.1% of these 44 studies included measures of both. Mental health (20.5%), emotional role (9.1%), and affect (6.8%) were also measured. The least common mental health outcomes measured were negative mood (2.3%), psychological quality of life (2.3%), emotion (2.3%), and emotional security (2.3%). The anxiety and depression items in the AIMS / AIMS2 (Meenan, Gertman, and Mason, 1980; Meenan, et al., 1992) were the most frequently used measures of anxiety and depression (22.7%). The CES-D (20.5%) (Radloff, 1977), the HADS (15.9%) (Zigmond and Snaith, 1983), and the mental health items within the SF-36 (13.6%) (Ware and Sherbourne, 1992) were also common measures of anxiety and depression. However, measures such as the AIMS and SF-36 measure a wide variety of outcomes and are not specific mental health outcome measures, they simply include subscales for assessing depression and anxiety (AIMS) and general mental health (SF-36). Further, a number of more obscure measures were also used, including the Human Service Scale (Wright, n.d.), the Geriatric Depression Scale (Brink, Yesavage, Lum, Heersema, Adey, and Rose, 1982), and the Depression Adjective List (Lubin, 1967).

Table 2.4 *Measures used to assess mental health*

| Study | Mental Health Outcomes | Mental Health Measures |
|---|---|---|
| Allen, et al. (2010) | • Affect | • AIMS2 |
| *Barlow, et al. (2000) | • Anxiety<br>• Depression | • EQ-5D<br>• HADS |
| *Beaupre, et al. (2004) | • Emotional Component | • Composite Score of Mental Health, Vitality, Social Function, and Role Emotional SF-36 Subscales |
| *Berge, et al. (2004) | • Anxiety<br>• Depression | • AIMS<br>• AIMS |
| *Blixen, et al. (2004) | • Anxiety<br>• Depression | • AIMS (Dutch version)<br>• AIMS (Dutch version) |
| Bradley, et al. (1987) | • Trait Anxiety<br>• Depression | • State-Trait Anxiety Inventory<br>• Depression Adjective Checklist |
| *Buszewicz, et al. (2006) | • Anxiety<br>• Depression<br>• Mental Health | • HAD<br>• HAD<br>• SF-36 |
| Cadbury (1997) | • | • GHQ |
| *Crotty, et al. (2009) | • Depression<br>• Emotional Wellbeing | • CES-D<br>• HEIQ |
| DeVellis, et al. (1988) | • Depression<br>• Depression<br>• Depression | • Numerical Scale<br>• AIMS<br>• General Wellbeing Scale |
| *Evers, et al. (2002) | • Anxiety<br>• Depression<br>• Negative Mood | • IRGL<br>• BDI (Dutch version)<br>• IRGL |
| Freeman, et al. (2002) | • Affect | • AIMS2 |
| *Frost (2005) | • Role Emotional<br>• Mental Health Component<br>• Mental Health | • SF-36<br>• Composite Score of Mental Health, Vitality, Social Function, and Role Emotional SF-36 Subscales<br>• SF-36 |
| Germond, et al. (1993) | • | • Profile Mood States |
| *Giraudet-Le Quintrec, et al. (2007) | • QoL Psychological<br>• Anxiety<br>• Depression | • EMIR<br>• HAD<br>• HAD |
| Goeppinger, et al. (1989) | • Depression | • CES-D |

*Note: * denotes studies included in meta-analyses; AIMS = arthritis impact measurement scale; AIMS2 = arthritis impact measurement scale 2; BDI = Beck depression inventory; BPI = brief pain inventory; CES-D = Center for Epidemiological Studies depression; cm = centimeters; EMIR = Echelle de Mesure de l'Impact de la polyarthrite Rhumatoïde; EQ-5D = EuroQoL 5 dimensions; GHQ = general health questionnaire; HAD = hospital anxiety and depression scale; HEIQ = health education impact questionnaire; IRGL = Invloed Reuma op Gezondheid en Leefwijze; MOS-SF-12 = medical outcomes study short form 12; PANAS = positive and negative affect scale; PHQ = patient health questionnaire; QoL = quality of life; SCL-90-R = symptom checklist 90 revised; SF-36 = short form 36*

Table 2.4, Continued *Measures used to assess mental health*

| Study | Mental Health Outcomes | Mental Health Measures |
|---|---|---|
| *Goeppinger, et al. (2009) | • Depression | • PHQ |
| Hammond, et al. (2004) | • Affect | • AIMS2 |
| *Helliwell, et al. (1999) | • Psychological Status | • SF-36 |
| Hewlett, et al. (2011) | • Anxiety<br>• Depression | • HADS<br>• HADS |
| Hurley, et al. (2007) | • Anxiety<br>• Depression | • HADS<br>• HADS |
| *Kaplan & Kozin, (1981) | • Depression | • Zung Self-Rating Depression Scale |
| *Keefe, et al. (2004) | • Psychological Disability | • AIMS |
| *Keefe, et al. (1990) | • Psychological Disability | • AIMS |
| *Kirwan, et al. (2005) | • Positive Affect<br>• Negative Affect<br>• Anxiety<br>• Depression | • PANAS<br>• PANAS<br>• HADS<br>• HADS |
| *Kraaimaat, et al. (1995) | • Anxiety<br>• Depression | • IRGL<br>• IRGL |
| *Lorig, et al. (1989) | • Depression | • CES-D |
| *Lorig, et al. (2004) | • Depression | • CES-D |
| *Masiero, et al. (2007) | • Psychological | • AIMS2 |
| *Neuberger, et al. (1993) | • Depression | • CES-D |
| *Nunez, et al. (2006a) | • Emotional Role<br>• Mental Health | • SF-36<br>• SF-36 |
| *Parker, et al. (1988) | • Anxiety<br>• Depression | • AIMS<br>• AIMS |
| Parker, et al. (1984) | • Depression | • Beck Depression Inventory |
| *Parker, et al. (1995) | • Anxiety<br>• Depression | • AIMS<br>• AIMS |
| *Petkova (2009) | • Enjoyment of Life<br>• Mood | • BPI<br>• BPI |
| *Pradhan, et al. (2007) | • Depression<br>• Psychological Distress Wellbeing | • SCL-90-R<br>• SCL-90-R<br>• SCL-90-R |
| Radojevic, et al. (1992) | • Psychological Status<br>• Depression | • AIMS<br>• CES-D |
| *Ravaud, et al. (2009) | • Mental | • MOS-SF-12 |

*Note: * denotes studies included in meta-analyses; AIMS = arthritis impact measurement scale; AIMS2 = arthritis impact measurement scale 2; BDI = Beck depression inventory; BPI = brief pain inventory; CES-D = Center for Epidemiological Studies depression; cm = centimeters; EMIR = Echelle de Mesure de l'Impact de la polyarthrite Rhumatoïde; EQ-5D = EuroQoL 5 dimensions; GHQ = general health questionnaire; HAD = hospital anxiety and depression scale; HEIQ = health education impact questionnaire; IRGL = Invloed Reuma op Gezondheid en Leefwijze; MOS-SF-12 = medical outcomes study short form 12; PANAS = positive and negative affect scale; PHQ = patient health questionnaire; QoL = quality of life; SCL-90-R = symptom checklist 90 revised; SF-36 = short form 36*

Table 2.4, Continued. *Measures used to assess mental health*

| Study | Mental Health Outcomes | Mental Health Measures |
|---|---|---|
| *Riemsma, et al. (1997) | • Depression<br>• Psychological Distress<br>Wellbeing | • SLR-90-R<br>• SLR-90-R<br>• SLR-90-R |
| *Scholten, et al. (1999) | • Depression<br>• Depression | • Freiburg Questionnaire<br>• BDI |
| *Sharpe & Schrieber (2012) | • Anxiety<br>• Depression<br>• Depression | • HAD<br>• HAD<br>• HAD |
| *Sharpe, et al. (2001) | • Anxiety<br>• Depression | • HAD<br>• HAD |
| *Taal, et al. (1993) | • Anxiety<br>• Depression | • AIMS (Dutch)<br>• AIMS (Dutch) |
| *Victor, et al. (2005) | • Mental<br>• Mental Health<br>• Role Emotional | • GHQ<br>• SF-36<br>• SF-36 |
| Wetstone, et al. (1985) | • Affect | • Affect Balance Scale |
| *Wetzels, et al. (2008) | • Affect | • AIMS2 (Dutch) |

*Note: * denotes studies included in meta-analyses; AIMS = arthritis impact measurement scale; AIMS2 = arthritis impact measurement scale 2; BDI = Beck depression inventory; BPI = brief pain inventory; CES-D = Center for Epidemiological Studies depression; cm = centimeters; EMIR = Echelle de Mesure de l'Impact de la polyarthrite Rhumatoïde; EQ-5D = EuroQoL 5 dimensions; GHQ = general health questionnaire; HAD = hospital anxiety and depression scale; HEIQ = health education impact questionnaire; IRGL = Invloed Reuma op Gezondheid en Leefwijze; MOS-SF-12 = medical outcomes study short form 12; PANAS = positive and negative affect scale; PHQ = patient health questionnaire; QoL = quality of life; SCL-90-R = symptom checklist 90 revised; SF-36 = short form 36*

#### *2.3.2.4 Self-Efficacy*

Self-efficacy is thought to be the main mechanism of change in SM interventions, but was only measured in 24 studies (Table 2.5). Most of these studies (71%) measured self-efficacy using the Arthritis Self-Efficacy Scale (ASES; Lorig, Chastain, Ung, Shoor, and Holman, 1989), but other measures, such as the Activities and Balance Confidence Questionnaire for falls efficacy (Powell and Myers, 1995), the ExBeliefs scale for exercise self-efficacy (Gecht, Connell, Sinacore, and Prohaska, 1996), and the Arthritis Helplessness Index (Nicassio, Wallston, Callahan, Herbert, and Pincus, 1985) were also employed. Bandura's (1997) original conceptualisation of self-efficacy was as a mediator of the effects of existing personal and environmental factors (ie. performance accomplishments, vicarious experience, social persuasion, and emotional arousal) on subsequent behaviour. However, none of the 23 studies that measured self-efficacy in this review analysed the variable as a potential mediator of effects, but rather as an outcome itself.

Table 2.5 *Measures used to assess self-efficacy*

| Study | Self-Efficacy Outcomes | Self-Efficacy Measures |
|---|---|---|
| Allen, et al., 2010 | • Self-efficacy | • ASES |
| *Arnold & Faulkner, 2010 | • Falls efficacy | • The Activities and Balance Confidence Questionnaire |
| *Barlow, et al., 2000 | • Arthritis self-efficacy | • Combination of ASES pain subscale and other subscale |
| *Buszewicz, et al., 2006 | • Pain self-efficacy<br>• Other self-efficacy | • ASES<br>• ASES |
| Cadbury, 1997 | • Arthritis self-efficacy | • Arthritis Helplessness Index |
| Freeman, et al., 2002 | • Self-efficacy | • ASES |
| Frost, 2005 | • Exercise self-efficacy | • Self-efficacy for Exercise scale |
| *Gallagher, et al., 1997 | • Self-efficacy | • ASES |
| *Goeppinger, et al., 2009 | • Arthritis self-efficacy | • ASES |
| *Hammond, et al., 1999 | • Self-efficacy | • ASES |
| Hammond, et al., 2004 | • Self-efficacy | • ASES |
| *Heuts, et al., 2005 | • Self-efficacy | • ASES |
| Hewlett, et al., 2011 | • Self-efficacy | • Rheumatoid Arthritis Self-Efficacy Scale |

*Note: * denotes studies included in meta-analyses; ASES = Arthritis Self-Efficacy Scale; VAS = visual analogue scale*

Table 2.5, Continued *Measures used to assess self-efficacy*

| Study | Self-Efficacy Outcomes | Self-Efficacy Measures |
|---|---|---|
| *Hopman-Rock & Westhoff, 2000 | • Self-efficacy | • VAS |
| *Hughes, et al., 2004 | • Exercise self-efficacy<br>• Pain self-efficacy<br>• Symptom management self-efficacy<br>• Barriers efficacy<br>• Adherence efficacy | • ASES<br>• ASES<br>• ASES<br>• McAuley Self-Efficacy Scale<br>• McAuley Self-Efficacy Scale |
| Hurley, et al., 2007 | • Self-efficacy | • ExBeliefs |
| *Keefe, et al., 2004 | • Self-efficacy | • ASES |
| *Kirwan, et al., 2005 | • Pain self-efficacy<br>• Function self-efficacy<br>• Other self-efficacy | • ASES<br>• ASES<br>• ASES |
| *Lorig, et al., 2004 | • Self-efficacy | • ASES |
| Lundgren, et al., 1999 | • Self-efficacy | • ASES |
| *Martire, et al., 2007 | • Self-efficacy | • ASES |
| *Parker, et al., 1995 | • Self-efficacy | • ASES |
| *Riemsma, et al., 1997 | • Pain self-efficacy<br>• Function self-efficacy<br>• Other symptoms self-efficcay | • ASES (Dutch version)<br>• ASES (Dutch version)<br>• ASES (Dutch version) |
| *Taal, et al., 1993 | • Pain self-efficacy<br>• Function self-efficacy<br>• Other symptoms self-efficcay | • ASES (Dutch version)<br>• ASES (Dutch version)<br>• ASES (Dutch version) |

*Note: * denotes studies included in meta-analyses; ASES = Arthritis Self-Efficacy Scale; VAS = visual analogue scale*

### *2.3.3 Risk of Bias in Included Studies*

The chances of selection bias was minimised by including only randomised studies. Eleven studies (13.8%) used block randomisation methods. This seems to be a fairly common practice in SM research because target populations are those with specific diagnoses and are, therefore, often recruited in blocks by hospital, medical practice, or therapist. Perhaps of more concern, only 12 (15.0%) studies used any method of allocation concealment – a procedure that has been estimated to effect outcome estimates by 41% (Schulz, et al., 1995). Wherever randomisation is possible, random allocation concealment is possible. Thus, this review has found that authors are either

neglecting to report this procedure or are, in fact, not including it as part of their methods.

### *2.3.4 Effects of Interventions*

The majority of studies reviewed (72.5%) reported positive outcomes in favour of the intervention. Of the studies that did not find positive effects (27.5%), only one reported negative outcomes with reduced activity and increased pain in the treatment group compared to controls (Parker, Singsen, Hewett, Walker, Hazelwood, Hall, Holsten, and Rodon, 1984). This study included only one SM technique (decision making) and this was delivered as didactic education.

## 2.4 Narrative Review Update: Methods

This section aims to update the narrative review presented in section 2.3 of the present thesis to include studies published between the years 2011 through 2017.

Searches were performed from December 6, 2017 until December 14, 2017 on PsycNET, Excerpta Medica database (Embase), ISI Web of Knowledge, Cochrane Library, the Cumulated Index to Nursing and Allied Health Literature (CINAHL), the Allied and Complementary Medicine Database (AMED), and the Health Management Information Consortium (HMIC) databases. The search terms employed were taken from Newman, Steed, and Mulligan (2004) and entered as:

(arthritis OR osteoarthritis OR musculoskeletal OR rheum*) AND (self-management OR self-care OR education* OR behav* OR psych* OR cognitive) AND (intervention OR program* OR trial) AND (random* OR RCT).

No additional data restrictions were applied. The searches returned 11,065 articles in total, with 9,350 remaining after duplicates were removed (see Figure 2.2).
Each of the 9,350 unique studies was screened for inclusion in the review. This involved screening titles, abstracts, and the full article when necessary. After

screening, 48 studies were judged as including one or more SM components. However, 12 could not be included as they were either protocols or conference abstracts with no full reports associated with them. This left 36 studies for review. The following data were extracted from each study: country of origin; target behaviour (e.g. physical activity, adherence to treatment, etc.); participant demographic information (age, gender, socioeconomic status, education level, ethnicity); clinical information (diagnostic criteria, joint involvement, disease duration, disease severity, and co-morbid conditions); sample size; methodology (recruitment methods, method of randomisation, attrition rates, outcomes, outcome measures, outcome validation methods, and follow-up length(s)); intervention provided [group vs. individual sessions, SM techniques used, group size, number of sessions, duration of sessions, duration of intervention, co-interventions, delivery format (eg. face-to-face meetings, mail-delivered intervention, online intervention), delivery source (eg. health professional, lay-person, exercise instructor, psychologist), and theoretical framework]; outcome effects (mean, standard deviation, statistic type, *p* value, effect direction, and number of responders); and number and type of self-management techniques included (i.e. PS, DM, CHCP, RU, or TA).

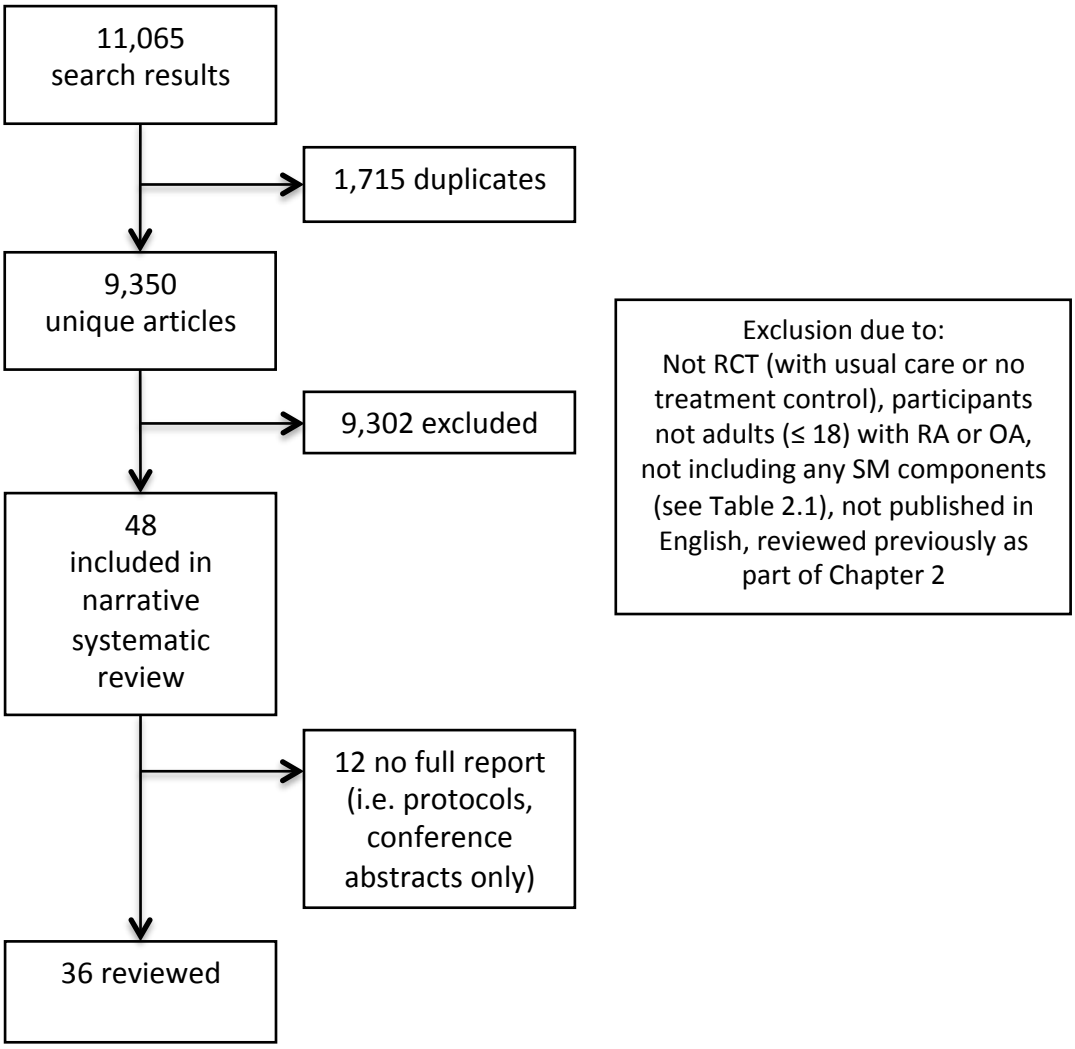


**Figure 2.2** ***Inclusion and exclusion of articles in the narrative review update***

## 2.5 Narrative Review Update: Results

### *2.5.1 Description of Studies*

All data extracted from studies included in this narrative review update are included in Appendix 2. The mean age across studies ranged from 30.2 (sd = 5.4) to 79.1 years (sd = 10.2). Aside from two studies that included only females, studies ranged from 7% : 93% female to male ratio to 97% : 3% female to male ratio. All but two studies included a majority of female participants, excluding two that did not report data regarding gender. Group sample sizes ranged from eight to 288. Across the 36 studies reviewed, slightly more than a quarter of the 76 study groups featured sample sizes of 100 participants or more (27.6%). Most studies included one intervention and one control group (83.3%), although some included three (5.6%) or four (11.1%) groups total.

Participants were most often recruited from medical centres (55.6%), but some recruited from the community through fliers, radio, newspaper advertisements, and online (19.4%), used a combination of recruitment from medical centres and from the community (13.9%), or recruited participants from medical records (8.3%). Only one recruited from a joint replacement waiting list (2.8%).

Block randomisation was used in more than a third (38.9%) of studies. Participants were matched or stratified based on certain variables in 22.2% of studies. Namely, participants were matched or stratified by sex, age, location, education, disease activity, affected joint, gender, and race.

Intervention length varied across studies, with the briefest lasting 3.5 hours while others continued for one or more years. The most common intervention length (33.3%) was six weeks. Nearly all interventions (86.1%) were delivered by health professionals, although some were delivered online (8.3%) and two did not report an intervention delivery source. All of the interventions delivered online were reportedly developed by healthcare professionals.

Attrition was reported according to each treatment group by 80.6% of studies. Apart from the few treatment (5.0%) and control (5.6%) groups that reportedly did not lose any participants, the rate of attrition amongst the studies reviewed ranged from 2% to 56% for treatment groups and 1% to 45% for control groups. Therefore, treatment (18.8%) and control (17.9%) groups had similar average attrition rates overall.

Three quarters of included studies (75.0%) measured outcomes at follow-up periods subsequent to immediate post. The most common follow-up period beyond immediate post-treatment were 6 months (38.9%), 12 months (30.6%), and 3 months (19.4%) after treatment, respectively, although the longest follow-up period took place five years post-treatment.

Of the 36 studies reviewed, only one usual care control group received any form of SM (i.e. 'decision making'). This was delivered in the form of didactic information. The comparative intervention in this study received both elements of 'decision making' and 'communication with healthcare professionals'. SM components were delivered to the intervention group in considerably more detail and intensity than that received by the control group.

Only 11 studies (30.6%) reported using theory to inform intervention development. Of those that did, the most commonly applied theories were Social Cognitive or Social Learning Theory (45.5%), self-efficacy theory or the self-efficacy construct (18.2%), and Behavioural Choice Theory (18.2%), although one used Gate Contol Model (Somers, Blumenthal, Guilak, Kraus, Schmitt, Babyak, Craighead, Caldwell, Rice, McKee, Shelby, Campbell, Pells, Sims, Queen, Carson, Connelly, Dixon, LaCaille, Huebner, Rejeski, and Keefe, 2012) and one used self-regulation model (Saraboon, Aree-Ue, and Maruo, 2015).

### *2.5.2 Outcomes Assessed and Measured Used*

Studies included many different outcomes and employed many different measures to quantify those outcomes. The same health outcome was often assessed by different measures both within and between studies (Tables 2.20, 2.21, and 2.22).

#### *2.5.2.1 Pain Outcomes*

Pain was assessed in 27 studies. Most of these studies (92.6%) reported measuring 'pain' in general (Table 2.6). However, some studies also included measures of pain intensity (Broderick, Keefe, Bruckenthal, Junghaenel, Schneider, Schwartz, Kaell, Caldwell, McKee, Reed, and Gould, 2014; Dziedzic, Healey, Porcheret, Afolabi, Lewis, Morden, Jinks, McHugh, Ryan, Finney, Main, Edwards, Paskins, Pushpa-Rajah, and Hay, 2018; Laforest, Nour, Gignac, Gauvin, and Parisien, 2012; Skou, Roos, Simonsen, Laursen, Rathleff, Arendt-Nielsen, and Rasmussen, 2016), intermittent pain and constant pain (Clarke, Poulis, Moreton, Walsh, and Lincoln, 2016), bodily pain (Helminen, Sinikallio, Valjakka, Väisänen-Rouvali, and Arokoski, 2015), pain severity and pain interference (Saw, Kruger-Jakins, Edries, and Parker, 2016), pain location and spreading of pain (Skou, et al., 2016). Seventeen different measures were used to assess pain. Visual anologue scales were the most common method of measuring pain (37.0%), but some also employed the pain subscales included in multi-dimensional measures such as AIMS / AIMS2 (14.8%), WOMAC (22.2%). Other studies included numerical rating scales (22.2%) and, less commonly, maps (3.7%), charts (3.7%), or diaries (3.7%).

Table 2.6 *Measures used to assess pain*

| Study | Pain Outcomes | Pain Measures |
|---|---|---|
| Allen, et al. (2017) | • Pain | • WOMAC Pain subscale |
| Bossen, et al. (2013) | • Pain | • Numerical scale |
| Broderick, et al. (2014) | • Pain<br>• Pain intensity | • Brief Pain Inventory<br>• Voice diaries |
| Callahan, et al. (2014) | • Pain | • VAS |
| Clarke, et al. (2017) | • Pain<br>• Intermittent pain<br>• Constant pain | • Numerical scale<br>• IOACP<br>• IOACP |
| Conn, et al. (2013) | • Pain | • VAS |
| Dziedzic, et al. (2018) | • Hip pain intensity<br>• Knee pain intensity<br>• Hand pain intensity<br>• Foot pain intensity | • NR<br>• NR<br>• NR<br>• NR |
| El Miedany, et al. (2012) | • Pain | • PROMs |
| Feldthusen, et al. (2016) | • Pain | • VAS |
| Ferwerda, et al. (2017) | • Pain | • IRGL pain subscale |
| Helminen, et al. (2015) | • Pain<br>• Pain<br>• Bodily pain | • WOMAC pain subscale<br>• Numerical scale<br>• RAND-36 |
| Laforest, et al. (2012) | • Pain intensity | • VAS |
| Manning, et al. (2014) | • Pain | • VAS |
| Moe, et al. (2013) | • Pain<br>• Pain<br>• Pain | • Numerical scale<br>• AUSCAN pain subscsale<br>• WOMAC pain subscale |
| Murphy, et al. (2016) | • Pain | • WOMAC pain subscale |
| Pisters, et al. (2010) | • Pain | • WOMAC pain subscale |
| Poulsen, et al. (2013) | • Pain<br>• Pain | • Numerical scale<br>• HOOS pain subscale |
| Rini, et al. (2015) | • Pain | • AIMS2 pain subscale |
| Saraboon, et al. (2015) | • Pain | • Numerical scale |
| Saw, et al. (2016) | • Pain severity<br>• Pain interference | • BPI severity subscale<br>• BPI interference subscale |
| Shigaki, et al. (2013) | • Pain<br>• Pain | • AIMS2 pain subscale<br>• RADAR pain subscale |
| Skou, et al. (2016) | • Pain<br>• Pain intensity while walking<br>• Knee pain location/pattern<br>• Spreading of pain | • VAS<br>• VAS after 30 minute walk<br>• Knee Pain Map<br>• Self-report using body chart |
| Somers, et al. (2012) | • Pain<br>• Pain | • AIMS pain subscale<br>• WOMAC pain subscale |
| Sperber, et al. (2013) | • Pain<br>• Pain | • AIMS2 pain subscale<br>• VAS |
| Thomsen, et al. (2016) | • Pain | • VAS |
| Thomsen, et al. (2017) | • Pain | • VAS |
| Yousefi, et al. (2015) | • Pain | • VAS |

*Note: IOACP = Intermittent and Constant Pain Scale; PROMs = Patient Reported Outcome Measures; IRGL = Impact of Rheumatic diseases on General health and Lifestyle; AUSCAN = Australian / Canadian hand osteoarthritis index; WOMAC = Western Ontario and McMaster Universities Arthritis Index; HOOS = Hip Osteoarthritis Disability and Osteoarthritis Outcome Score; AIMS = Arthritis Impact Measurement Scale; BPI = Brief Pain Inventory; RADAR = Rapid Assessment of Disease Activity in Rheumatology; VAS = visual anologue scale; NR = not reported*

#### *2.5.2.2 Disability Outcomes*

Disability was assessed in 29 studies. Forty-five different disability-related outcomes were measured, including physical function, disease activity, health, disability, and stiffness (Table 2.7). However, some studies targeted more specific outcomes, such as daily sitting time and breaks in daily sitting time (Thomsen, Aadahl, Beyer, Hetland, Løppenthin, Midtgaard, Christensen, and Esbensen, 2016; Thomsen, Aadahl, Beyer, Hetland, Løppenthin, Midtgaard, Christensen, Østergaard, Jennum, and Esbensen, 2017), fast and normal gait velocity (Somers, et al., 2012), flexion (Poulsen, Hartvigsen, Christensen, Roos, Vach, and Overgaard, 2013), or hand and finger function (Dziedzic, et al., 2018). Disability-related outcomes were assessed using 64 different measures. The most frequently used measures of disability were the Western Ontario and McMaster Universities Osteoarthritis Index or one or more of its subscales (WOMAC; 34.5%), the Health Assessment Questionnaire (HAQ; 20.7%), the Arthritis Impact Measurement Scale or one or more of its subscales (AIMS, AIMS2; 20.7%), and the Short Form Health Survey (SF-36; 17.2%).

Table 2.7 *Measures used to assess disability*

| Study | Disability Outcomes | Disability Measures |
|---|---|---|
| Allen, et al. (2017) | • Function<br>• Function<br>Function | • WOMAC total<br>• WOMAC Function subcale<br>Short Physcial Performance Battery |
| Bossen, et al. (2013) | • Function<br>Function | • Knee OA Outcome Score<br>Hip Injury OA Outcome Score |
| Breedland, et al. (2011) | • Aerobic capacity<br>• Muscle strength<br>Health status | • Cycle ergometer<br>• Handheld dynamometer<br>Dutch AIMS2 |
| Broderick, et al. (2014) | • Physical function | • WOMAC |
| Callahan, et al. (2014) | • Physical functioning<br>• Physical functioning<br>• Functional mobility<br>• Disability | • Timed chair stand<br>• Timed 360-degree turn test<br>• Gait speed<br>• HAQ |
| Conn, et al. (2013) | • Disability<br>• Health<br>• Tender joints<br>• Swollen joints<br>• Disease activity | • HAQ<br>• SF-36<br>• Number tender joints<br>• Number swollen joints<br>• ACR20 |
| Dziedzic, et al. (2018) | • Physical function<br>• Physical activity<br>• Physical activity<br>• Hand and finger function | • WOMAC<br>• IPAQ<br>• PASE<br>• AIMS2 |
| El Miedany, et al. (2012) | • Patient Global Assessment<br>• Functional Disability<br>• Disease Activity | • PROMs<br>• PROMs<br>• DAS-28 |
| Feldthusen, et al. (2016) | • Disease activity<br>• Leg strength / endurance<br>• Physical activity<br>• Health status | • DAS-28<br>• 1-minute sit-to-stand test<br>• Leisure Time Physical Activity Index<br>• VAS |
| Ferguson, et al. (2015) | • Disease features<br>• Functioning | • DAS-28<br>• HAQ |
| Ferwerda, et al. (2017) | • Mobility<br>• Role – physical limitations<br>• Disease activity | • IRGL mobility subscale<br>• RAND-36<br>• RADAI |
| Helminen, et al. (2015) | • Physical functioning<br>• Stiffness<br>• Health-related quality of life<br>• Physical functioning<br>• Role-physical<br>• General health | • WOMAC function subscale<br>• WOMAC stiffness subscale<br>• Health Related QoL-15D<br>• RAND-36<br>• RAND-36<br>• RAND-36 |
| Laforest, et al. (2012) | • Functional limitations | • WOMAC |

*Note: ACR = American College of Rheumatology; AIMS = Arthritis Impact Measurement Scale; AUSCAN = Australian / Canadian hand osteoarthritis index; DAS = Disease Activity Score; HAQ = Health Assessment Questionnaire; HOOS = Hip Osteoarthritis Disability and Osteoarthritis Outcome Score; HSCL = Hopkins Symptom Checklist; IPAQ = International Physcial Activity Questionnaire; IRGL = Impact of Rheumatic diseases on General health and Lifestyle; MACTAR = McMaster Toronto Arthritis Patient Preference Disability Questionnaire; NR = not reported; PASE = Physical Activity for the Elderly; PROMs = patient related outcome measures; QoL = quality of life; RADAI = Rheumatoid Arthritis Disease Activity Index; RAQoL = Rheumatoid Arthritis Quality-of-Life Scale; SF-36 = Short Form Health Survey-36; SPPB = Short Physical Performance Battery; WOMAC = Western Ontario and McMaster Universities Arthritis Index*

Table 2.7, Continued. *Measures used to assess disability*

| Study | Disability Outcomes | Disability Measures |
|---|---|---|
| Lee, et al. (2012) | • Perceived health status<br>Joint pain | • NR<br>Number of painful joints |
| Manning, et al. (2014) | • Hand functional ability<br>• Upper extremity function<br>• Upper extremity function<br>• Disease activity<br>• Morning stiffness<br>• Disease activity<br>• Quality of life<br>• Dominant handgrip strength<br>• Nondominant handgrip strength | • Grip Ability Test<br>• Timed dressing (seconds)<br>• Timed eating (seconds)<br>• DAS-28<br>• Duration (minutes)<br>• Assessor-rated<br>• RAQoL<br>• Hydraulic handgrip dynamometer<br>• Hydraulic handgrip dynamometer |
| Moe, et al. (2013) | • Stiffness<br>• Stiffness<br>• Stiffness<br>• Disease activity<br>• Disease activity<br>• Disease activity<br>• Physical health | • Numerical scale<br>• AUSCAN stiffness subscale<br>• WOMAC stiffness subscale<br>• HSCL-25<br>• AUSCAN physical subscale<br>• WOMAC physical subscale<br>• SF-36 physical composite |
| Murphy, et al. (2016) | • Physical function<br>• Disability | • Six minute walk<br>• WOMAC disability subscale |
| Pisters, et al. (2010) | • Physical function<br>• Physical function<br>• Physical performance | • WOMAC function subscale<br>• MACTAR<br>• 5 minute walk (inches) |
| Poulsen, et al. (2013) | • Symptoms<br>• Function in daily living<br>• Sport and recreation<br>• Hip-related quality of life<br>• Flexion<br>• Abduction-adduction<br>• Internal-external rotation | • HOOS symptoms subscale<br>• HOOS function subscale<br>• HOOS sport and recreation subscale<br>• HOOS quality of life subscale<br>• Range of motion<br>• Range of motion<br>• Range of motion |
| Rini, et al. (2015) | • Pain-related function | • AIMS2 lower extremity subscales |
| Saraboon, et al. (2015) | • Disease activity<br>• Movement ability<br>• Range of motion | • The Knee Severity Scale<br>• The Timed Up and Go Test<br>• Goniometer |
| Saw, et al. (2016) | • Disability<br>• Health-related quality of life<br>• Function | • HAQ<br>• EuroQol-5D<br>• Physical Performance Task Battery |

*Note: ACR = American College of Rheumatology; AIMS = Arthritis Impact Measurement Scale; AUSCAN = Australian / Canadian hand osteoarthritis index; DAS = Disease Activity Score; HAQ = Health Assessment Questionnaire; HOOS = Hip Osteoarthritis Disability and Osteoarthritis Outcome Score; HSCL = Hopkins Symptom Checklist; IPAQ = International Physcial Activity Questionnaire; IRGL = Impact of Rheumatic diseases on General health and Lifestyle; MACTAR = McMaster Toronto Arthritis Patient Preference Disability Questionnaire; NR = not reported; PASE = Physical Activity for the Elderly; PROMs = patient related outcome measures; QoL = quality of life; RADAI = Rheumatoid Arthritis Disease Activity Index; RAQoL = Rheumatoid Arthritis Quality-of-Life Scale; SF-36 = Short Form Health Survey-36; SPPB = Short Physical Performance Battery; WOMAC = Western Ontario and McMaster Universities Arthritis Index*

Table 2.7, Continued. *Measures used to assess disability*

| Study | Disability Outcomes | Disability Measures |
|---|---|---|
| Schlenk, et al. (2011) | • Physical function<br>• Physical function<br>• Physical function | • 6 minute walk (yards)<br>• SPPB<br>• WOMAC function subscale |
| Shigaki, et al. (2013) | • Physical health | • AIMS2 physical composite |
| Somers, et al. (2012) | • Disability<br>• Stiffness<br>• Physical functioning<br>• Normal gate velocity<br>• Fast gate velocity | • AIMS physical subscale<br>• WOMAC stiffness subscale<br>• WOMAC function subscale<br>• EvaRT motion analysis<br>• EvaRT motion analysis |
| Sperber, et al. (2013) | • Mobility<br>• Walking and bending | • AIMS2 mobility subscale<br>• AIMS2 walking and bending subscale |
| Thomsen, et al. (2016) | • Daily sitting time<br>• Breaks in daily sitting time<br>• Functional function<br>• Health-related quality of life<br>• Disease activity<br>• Disease activity | • ActivPAL Activity Monitor<br>• ActivPAL Activity Monitor<br>• HAQ<br>• SF-36 physical component<br>• C-reactive protein level<br>• HbA1c level |
| Thomsen, et al. (2017) | • Daily sitting time<br>• Breaks in daily sitting time<br>• Functional function<br>• Health-related quality of life<br>• Disease activity<br>• Disease activity | • ActivPAL Activity Monitor<br>• ActivPAL Activity Monitor<br>• HAQ<br>• SF-36 physical component<br>• C-reactive protein level<br>• HbA1c level |
| Yousefi, et al. (2015) | • General health<br>• Physical health | • VAS<br>• SF-36 physical component |

*Note: ACR = American College of Rheumatology; AIMS = Arthritis Impact Measurement Scale; AUSCAN = Australian / Canadian hand osteoarthritis index; DAS = Disease Activity Score; HAQ = Health Assessment Questionnaire; HOOS = Hip Osteoarthritis Disability and Osteoarthritis Outcome Score; HSCL = Hopkins Symptom Checklist; IPAQ = International Physcial Activity Questionnaire; IRGL = Impact of Rheumatic diseases on General health and Lifestyle; MACTAR = McMaster Toronto Arthritis Patient Preference Disability Questionnaire; NR = not reported; PASE = Physical Activity for the Elderly; PROMs = patient related outcome measures; QoL = quality of life; RADAI = Rheumatoid Arthritis Disease Activity Index; RAQoL = Rheumatoid Arthritis Quality-of-Life Scale; SF-36 = Short Form Health Survey-36; SPPB = Short Physical Performance Battery; WOMAC = Western Ontario and McMaster Universities Arthritis Index*

#### *2.5.2.3 Mental Health Outcomes*

Mental health was assessed in 19 studies. Fourteen different mental health related outcomes were measured using 17 different measures (Table 2.8). Depression, depressed mood, or depressive symptoms (57.9%) and anxiety (36.8%) were the most common mental health outcomes; 36.8% of these 19 studies included measures of both. Positive, negative, and overall affect (15.8%), mental health (15.8%), and emotional role (10.5%) were also measured. The mental component of the SF-36 was the most frequently used measure of mental health (26.3%), while the Beck Depression Inventory (BDI; 15.8%), the Patient Health Questionnaire (PHQ-8, PHQ-9; 15.8%) and the depression subscale of the Hospital Anxiety and Depression Scale (HADS; 15.8%) were most commonly used to measure depression. The anxiety subscale of the HADS was a common measure of anxiety (15.8%). However, certain studies also used the Beck Anxiety Inventory (5.3%), the General Health Questionnaire (5.3%), the Impact of Rheumatic Diseases on General Health and Lifestyle scale (5.3%), and the RAND-36 (10.5%).

Table 2.8 *Measures used to assess mental health*

| Study | Mental Health Outcomes | Mental Health Measures |
|---|---|---|
| Allen, et al. (2017) | • Depressive Symptoms | • PHQ-8 |
| Bossen, et al. (2013) | • Anxiety<br>• Depression | • HADS anxiety subscale<br>• HADS depression subscale |
| Broderick, et al. (2014) | • Depressed mood | • BDI |
| Clarke, et al. (2017) | • Mood | • GHQ-12 |
| Dziedzic, et al. (2018) | • Depression<br>• Anxiety<br>• Mental health | • PHQ-8<br>• GAD-7<br>• SF-12 mental score |
| Feldthusen, et al. (2016) | • Anxiety<br>• Depression | • HADS anxiety subscale<br>• HADS depression subscale |
| Ferguson, et al. (2015) | • Depression<br>• Anxiety | • PHQ-9<br>• GAD-7 |
| Ferwerda, et al. (2017) | • Depressed mood<br>• Negative mood<br>• Anxiety<br>• Role-emotional limitations | • BDI<br>• IRGL negative mood subscale<br>• IRGL anxiety subscale<br>• RAND-36 |
| Helminen, et al. (2015) | • Role-emotional<br>• Emotional well-being<br>• Depression<br>• Anxiety | • RAND-36<br>• RAND-36<br>• BDI<br>• BAI |
| Laforest, et al. (2012) | • Depressive symptomatology | • CES-D |
| Meade, et al. (2015) | • Depression<br>• Anxiety | • HADS anxiety subscale<br>• HADS depression subscale |
| Moe, et al. (2013) | • Mental health | • SF-36 mental composite |
| Rini, et al. (2015) | • Negative affect<br>• Positive affect | • PANAS<br>• PANAS |
| Shigaki, et al. (2013) | • Affective<br>• Depressive symptoms | • AIMS2 mental composite<br>• CES-D |
| Somers, et al. (2012) | • Psychological disability | • AIMS psychological subscale |
| Sperber, et al. (2013) | • Affect | • AIMS2 affect subscale |
| Thomsen, et al. (2016) | • Health-related quality of life | • SF-36 mental component |
| Thomsen, et al. (2017) | • Health-related quality of life | • SF-36 mental component |
| Yousefi, et al. (2015) | • Mental health | • SF-36 mental component |

*Note: AIMS = Arthritis Impact Measurement Scales; BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory; CES-D = Center for Epidemiological Studies-Depression Scale; GAD = Generalised Anxiety Disorder; GHQ = General Health Questionnaire; HADS = Hospital Anxiety and Depression Scale; IRGL = Impact of Rheumatic diseases on General health and Lifestyle; PANAS= Positive and Negative Affect Scale; PHQ = Patient Health Questionnaire; SF-36 = Short Form Health Survey-36*

#### *2.5.2.4 Self-Efficacy*

Self-efficacy was measured in 20 studies (Table 2.9). The Arthritis Self-Efficacy Scale (ASES; Lorig, et al., 1989) was the most common measure of self-efficacy employed (70.0%), but other measures, such as the Self-efficacy for Exercise Scale (SEE; McAuley, 1992; McAuley, 1993), the General Self-efficacy Scale (GSES; Luszczynska, Scholz, and Schwarzer, 2005), the Rheumatoid Arthritis Self-efficacy Scale (RASE; ), the Weight Efficacy Lifestyle Questionnaire (WELSQ; Clark, Abrams, Niaura, Eaton, and Rossi, 1991), the Pain Self-efficacy Questionnaire (PSEQ; Nicholas, 2007), and the Self-Efficacy for Managing Chronic Disease scale (Lorig, et al., 2001b) were also employed.

Table 2.9 *Measures used to assess self-efficacy*

| Study | Self-Efficacy Outcomes | Self-Efficacy Measures |
|---|---|---|
| Bossen, et al. (2013) | • Pain self-efficacy<br>• Other self-efficacy | • ASES<br>• ASES |
| Breedland, et al. (2011) | • Self-efficacy | • ASES (Dutch) |
| Broderick, et al. (2014) | • Self-efficacy | • ASES |
| Callahan, et al. (2014) | • Exercise self-efficacy<br>• Pain self-efficacy<br>• Symptoms self-efficacy | • SEE<br>• ASES<br>• ASES |
| Dziedzic, et al. (2018) | • Pain self-efficacy | • ASES |
| Feldthusen, et al. (2016) | • Self-efficacy | • ASES (Swedish) other symptoms scale |
| Hansson, et al., 2010 | • Pain self-efficacy<br>• Function self-efficacy<br>• Symptoms self-efficacy | • ASES pain subscale<br>• ASES function subscale<br>• ASES other symptoms subscale |
| Helminen, et al. (2015) | • Pain self-efficacy | • PSEQ (Finnish) |
| Hewlett, et al. (2011) | • Self-efficacy | • RASE |
| Manning, et al. (2014) | • Pain self-efficacy<br>• Function self-efficacy<br>• Symptoms self-efficacy | • ASES pain subscale<br>• ASES function subscale<br>• ASES symptoms subscale |
| Meade, et al. (2015) | • Self-efficacy | • ASES |
| Moe, et al. (2013) | • Pain self-efficacy<br>• Symptoms self-efficacy | • ASES pain subscale<br>• ASES symptoms subscale |
| Rini, et al. (2015) | • Pain self-efficacy | • ASES pain subscale |
| Saw, et al. (2016) | • Self-efficacy | • The Self-Efficacy for Managing Chronic Disease 6-item Scale |

*Note: ASES = Arthrits Self-Efficacy Scale; GSES = General Self-Efficacy Scale; PSEQ = Pain Self-efficacy Questionnaire; RASE = Rheumatoid Arthritis Self-Efficacy Scale; SEE = Self-Efficacy for Exercise Scale; WELSQ = Weight Efficacy Life-Style Questionnaire*

Table 2.9, Continued. *Measures used to assess self-efficacy*

| Study | Self-Efficacy Outcomes | Self-Efficacy Measures |
|---|---|---|
| Schlenk, et al. (2011) | • Exercise self-efficacy | • SEE |
| Shigaki, et al. (2013) | • Self-efficacy | • ASES |
| Somers, et al. (2012) | • Self-efficacy<br>• Weight control self-efficacy | • ASES<br>• WELSQ |
| Sperber, et al. (2013) | • Self-efficacy | • ASES |
| Thomsen, et al. (2016) | • Self-efficacy | • GSES |
| Thomsen, et al. (2017) | • Self-efficacy | • GSES |

*Note: ASES = Arthrits Self-Efficacy Scale; GSES = General Self-Efficacy Scale; PSEQ = Pain Self-efficacy Questionnaire; RASE = Rheumatoid Arthritis Self-Efficacy Scale; SEE = Self-Efficacy for Exercise Scale; WELSQ = Weight Efficacy Life-Style Questionnaire*

### *2.5.3 Risk of Bias in Included Studies*

The chances of selection bias was minimised by including only randomised studies. Fourteen studies (38.9%) used block randomisation methods. Seventeen studies (52.8%) included allocation concealment as part of their procedure: a nearly 38% higher proportion when compared with the cohort of studies included in this thesis' original Chapter 2.3 narrative review.

### *2.5.4 Effects of Interventions*

The majority of the studies reviewed (72.2%) reported positive outcomes in favour of the intervention. Of the remaining studies (27.8%), none reported any negative outcomes of the intervention, but simply found their effects to be statistically nonsignificant.

## 2.6 Meta-Analyses

Of the 80 studies included in the narrative review presented in section 2.3 of the present thesis, 19 did not provide sufficient data to be meta-analysed and a further 2 did not measure one or more of the target outcomes for inclusion in meta-analyses (ie. pain, disability, mental health). Thus, 59 of the studies included in the narrative review were also included in meta-analyses. Table 2.10 details study characteristics included in the meta-regression analyses according to each study and their target outcome(s).

Figure 5 shows the number of studies that included each of the five SM components. Twenty seven percent of studies included one self-management technique, 27% included two, 30% included three, 10% included four, and 5% included five. The number of SM components included in an intervention did not significantly affect any outcome. Overall, decision making was included most frequently, followed by problem-solving, taking action, and communication with healthcare providers, while resource utilisation was included least frequently.

Table 2.10 *Characteristics of each study included in meta-analyses*

| Author, Year | N | Duration (weeks) | Time of Follow-Up | Delivery Format | Delivery Source | Country | Outcome | Number of SM Techniques | Number of Sessions | Cointervention |
|---|---|---|---|---|---|---|---|---|---|---|
| Appelbaum, et al., 1988 | 9 | 6 | PT | U | Non-HP | US | D; P; M | 2 | 10 | Yes |
| Arnold, et al., 2010 | 26 | 11 | PT | G | Mixed | Other | D | 3 | 33 | Yes |
| Barlow, et al., 2000 | 114 | 6 | 1 | G | Non-HP | UK | D; P; M | 4 | 6 | No |
| Bell, et al., 1998 | 69 | 6 | PT | I | HP | Other | D; P | 3 | 4 | Yes |
| Berge, et al., 2004 | 19 | 6 | 1 | G | HP | UK | D; P; M | 3 | 8 | Yes |
| Blixen, et al., 2004 | 15 | 6 | 1 | I | HP | US | D; P; M | 2 | 6 | No |
| Brus, et al., 1998 | 24 | 32 | PT; 2 | G | HP | EU | D; P; M | 3 | 6 | Yes |
| Buszewicz, et al., 2006 | 234 | 6 | 1; 2 | G | Non-HP | UK | D; P; M | 4 | 6 | No |
| Cronan, et al., 1997 | 89 | 50 | PT; 2 | G | HP | US | D | 1 | 20 | Yes |
| Crotty, et al., 2009 | 75 | 8 | 1 | I | M | Other | D; P; M | 2 | 10 | No |
| Evers, et al., 2002 | 30 | 14 | 1; 2 | I | HP | EU | D; P; M | 2 | 11 | Yes |
| Fries, et al., 1997 | 375 | 24 | PT | I | Non-HP | US | D; P | 5 | 10 | No |
| Frost, et al., 2005 | 13 | 8 | PT | I | Non-HP | US | D; P; M | 2 | 4 | No |
| Gallagher, et al., 1997 | 70 | 52 | PT; 2 | G | U | US | D | 1 | 20 | No |
| Gerber, et al., 1987 | 14 | 6 | 1 | Mixed | HP | US | D | 1 | 6 | No |
| Giraudet-Le Quintrec, 2007 | 103 | 32 | 1; 2 | G | Mixed | EU | D; M | 1 | 9 | No |
| Goeppinger, et al., 2009 | 359 | 0.14 | 1 | I | Non-HP | US | D; P; M | 4 | 0 | No |
| Hammond & Freeman 2001 | 63 | U | 1; 2 | G | HP | UK | D; P | 3 | 4 | No |
| Hammond, et al., 1999 | 16 | 4 | 1 | G | HP | UK | D; P | 3 | 5 | No |
| Hansson, et al., 2010 | 61 | 5 | 1 | G | HP | EU | D | 2 | 5 | No |

*Note: N = sample size; U = unreported; Duration = intervention duration; Time of Follow-Up: PT = post-treatment, 1 =* ≤ 6 months, 2 = > 6 months*; I = individual sessions; G = group sessions; HP = health professional; EU = European Union UK = United Kingdom; US = United States; D = disability outcomes; P = pain outcomes; M = mental health outcomes; Cointervention = included component that was not one of the five self-management techniques*

Table 2.10, Continued *Characteristics of each study included in meta-analyses*

| Author, Year | N | Duration (weeks) | Time of Follow-Up | Delivery Format | Delivery Source | Country | Outcome | Number of SM Techniques | Number of Sessions | Cointervention |
|---|---|---|---|---|---|---|---|---|---|---|
| Helliwell, et al., 1999 | 43 | 4 | PT; 2 | G | HP | UK | D; P; M | 1 | 4 | No |
| Heuts, et al., 2005 | 132 | U | 1; 2 | G | HP | EU | D; P | 4 | 6 | No |
| Hill, et al., 2001 | 33 | 24 | PT | I | HP | UK | P | 1 | 7 | No |
| Hopman-Rock, et al., 2000 | 49 | 6 | PT; 1 | G | Mixed | EU | D; P | 2 | 6 | Yes |
| Hughes, et al., 2004 | 68 | 8 | PT; 1 | G | HP | US | D; P | 3 | 24 | Yes |
| Kaplan, et al., 1981 | 11 | 15 | 1 | G | HP | US | M | 3 | 15 | No |
| Keefe, et al., 2004 | 20 | 12 | PT | G | HP | US | P; M | 2 | 48 | Yes |
| Keefe, et al., 1990 | 36 | 10 | PT | G | HP | US | D; P; M | 1 | 48 | Yes |
| Kirwan, et al., 2005 | 28 | 8 | PT; 1; 2 | G | HP | UK | D; P; M | 2 | 5 | No |
| Kovar, et al., 1992 | 47 | 8 | PT | G | HP | US | D; P | 1 | 24 | Yes |
| Kraaimaat, et al., 1995 | 24 | 10 | PT; 1 | G | HP | EU | D; P; M | 1 | 10 | Yes |
| Laforest, et al., 2008 | 59 | 6 | PT | I | HP | Other | D; P | 4 | 6 | Yes |
| Lindroth, et al., 1997 | 37 | 8 | PT; 1 | G | HP | EU | D; P | 2 | 8 | No |
| Lorig, et al., 1986 | 27 | 6 | PT | G | Non-HP | US | D; P | 3 | 6 | No |
| Lorig, et al., 1985 | 129 | 16 | PT | G | Non-HP | US | D; P | 3 | 6 | No |
| Lorig, et al., 1989 | 501 | 6 | 1 | G | Non-HP | US | D; P; M | 3 | 6 | No |
| Lorig, et al., 2004 | 468 | 64 | PT; 2 | I | Non-HP | US | D; P; M | 5 | 4 | No |
| Lorig, et al., 1999 | 561 | 7 | 1 | G | Non-HP | US | D; P; M | 5 | 7 | No |
| Martire, et al. 2011 | 89 | 6 | PT; 1 | G | Non-HP | US | D; P | 3 | 6 | No |
| Masiero, et al., 2007 | 36 | 12 | 1 | G | HP | EU | D; P; M | 2 | | Yes |
| Mazzuca, et al., 2004 | 95 | 18 | 1; 2 | I | HP | US | D; P | 1 | 10 | Yes |

*Note: N = sample size; U = unreported; Duration = intervention duration; Time of Follow-Up: PT = post-treatment, 1 = ≤* 6 months, 2 = > 6 months*; I = individual sessions; G = group sessions; HP = health professional; EU = European Union UK = United Kingdom; US = United States; D = disability outcomes; P = pain outcomes; M = mental health outcomes; Cointervention = included component that was not one of the five self-management techniques*

Table 2.10, Continued *Characteristics of each study included in meta-analyses*

| Author, Year | N | Duration (weeks) | Time of Follow-Up | Delivery Format | Delivery Source | Country | Outcome | Number of SM Techniques | Number of Sessions | Cointervention |
|---|---|---|---|---|---|---|---|---|---|---|
| Neuberger, et al., 1993 | 13 | 12 | 1 | I | Non-HP | US | P; M | 2 | 4 | Yes |
| Nuñez, et al., 2006a | 43 | 12 | 1 | Mixed | HP | EU | D; P; M | 1 | 4 | Yes |
| Nuñez, et al., 2006b | 22 | 52 | 1 | Mixed | HP | EU | D; P | 2 | 2 | No |
| Parker, et al., 1988 | 29 | 53 | PT; 2 | G | HP | US | D; P; M | 2 | 32 | No |
| Parker, et al., 1995 | 44 | 74 | PT; 1 | I | HP | US | D; P; M | 1 | 14 | No |
| Peterson, et al., 1993 | 47 | 8 | PT | G | Non-HP | US | D | 3 | 24 | Yes |
| Petkova, et al., 2009 | 43 | 16 | PT | U | Non-HP | EU | D; M | 1 | 4 | No |
| Radojevic, et al., 1992 | 15 | 6 | PT; 1 | G | Non-HP | US | D; P; M | 1 | 4 | Yes |
| Ravaud, et al., 2009 | 146 | 4 | 1 | I | HP | EU | D; P; M | 1 | 3 | Yes |
| Riemsma, et al., 1997 | 28 | 8 | 1 | I | HP | EU | M | 3 | 9 | No |
| Scholten, et al., 1999 | 38 | 2 | PT; 1 | G | Mixed | EU | D; M | 3 | 9 | No |
| Sharpe & Schrieber, 2012 | 27 | 8 | PT; 1 | I | HP | Other | D; M | 3 | 8 | Yes |
| Sharpe, et al., 2001 | 19 | 8 | PT; 1 | I | HP | Other | D; P; M | 3 | 8 | Yes |
| Stamm, et al., 2002 | 20 | 12 | PT | I | HP | EU | D | 1 | 1 | Yes |
| Taal, et al., 1993 | 27 | 5 | 1; 2 | G | Mixed | EU | D; P; M | 4 | 5 | No |
| Victor, et al., 2005 | 87 | U | PT; 2 | G | HP | UK | D; P; M | 2 | 4 | No |
| Wetzels, et al., 2008 | 40 | 12 | 1 | I | HP | EU | D; M | 1 | 3 | No |
| Yip, et al., 2007 | 94 | 6 | PT; 1 | G | Mixed | Other | D; P | 3 | 6 | Yes |

*Note: N = sample size; U = unreported; Duration = intervention duration; Time of Follow-Up: PT = post-treatment, 1 = ≤* 6 months, 2 = > 6 months*; I = individual sessions; G = group sessions; HP = health professional; EU = European Union UK = United Kingdom; US = United States; D = disability outcomes; P = pain outcomes; M = mental health outcomes; Cointervention = included component that was not one of the five self-management techniques*

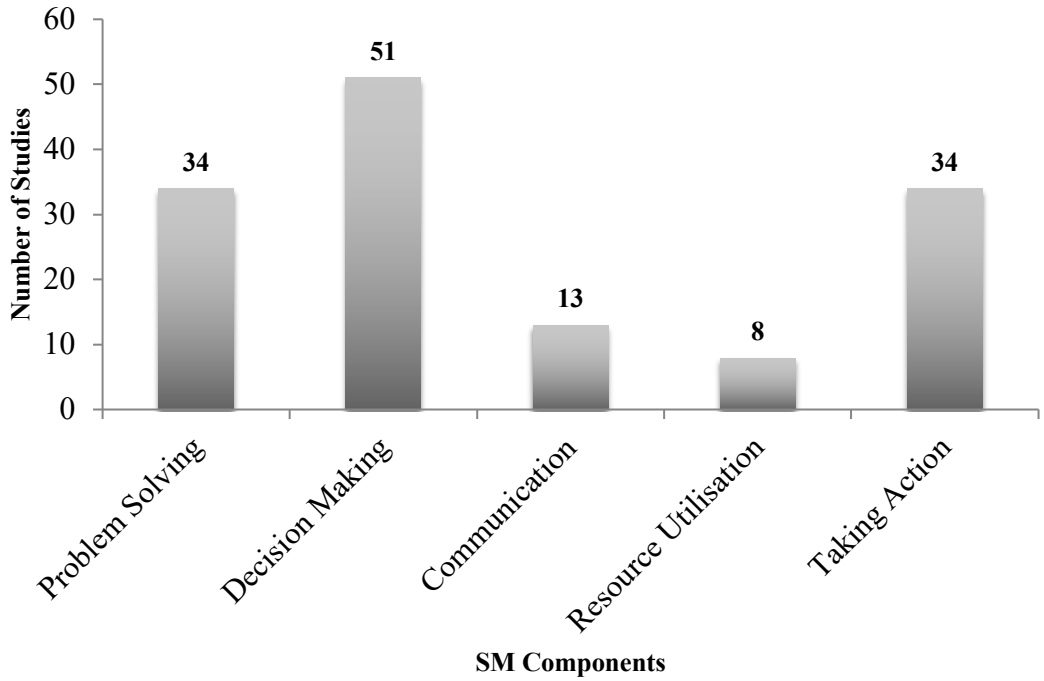


**Figure 2.3** ***Number of interventions including each of the 5 SM components***

### *2.6.1 Pain*

Tables 2.11, 2.12, and 2.13 show the effect sizes for pain at post-treatment, ≤ 6 month, and > 6 month months, respectively. Figures 2.4, 2.5, and 2.6 are the respective forest plots.

Overall results show a significant improvement in pain ($d$ = 0.19, 95% CI = 0.09, 0.29) immediately after the intervention and at ≤ 6 month follow-up ($d$ = 0.20, 95% CI = 0.12, 0.28). However, these effects were no longer significant at > 6 month follow-up ($d$ = 0.07, 95% CI = -0.02, 0.16) and effect sizes were small at all three time points (Cohen, 1992).

#### *2.6.1.1 Risk of Bias Across Studies*

Tests of heterogeneity amongst studies measuring pain were significant immediately post-treatment ($I^2$ = 39.8%, $p$ = 0.02) and remained significant at ≤ 6 month follow-up ($I^2$ = 33.6%, $p$ = 0.04).

Publication bias was assessed by visual inspection and Egger's linear regressions. No significant publication bias was found for studies testing pain at any time point.

#### *2.6.1.2 Sensitivity Analyses*

'One study removed' sensitivity analyses were used to identify any potential outliers. Visual inspection of the forest plots and examination of the data determined that there were no outlying studies.

Fixed effects analyses for pain (post: $d = 0.17$, CI = 0.11, 0.24, $p > 0.001$; ≤ 6 months: $d = 0.18$, CI = 0.12, 0.23, $p > 0.001$; > 6 months: $d = 0.06$, CI = -0.02, 0.14, $p = 0.11$) were compared with results of random effects analyses (see Table 13). As these results do not vary in the level of statistical significance of any of the findings reported here, it was concluded that they are robust.

Univariable meta-regressions of intervention duration, delivery source, group vs. individual delivery, number of sessions, co-interventions, country of delivery, use of block randomisation, and gender were conducted to identify any confounding effects of these variables (Table 2.14).

Significant effects of gender at post-treatment ($d = 0.01$, 95% CI = 0.001, 0.03, $p = 0.03$) and intervention duration at ≤ 6 month follow-up ($d = -0.01$, 95% CI = -0.02, -0.003, $p = 0.01$) were found for pain. Also, significant effects of group vs. individual delivery ($d = -0.20$, 95% CI = -0.36, -0.03, $p = 0.02$) and country ($d = -0.08$, 95% CI = -0.15, -0.01, $p = 0.02$) were found for pain at > 6 month follow-up.

These findings indicate that effects on pain at post-treatment were more positive as the percentage of male participants increased and where the studies were conducted in the USA or other countries when compared to those from the UK or EU. Also, effects on pain at post-treatment were more positive when interventions were delivered on a group or mixed basis as opposed to individual sessions. At ≤ 6 months, effects on pain were more positive as interventions became shorter in

duration and when interventions were delivered using a mixed method as opposed to being delivered on an individual or group basis.

These variables (ie. delivery method, country, delivery source, intervention duration, and gender) were controlled for in all meta-regressions on pain outcomes.

#### *2.6.1.3 Number of Components Included*

Meta-regression analyses found no statistically significant effect of the number of SM components in an intervention on pain ($d$ = 0.009, 95% CI = -0.08, 0.09, p = 0.83) at post-treatment, ≤ 6 month ($d$ = -0.05, 95% CI = -0.11, 0.009, p = 0.10), or > 6 month ($d$ = -0.02, 95% CI = -0.09, 0.06, p = 0.62) follow-ups.

#### *2.6.1.4 Identification of Effective SM Components*

Univariable meta-regression analyses revealed a significant effect of decision making on pain at post-treatment ($d$ = 0.51, 95% CI = 0.15, 0.88, p = 0.006). This effect remained significant when all five components were included in a multivariable model ($d$ = 0.50, 95% CI = 0.10, 0.90, p = 0.01).

Table 2.11 *Effect size (standardised difference in means) and standard error for each study measuring pain at post-treatment*

| Study Name | Standardised Difference in Means | Standard Error |
|---|---|---|
| Appelbaum, et al. (1988) | 0.557 | 0.487 |
| Bell, et al. (1998) | -0.004 | 0.178 |
| Brus, et al. (1998) | -0.239 | 0.277 |
| Fries, et al. (1997) | 0.208 | 0.071 |
| Frost (2005) | 0.149 | 0.411 |
| Hill, et al. (2001) | 0.111 | 0.252 |
| Hopman-Rock & Westhoff (2000) | 0.253 | 0.216 |
| Hughes, et al. (2004) | 0.186 | 0.195 |
| Keefe, et al. (1990) | 0.292 | 0.253 |
| Keefe, et al. (2004) | 0.597 | 0.332 |
| Kirwan, et al. (2005) | 0.185 | 0.266 |
| Kovar, et al. (1992) | 0.663 | 0.214 |
| Kraaimaat, et al. (1995) | -0.184 | 0.308 |
| Laforest, et al. (2008) | 0.326 | 0.209 |
| Lorig, et al. (1985) | 0.430 | 0.157 |
| Lorig, et al. (1986) | 0.282 | 0.269 |
| Lorig, et al. (2004) | 0.054 | 0.068 |
| Martire, et al. (2007) | 0.112 | 0.173 |
| Parker, et al. (1988) | 0.375 | 0.267 |
| Parker, et al. (1995) | -0.489 | 0.216 |
| Radojevic, et al. (1992) | -0.167 | 0.372 |
| Sharpe, et al. (2001) | 0.159 | 0.329 |
| Victor, et al. (2005) | 0.127 | 0.171 |
| Yip, et al. (2007) | 0.599 | 0.152 |
| **TOTAL pain posttreatment** | **0.191** | **0.052** |

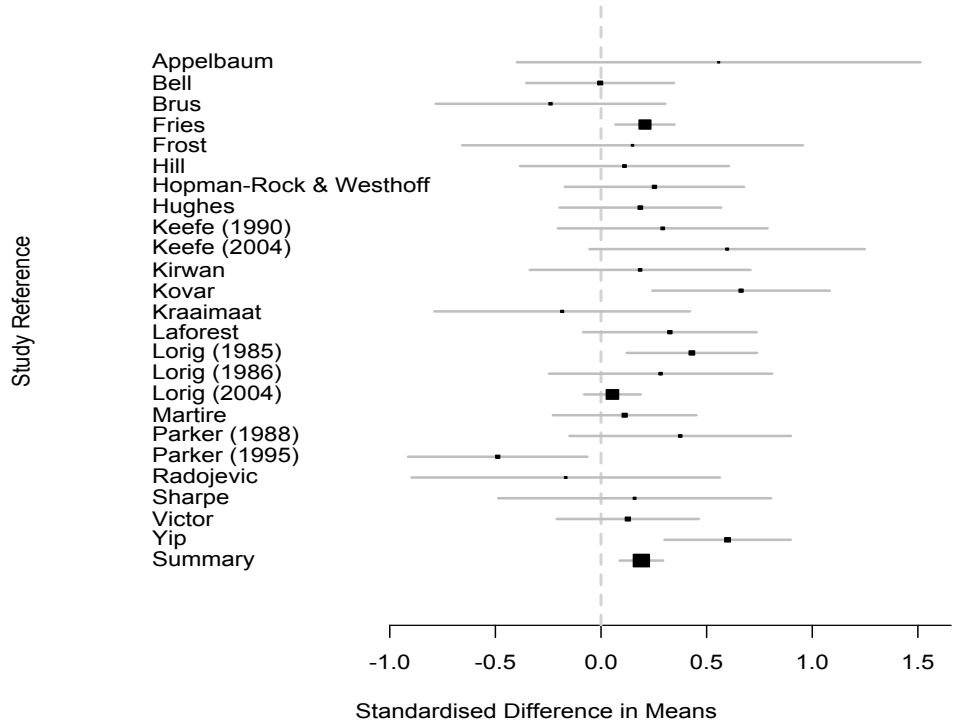


**Figure 2.4** ***Forest plot of the effect sizes of all studies measuring pain at post-treatment***

Table 2.12 *Effect size (standardised difference in means) and standard error for each study measuring pain at ≤ 6 months*

| Study Name | Standardised Difference in Means | Standard Error |
|---|---|---|
| Barlow, et al. (2000) | 0.126 | 0.148 |
| Berge, et al. (2004) | 0.820 | 0.342 |
| Blixen, et al. (2004) | 0.287 | 0.362 |
| Buszewicz, et al. (2006) | 0.078 | 0.081 |
| Crotty, et al. (2009) | -0.046 | 0.162 |
| Evers, et al. (2002) | -0.093 | 0.261 |
| Goeppinger, et al. (2009) | 0.348 | 0.073 |
| Hammond and Freeman (2001) | 0.087 | 0.182 |
| Hammond, et al. (1999) | 0.043 | 0.348 |
| Heuts, et al. (2005) | 0.145 | 0.122 |
| Hopman-Rock and Westhoff (2000) | 0.215 | 0.215 |
| Hughes, et al. (2004) | 0.265 | 0.212 |
| Kirwan, et al. (2005) | 0.203 | 0.268 |
| Kraaimaat, et al. (1995) | 0.120 | 0.307 |
| Lindroth, et al. (1997) | 0.417 | 0.237 |
| Lorig, et al. (1989) | 0.158 | 0.083 |
| Lorig, et al. (1999) | -0.021 | 0.066 |
| Martire, et al. (2007) | 0.270 | 0.173 |
| Masiero, et al. (2007) | 0.549 | 0.244 |
| Mazzuca, et al. (2004) | 0.141 | 0.163 |
| Neuberger, et al. (1993) | 0.126 | 0.397 |
| Nuñez, et al. (2006 a) | 0.787 | 0.233 |
| Nuñez, et al. (2006 b) | 0.759 | 0.316 |
| Parker, et al. (1995) | 0.205 | 0.224 |
| Radojevic, et al. (1992) | 0.332 | 0.374 |
| Ravaud, et al. (2009) | 0.213 | 0.112 |
| Sharpe, et al. (2001) | -0.205 | 0.330 |
| Taal, et al. (1993) | 0.174 | 0.266 |
| Yip, et al. (2007) | 0.443 | 0.150 |
| **TOTAL pain ≤ 6 months** | **0.201** | **0.039** |

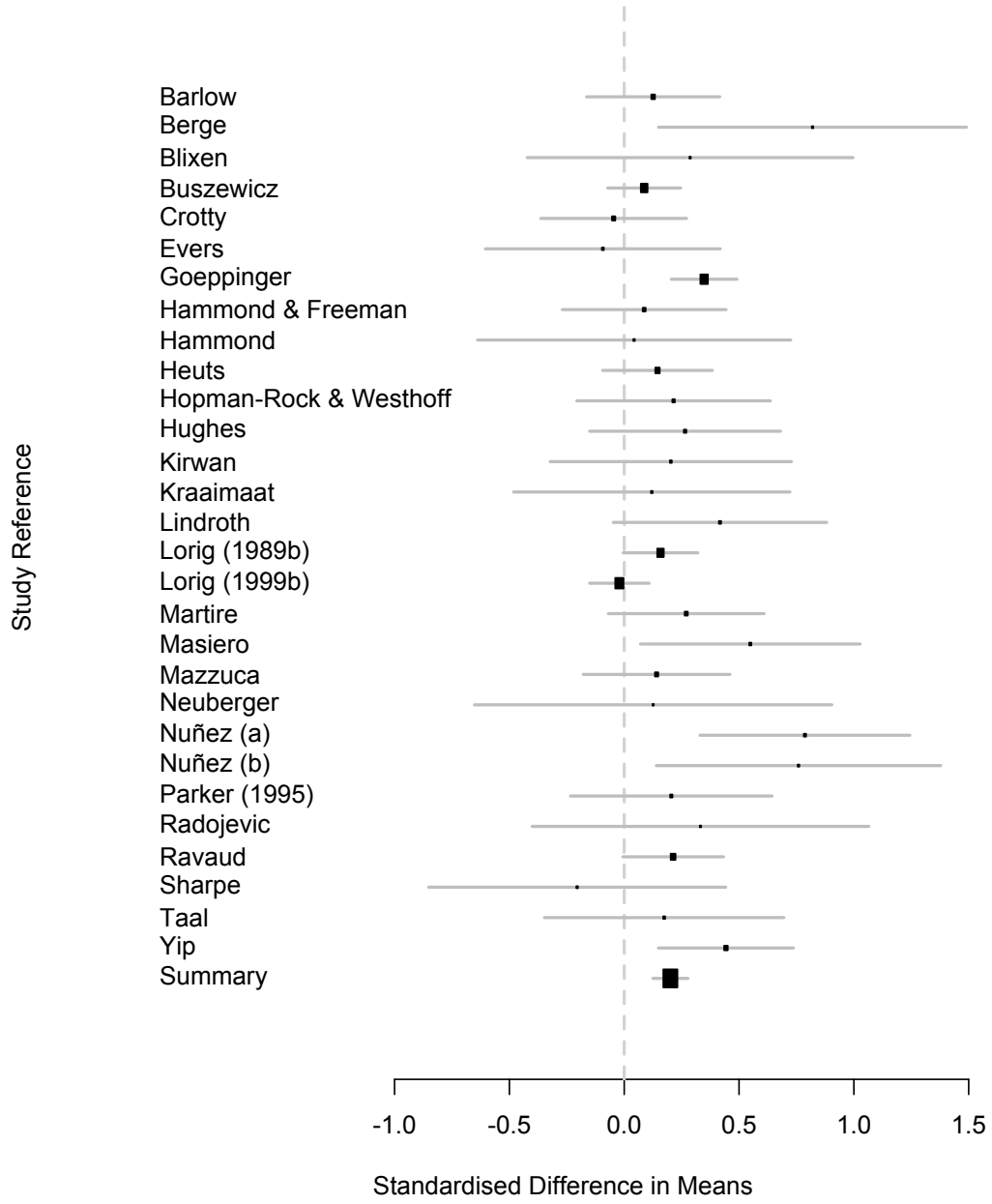


**Figure 2.5** ***Forest plot of the effect sizes of all studies measuring pain at ≤ 6 months***

Table 2.13 *Effect size (standardised difference in means) and standard error for each study measuring pain at > 6 months*

| Study Name | Standardised Difference in Means | Standard Error |
|---|---|---|
| Brus, et al. (1998) | 0.000 | 0.286 |
| Buszewicz, et al. (2006) | 0.103 | 0.084 |
| Evers, et al. (2002) | -0.016 | 0.260 |
| Hammond and Freeman (2001) | 0.301 | 0.181 |
| Helliwell, et al. (1999) | 0.343 | 0.246 |
| Heuts, et al. (2005) | 0.277 | 0.122 |
| Kirwan, et al. (2005) | 0.039 | 0.280 |
| Lindroth, et al. (1997) | 0.399 | 0.236 |
| Lorig, et al. (2004) | -0.053 | 0.071 |
| Mazzuca, et al. (2004) | -0.047 | 0.163 |
| Parker, et al. (1988) | -0.151 | 0.265 |
| Taal, et al. (1993) | -0.135 | 0.266 |
| Victor, et al. (2005) | 0.009 | 0.181 |
| **TOTAL pain > 6 months** | **0.071** | **0.044** |

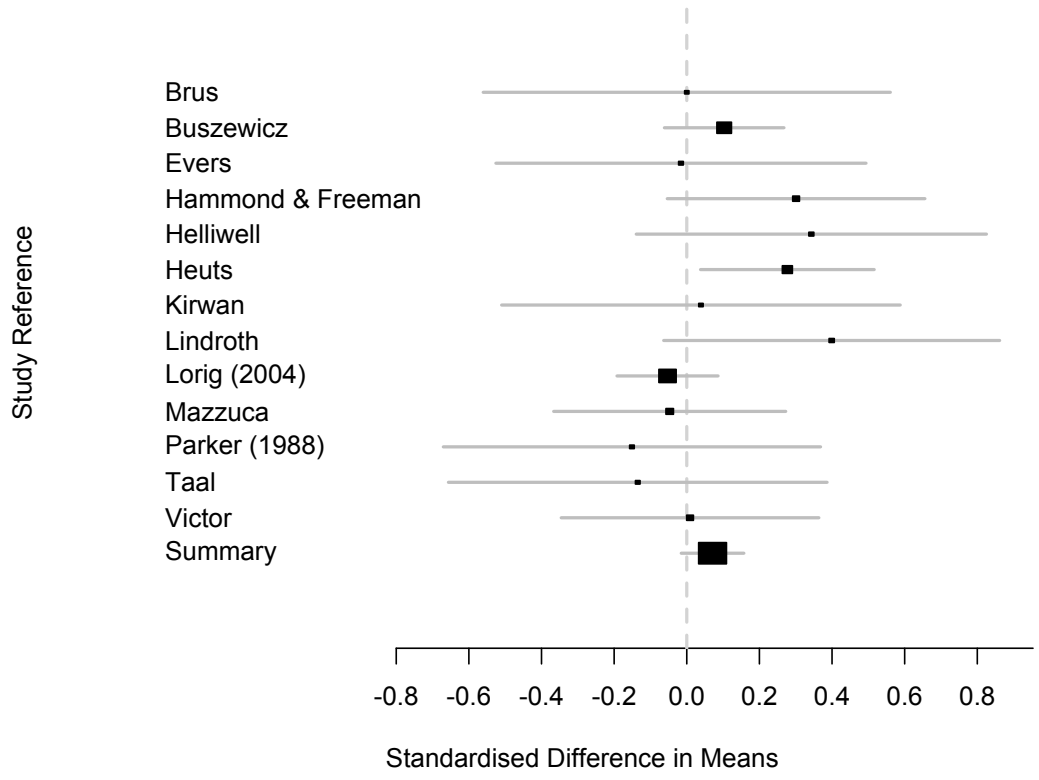


**Figure 2.6** ***Forest plot of the effect sizes of all studies measuring pain at > 6 months***

Table 2.14 *Results of univariable meta-regressions testing the effects of confounding variables on pain outcomes*

| Confounder | Effect size | PT<br>N= 24 (1852) | ≤ 6 months<br>N=29 (3005) | > 6 months<br>N=13 (1250) |
|---|---|---|---|---|
| INTERVENTION DURATION | *d* | -0.005 | -0.01 | 0.015 |
| | *SE* | 0.010 | 0.005 | 0.011 |
| | 95% CI | -0.024, 0.015 | -0.02, -0.003 | -0.007, 0.036 |
| | *p* | 0.650 | 0.014 | 0.174 |
| DELIVERY SOURCE (relative to HP) | | | | |
| Non-HP | *d* | 0.046 | -0.077 | -0.021 |
| | *SE* | 0.137 | 0.117 | 0.105 |
| | 95% CI | -0.222, 0.313 | -0.306, 0.152 | -0.226, 0.184 |
| | *p* | 0.739 | 0.508 | 0.839 |
| Mixed | *d* | 0.308 | 0.066 | -0.373 |
| | *SE* | 0.203 | 0.188 | 0.283 |
| | 95% CI | -0.089, 0.704 | -0.302, 0.433 | -0.929, 0.182 |
| | *p* | 0.129 | 0.727 | 0.188 |
| DELIVERY METHOD (relative to Group) | | | | |
| Individual | *d* | -0.230 | -0.039 | -0.078 |
| | *SE* | 0.114 | 0.101 | 0.200 |
| | 95% CI | -0.452,-0.007 | -0.236, 0.159 | -0.470, 0.315 |
| | *p* | 0.044 | 0.700 | 0.698 |
| Mixed | *d* | no data | 0.562 | no data |
| | *SE* | no data | 0.229 | no data |
| | 95% CI | no data | 0.114, 1.010 | no data |
| | *p* | no data | 0.014 | no data |
| Unreported | *d* | 0.238 | no data | no data |
| | *SE* | 0.507 | no data | no data |
| | 95% CI | -0.756, 1.233 | no data | no data |
| | *p* | 0.639 | no data | no data |
| NUMBER OF SESSIONS | *d* | -0.007 | -0.007 | -0.008 |
| | *SE* | 0.005 | 0.009 | 0.010 |
| | 95% CI | -0.003, 0.016 | -0.025, 0.012 | -0.028, 0.012 |
| | *p* | 0.167 | 0.483 | 0.423 |
| CO-INTERVENTION | *d* | 0.124 | 0.131 | -0.130 |
| | *SE* | 0.108 | 0.081 | 0.148 |
| | 95% CI | -0.088, 0.335 | -0.027, 0.289 | -0.420, -.160 |
| | *p* | 0.251 | 0.105 | 0.380 |

*Note: PT = post treatment; HP = health professional; Non-HP = non health professional or lay person; Mixed = both HP and Non-HP; Mixed = both group and individual sessions; # sessions = number of sessions in intervention; co-interventions = study included non-SM intervention components in addition to the SM intervention reviewed; EU = European Union; UK = United Kingdom; US = United States;* ***bold*** *figures indicate statistical significance*

Table 2.14, Continued *Results of univariable meta-regressions testing the effects of confounding variables on pain outcomes*

| **Confounder** | **Effect size** | **PT** N=24 (1852) | **≤ 6 months** N=29 (3005) | **> 6 months** N=13 (1250) |
|---|---|---|---|---|
| COUNTRY (relative to EU) | | | | |
| UK | *d* | 0.324 | -0,021 | -0.095 |
| | *SE* | 0.230 | 0.146 | 0.137 |
| | 95% CI | -0.127, 0.776 | -0.308, 0.266 | -0.363, 0.173 |
| | *p* | 0.159 | 0.884 | 0.4878 |
| US | *d* | 0.414 | 0.044 | -0.206 |
| | *SE* | 0.211 | 0.139 | 0.200 |
| | 95% CI | 0.0004, 0.828 | -0.229, 0.317 | -0.598, 0.187 |
| | *p* | 0.05 | 0.754 | 0.304 |
| Other | *d* | 0.484 | -0.095 | no data |
| | *SE* | 0.207 | 0.203 | no data |
| | 95% CI | 0.078, 0.890 | -0.492, 0.302 | no data |
| | *p* | 0.019 | 0.639 | no data |
| BLOCK RANDOMISATION (relative to individual randomisation) | *d* | -0.099 | 0.011 | 0.710 |
| | *SE* | 0.249 | 0.166 | 0.209 |
| | 95% CI | -0.586, 0.388 | -0.002, 0.012 | -0.488, 0.332 |
| | *p* | 0.691 | 0.946 | 0.710 |
| GENDER (relative to Male) | *d* | 0.01 | 0.005 | -0.003 |
| | *SE* | 0.006 | 0.004 | 0.007 |
| | 95% CI | 0.001, 0.03 | -0.313, 0.336 | -0.016, 0.010 |
| | *p* | 0.032 | 0.186 | 0.661 |

*Note: PT = post treatment; HP = health professional; Non-HP = non health professional or lay person; Mixed = both HP and Non-HP; Mixed = both group and individual sessions; # sessions = number of sessions in intervention; co-interventions = study included non-SM intervention components in addition to the SM intervention reviewed; EU = European Union; UK = United Kingdom; US = United States;* ***bold*** *figures indicate statistical significance*

### 2.6.2 Disability

Tables 2.15, 2.16, and 2.17 show the effect sizes for disability at post-treatment, ≤ 6 month, and > 6 month months, respectively. Figures 2.7, 2.8, and 2.9 are the respective forest plots.

Overall results show a significant improvement in disability immediately after the intervention ($d$ = 0.18, 95% CI = 0.08, 0.29), at ≤ 6 month follow-up ($d$ = 0.15, 95% CI = 0.08, 0.21) and at > 6 month follow-up ($d$ = 0.09, 95% CI = 0.02, 0.16). Effect sizes were small at all three time points (Cohen, 1992).

#### *2.6.2.1 Risk of Bias Across Studies*

Tests of heterogeneity amongst studies measuring disability were significant immediately post-treatment ($I^2$ = 54.6%, $p$ < 0.001) only.

Publication bias was assessed by visual inspection and Egger's linear regressions. No significant publication bias was found for studies testing disability at any time point.

#### *2.6.2.2 Sensitivity Analyses*

'One study removed' sensitivity analyses were used to identify any potential outliers. Visual inspection of the forest plots and examination of the data determined that there were no outlying studies.

Fixed effects analyses for disability (post: $d$ = 0.17, CI = 0.11, 0.23, p > 0.001; ≤ 6 months: $d$ = 0.15, CI = 0.09, 0.20, p > 0.001; > 6 months: $d$ = 0.09, CI = 0.02, 0.16, p = 0.01) were compared with results of random effects analyses (see Table 2.14). As these results do not vary in the level of statistical significance of any of the findings reported here, it was concluded that they are robust.

Univariable meta-regressions of intervention duration, delivery source, group vs. individual delivery, number of sessions, co-interventions, country of delivery, use of block randomisation, and gender were conducted to identify any confounding effects

of these variables (Table 2.18).

No significant effects of delivery method, country, delivery source, intervention duration, or gender were found for disability.

#### *2.6.2.3 Number of Components Included*

There was no significant effect of the number of SM components on disability at post-treatment ($d$ = 0.03, 95% CI = -0.07, 0.13, p = 0.55), ≤ 6 months follow-up ($d$ = 0.008, 95% CI = -0.04, 0.05, p = 0.73) and > 6 months follow-up ($d$ = 0.01, 95% CI = -0.03, 0.06, p = 0.58).

#### *2.6.2.4 Identification of Effective SM Components*

No significant effects of any single component of SM were found for disability.

Table 2.15 *Effect size (standardised difference in means) and standard error for each study measuring disability at post-treatment*

| Author | Standardised Difference in Means | Standard Error |
|---|---|---|
| Appelbaum, et al. (1988) | 0.450 | 0.477 |
| Arnold and Faulkner (2010) | 0.380 | 0.278 |
| Bell, et al. (1998) | 0.040 | 0.178 |
| Brus, et al. (1998) | 0.000 | 0.276 |
| Cronan, et al. (1997) | 0.181 | 0.152 |
| Fries, et al. (1997) | 0.198 | 0.071 |
| Frost (2005) | 0.707 | 0.490 |
| Gallagher, et al. (1997) | 0.069 | 0.172 |
| Helliwell, et al. (1999) | -0.134 | 0.234 |
| Hopman-Rock and Westhoff (2000) | 0.093 | 0.214 |
| Hughes, et al. (2004) | 0.046 | 0.195 |
| Keefe, et al. (1990) | 0.000 | 0.252 |
| Kirwan, et al. (2005) | 0.077 | 0.272 |
| Kovar, et al. (1992) | 0.750 | 0.216 |
| Kraaimaat, et al. (1995) | 0.241 | 0.308 |
| Laforest, et al. (2008) | 0.150 | 0.208 |
| Lorig, et al. (1986) | -0.281 | 0.269 |
| Lorig, et al. (1985) | 0.128 | 0.156 |
| Lorig, et al. (2004) | 0.178 | 0.068 |
| Martire, et al. (2007) | 0.078 | 0.173 |
| Parker, et al. (1988) | 0.109 | 0.265 |
| Parker, et al. (1995) | -0.478 | 0.216 |
| Peterson, et al. (1993) | 0.281 | 0.212 |
| Petkova, et al. (2009) | 0.083 | 0.216 |
| Radojevic, et al. (1992) | 0.149 | 0.372 |
| Scholten, et al. (1999) | 1.834 | 0.290 |
| Sharpe and Schrieber (in press) | 0.781 | 0.288 |
| Sharpe, et al. (2001) | 0.336 | 0.331 |
| Stamm, et al. (2002) | 0.501 | 0.321 |
| Victor, et al. (2005) | -0.011 | 0.172 |
| Yip, et al. (2007) | 0.110 | 0.148 |
| **TOTAL disability posttreatment** | **0.182** | **0.054** |

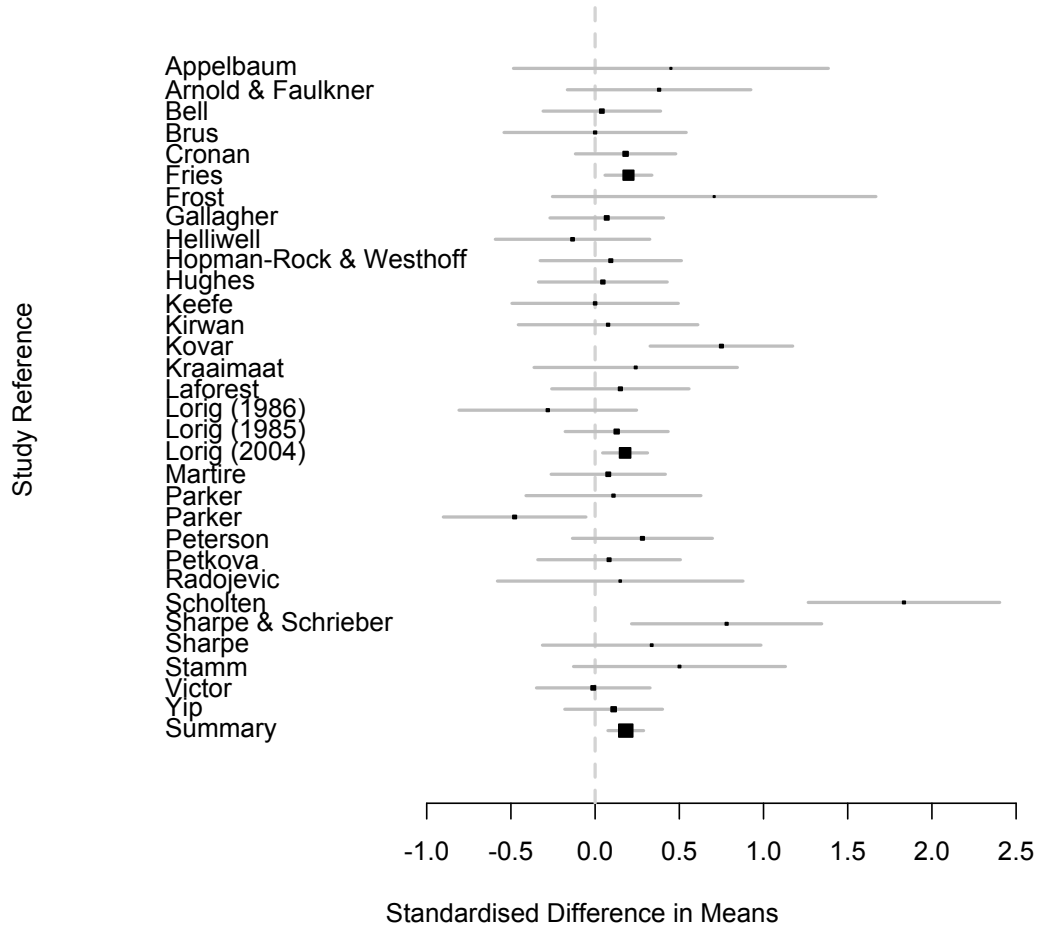


**Figure 2.7** ***Forest plot of the effect sizes of all studies measuring disability at post-treatment***

Table 2.16 *Effect size (standardised difference in means) and standard error for each study measuring disability at ≤ 6 months*

| Author | Standardised Difference in Means | Standard Error |
|---|---|---|
| Barlow, et al. (2000) | -0.094 | 0.148 |
| Berge, et al. (2004) | 0.527 | 0.335 |
| Blixen, et al. (2004) | 0.051 | 0.360 |
| Buszewicz, et al. (2006) | 0.029 | 0.085 |
| Crotty, et al. (2009) | 0.074 | 0.162 |
| Evers, et al. (2002) | -0.210 | 0.261 |
| Gerber, et al. (1987) | -0.333 | 0.437 |
| Giraudet-Le Quintrec, et al. (2007) | 0.118 | 0.139 |
| Goeppinger, et al. (2009) | 0.270 | 0.073 |
| Hammond and Freeman (2001) | 0.003 | 0.182 |
| Hammond, et al. (1999) | -0.041 | 0.348 |
| Hansson, et al. (2010) | 0.140 | 0.188 |
| Heuts, et al. (2005) | 0.169 | 0.121 |
| Hopman-Rock and Westhoff (2000) | 0.105 | 0.214 |
| Hughes, et al. (2004) | 0.092 | 0.211 |
| Kirwan, et al. (2005) | -0.120 | 0.278 |
| Kraaimaat, et al. (1995) | -0.030 | 0.307 |
| Lindroth, et al. (1997) | 0.517 | 0.238 |
| Lorig, et al. (1989) | 0.086 | 0.083 |
| Lorig, et al. (1999) | 0.152 | 0.066 |
| Martire, et al. (2007) | 0.113 | 0.173 |
| Masiero, et al. (2007) | 0.787 | 0.248 |
| Mazzuca, et al. (2004) | -0.028 | 0.162 |
| Nuñez, et al. (2006 a) | 0.383 | 0.227 |
| Nuñez, et al. (2006 b) | 0.586 | 0.312 |
| Parker, et al. (1995) | 0.315 | 0.236 |
| Radojevic, et al. (1992) | 0.164 | 0.372 |
| Ravaud, et al. (2009) | 0.010 | 0.111 |
| Scholten, et al. (1999) | 0.967 | 0.258 |
| Sharpe and Schrieber (in press) | 0.421 | 0.281 |
| Sharpe, et al. (2001) | 0.147 | 0.329 |
| Taal, et al. (1993) | 0.382 | 0.268 |
| Wetzels, et al. (2008) | 0.192 | 0.215 |
| Yip, et al. (2007) | 0.077 | 0.148 |
| **TOTAL disability ≤ 6 months** | **0.147** | **0.033** |

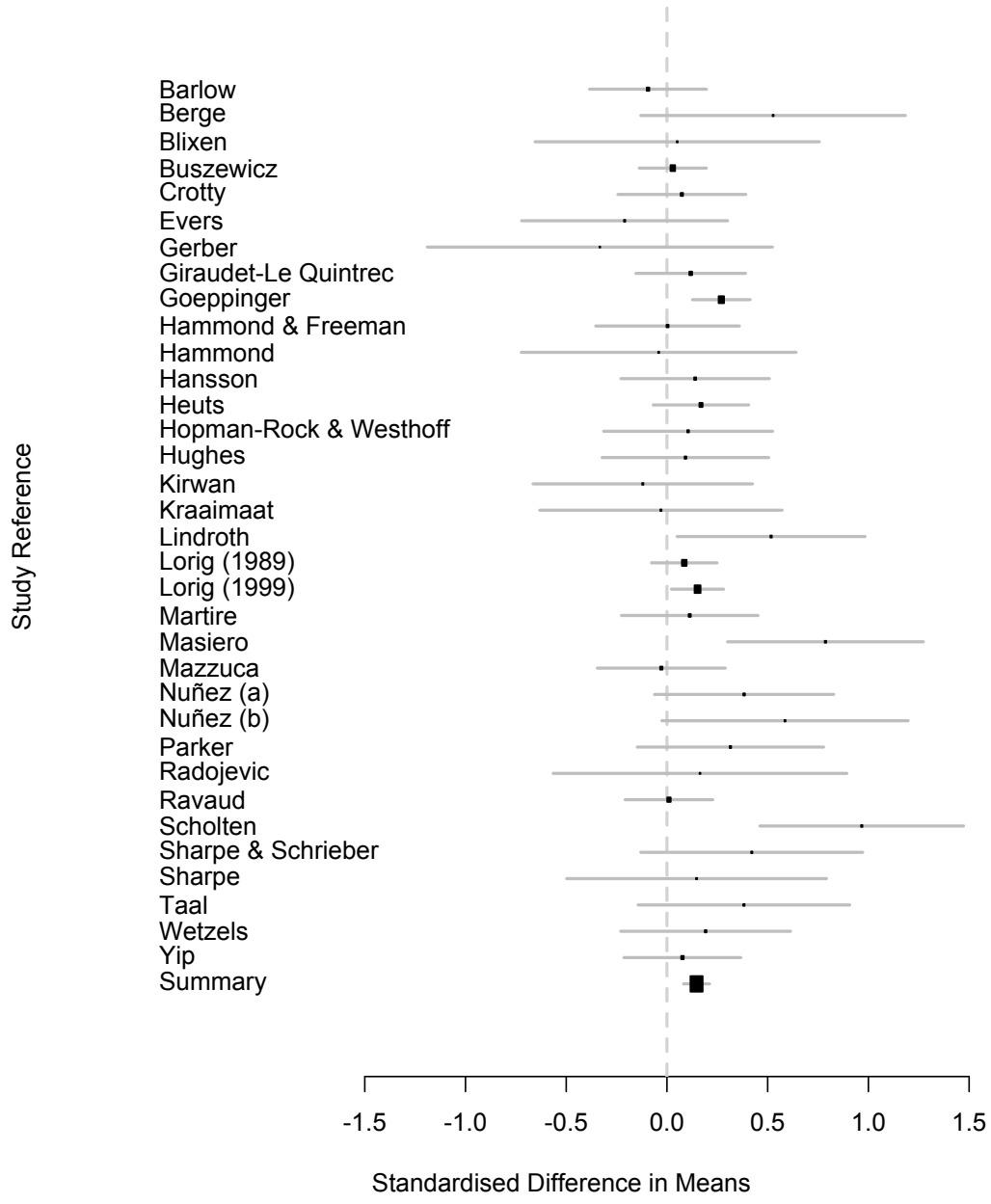


**Figure 2.8** ***Forest plot of the effect sizes of all studies measuring disability at ≤ 6 months***

Table 2.17 *Effect size (standardised difference in means) and standard error for each study measuring disability at > 6 months*

| Author | Standardised Difference in Means | Standard Error |
|---|---|---|
| Brus, et al. (1998) | -0.200 | 0.282 |
| Buszewicz, et al. (2006) | 0.030 | 0.087 |
| Cronan, et al. (1997) | 0.102 | 0.151 |
| Evers, et al. (2002) | -0.183 | 0.261 |
| Gallagher, et al. (1997) | 0.000 | 0.172 |
| Giraudet-Le Quintrec, et al. (2007) | -0.012 | 0.139 |
| Hammond and Freeman (2001) | 0.138 | 0.181 |
| Helliwell, et al. (1999) | 0.197 | 0.232 |
| Heuts, et al. (2005) | 0.236 | 0.122 |
| Kirwan, et al. (2005) | -0.193 | 0.284 |
| Lindroth, et al. (1997) | 0.163 | 0.234 |
| Lorig, et al. (2004) | 0.112 | 0.071 |
| Mazzuca, et al. (2004) | 0.068 | 0.163 |
| Parker, et al. (1988) | 0.442 | 0.268 |
| Scholten, et al. (1999) | 0.194 | 0.245 |
| Taal, et al. (1993) | 0.123 | 0.266 |
| Victor, et al. (2005) | 0.156 | 0.181 |
| **TOTAL disability > 6 months** | **0.090** | **0.037** |

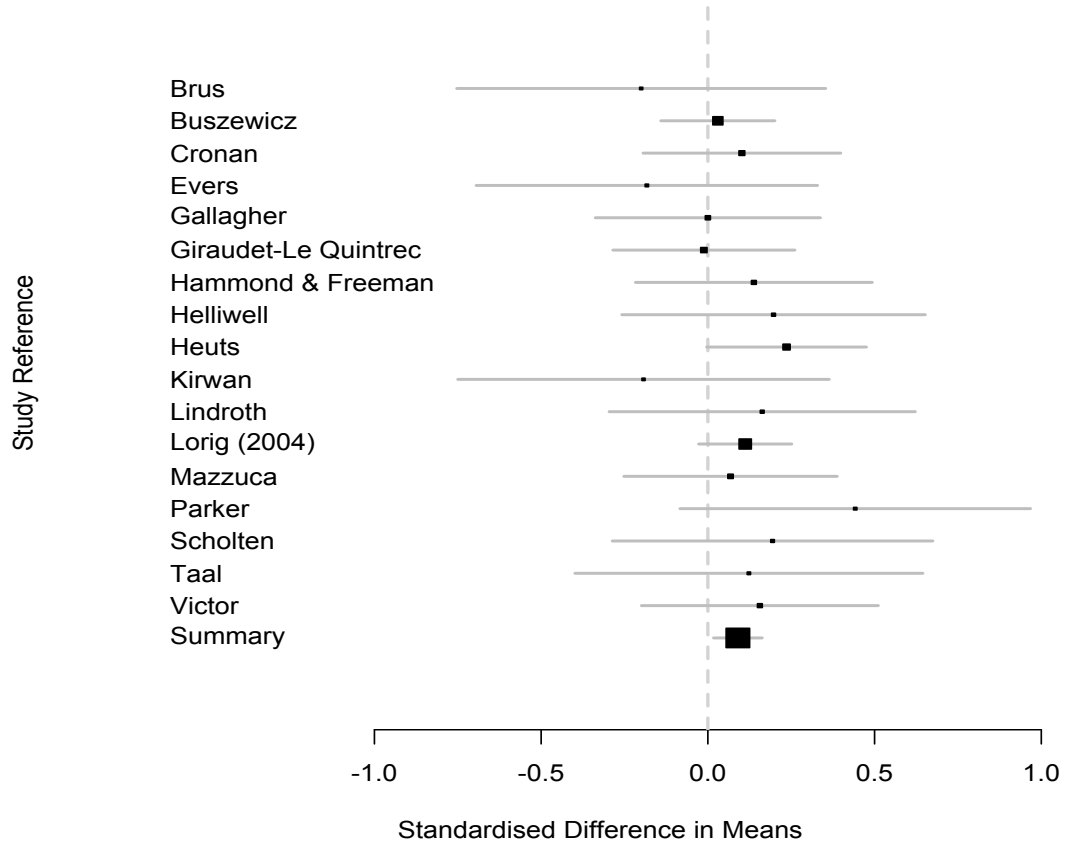


**Figure 2.9** ***Forest plot of the effect sizes of all studies measuring disability at > 6 months***

Table 2.18 *Results of univariable meta-regressions testing the effects of confounding variables on disability outcomes*

| Confounder | Effect Size | PT N=31 (2205) | ≤ 6 months N=34 (3219) | > 6 months N=17 (1506) |
|---|---|---|---|---|
| INTERVENTION | *d* | -0.007 | -0.007 | 0.011 |
| DURATION | *SE* | 0.010 | 0.004 | 0.008 |
| | 95% CI | -0.027, 0.014 | -0.015,0.0003 | -0.006, 0.028 |
| | *p* | 0.522 | 0.061 | 0.210 |
| DELIVERY SOURCE (relative to HP) | | | | |
| Non-HP | *d* | -0.000 | 0.040 | 0.008 |
| | *SE* | 0.202 | 0.104 | 0.197 |
| | 95% CI | -0.396, 0.396 | -0.164, 0.245 | -0.378, 0.395 |
| | *p* | 1.000 | 0.699 | 0.967 |
| Mixed | *d* | 0.317 | 0.032 | 1.902 |
| | *SE* | 0.276 | 0.122 | 0.322 |
| | 95% CI | -0.224, 0.859 | -0.208, 0.271 | 0.560, 1.821 |
| | *p* | 0.251 | 0.796 | 0.0002 |
| DELIVERY METHOD (relative to Group) | | | | |
| Indiv. | *d* | 0.078 | -0.037 | -0.240 |
| | *SE* | 0.196 | 0.084 | 0.084 |
| | 95% CI | -0.306, 0.463 | -0.201, 0.128 | -0.667, 0.187 |
| | *p* | 0.690 | 0.662 | 0.270 |
| Mixed | *d* | no data | 0.131 | no data |
| | *SE* | no data | 0.191 | 0.191 |
| | 95% CI | no data | -0.244, 0.506 | no data |
| | *p* | no data | 0.495 | no data |
| Unreported | *d* | -0.062 | no data | 0.723 |
| | *SE* | 0.395 | no data | no data |
| | 95% CI | 0.835, 0.712 | no data | 0.078, 1.367 |
| | *p* | 0.876 | no data | 0.028 |
| # SESSIONS | *d* | 0.0008 | -0.004 | 0.002 |
| | *SE* | 0.006 | 0.008 | 0.006 |
| | 95% CI | -0.011, 0.012 | -0.019, 0.012 | -0.011, 0.014 |
| | *p* | 0.892 | 0.642 | 0.014 |
| CO-INTV. | *d* | 0.105 | -0.015 | -0.086 |
| | *SE* | 0.121 | 0.070 | 0.104 |
| | 95% CI | -0.133, 0.343 | -0.152, 0.121 | -0.289, 0.117 |
| | *p* | 0.388 | 0.827 | 0.407 |

*Note: PT = post treatment; HP = health professional; Non-HP = non health professional or lay person; Mixed = both HP and Non-HP; G vs. I = group versus individual delivery; Indiv. = Individual; Mixed = both group and individual sessions; # sessions = number of sessions in intervention; co-intv. = co-interventions; EU = European Union; UK = United Kingdom; US = United States; b. random = block randomization;* ***bold*** *figures indicate statistical significance*

Table 2.18, Continued *Results of univariable meta-regressions testing the effects of confounding variables on disability outcomes*

| **Confounder** | **Effect Size** | **PT** N=31 (2205) | **≤ 6 months** N=34 (3219) | **> 6 months** N=17 (1506) |
|---|---|---|---|---|
| COUNTRY (relative to EU) | | | | |
| UK | *d* | -0.339 | -0.232 | 0.293 |
| | *SE* | 0.311 | 0.126 | 0.245 |
| | 95% CI | -0.948, 0.270 | -0.478, 0.015 | -0.186, 0.772 |
| | *p* | 0.275 | 0.066 | 0.231 |
| US | *d* | -0.194 | -0.091 | 0.756 |
| | *SE* | 0.250 | 0.117 | 0.236 |
| | 95% CI | -0.683, 0.296 | -0.320, 0.138 | 0.293, 1.219 |
| | *p* | 0.438 | 0.437 | 0.001 |
| Other | *d* | no data | -0.068 | 0.853 |
| | *SE* | 0.251 | 0.141 | 0.359 |
| | 95% CI | -0.707, 0.278 | -0.344, 0.208 | 0.150, 1.557 |
| | *p* | 0.394 | 0.629 | 0.018 |
| B. RANDOM | *d* | -0.209 | -0.100 | 0.068 |
| | *SE* | 0.314 | 0.111 | 0.185 |
| | 95% CI | -0.825, 0.407 | -0.318, 0.118 | -0.295, 0.431 |
| | *p* | 0.506 | 0.369 | 0.713 |
| GENDER | *d* | 0.012 | 0.004 | 0.004 |
| (relative to Male) | *SE* | 0.007 | 0.003 | 0.005 |
| | 95% CI | -0.001, 0.024 | -0.001, 0.010 | -0.005, 0.014 |
| | *p* | 0.079 | 0.122 | 0.392 |

*Note: PT = post treatment; HP = health professional; Non-HP = non health professional or lay person; Mixed = both HP and Non-HP; G vs. I = group versus individual delivery; Indiv. = Individual; Mixed = both group and individual sessions; # sessions = number of sessions in intervention; co-intv. = co-interventions; EU = European Union; UK = United Kingdom; US = United States; b. random = block randomization;* ***bold*** *figures indicate statistical significance*

### 2.6.3 Mental Health

Tables 2.19, 2.20, and 2.21 show effect sizes for mental health at post-treatment, ≤ 6 month, and > 6 month months, respectively, while Figures 2.10, 2.11, and 2.12 are the respective forest plots.

Overall results show a significant improvement in mental health ($d$ = 0.18, 95% CI = 0.003, 0.35) immediately after the intervention and at ≤ 6 month follow-up ($d$ = 0.17, 95% CI = 0.10, 0.24). However, these effects were no longer significant at > 6 month follow-up ($d$ = 0.08, 95% CI = -0.03, 0.18). Effect sizes were small at all three time points (Cohen, 1988).

#### *2.6.3.1 Risk of Bias Across Studies*

Tests of heterogeneity amongst studies testing mental health were significant immediately post-treatment ($I^2$ = 52.5%, $p$ = 0.007) only.

Publication bias was assessed by visual inspection and Egger's linear regressions. No significant publication bias was found for studies testing mental health at any time point.

#### *2.6.3.2 Sensitivity Analyses*

'One study removed' sensitivity analyses were used to identify any potential outliers. Visual inspection of the forest plots and examination of the data determined that there were no outlying studies.

Fixed effects analyses for mental health (post: $d$ = 0.13, CI = 0.04, 0.23, p = 0.007; ≤ 6 months: $d$ = 0.16, CI = 0.10, 0.22, p > 0.001; > 6 months: $d$ = 0.07, CI = -0.02, 0.16, p = 0.11) were compared with results of random effects analyses (see Table 2.13). As these results do not vary in the level of statistical significance of any of the findings reported here, it was concluded that they are robust.

Univariable meta-regressions of intervention duration, delivery source, group vs. individual delivery, number of sessions, co-interventions, country of delivery, use of block randomisation, and gender were conducted to identify any confounding effects of these variables (Table 2.22).

Significant effects of group vs. individual vs. unreported sessions (Unreported: *d* = 0.82, 95% CI = 0.08, 1.37, p = 0.03), country (USA: *d* = 0.76, CI = 0.29, 1.22, p = 0.001; Other countries: *d* = 0.85, CI = 0.15, 1.56, p = 0.02), and delivery source (Mixed delivery: *d* = 1.19, CI = 0.56, 1.82, p = 0.0002) were found for mental health at post-treatment. Significant effects of intervention duration (*d* = -0.01, 95% CI = -0.02, -0.005, p = 0.002) and gender (*d* = 0.008, 95% CI = 0.002, 0.01, p = 0.009) were also found for mental health at ≤ 6 months follow-up.

These findings indicate that effects on mental health at post-treatment were more positive in studies that did not report whether sessions were led in groups or on an individual basis, when studies were conducted in the US and other countries outside of the UK and European Union (EU), and when the delivery sources included both health care professionals and lay people. At ≤ 6 months, mental health became more positive as interventions became shorter in duration and as the percentage of male participants increased.

Once these variables were entered into multivariable models with the five SM components, only the effect of intervention duration on mental health at ≤ 6 month follow-up remained significant (*d* = -0.02, 95% CI = -0.03, -0.001, p = 0.03), with interventions of shorter duration having more positive outcomes.

These variables (ie. delivery method, country, delivery source, intervention duration, and gender) were controlled for in all meta-regressions on mental health outcomes.

#### *2.6.3.3 Number of Components Included*

No statistically significant effect of the number of SM components on mental health was found at post-treatment (*d* = 0.03, 95% CI = -0.12, 0.18, p = 0.70), ≤ 6 months

follow-up ($d$ = 0.04, 95% CI = -0.05, 0.06, p = 0.88), or > 6 months follow-up ($d$ = -0.008, 95% CI = -0.07, 0.05, p = 0.78).

#### *2.6.3.4 Identification of Effective SM Components*

A significant effect of problem-solving and communication with healthcare professionals was found for mental health at > 6 months follow-up when included in a model together ($d$ = 0.36, 95% CI = 0.04, 0.68, p = 0.03) only.

Table 2.19 *Effect size (standardised difference in means) and standard error for each study measuring mental health at post-treatment*

| **Author** | **Standardised Difference in Means** | **Standard Error** |
|---|---|---|
| Appelbaum, et al. (1988) | 2.004 | 0.578 |
| Brus, et al. (1998) | -0.066 | 0.276 |
| Frost (2005) | 0.604 | 0.420 |
| Keefe, et al. (2004) | 0.274 | 0.326 |
| Keefe, et al. (1990) | 0.359 | 0.254 |
| Kirwan, et al. (2005) | -0.191 | 0.274 |
| Kraaimaat, et al. (1995) | -0.580 | 0.313 |
| Lorig, et al. (2004) | 0.109 | 0.068 |
| Parker, et al. (1988) | 0.295 | 0.266 |
| Parker, et al. (1995) | 0.034 | 0.216 |
| Petkova (2009) | 0.191 | 0.216 |
| Radojevic, et al. (1992) | 0.137 | 0.374 |
| Scholten, et al. (1999) | 0.780 | 0.254 |
| Sharpe and Schrieber (in press) | -0.088 | 0.278 |
| Sharpe, et al. (2001) | 0.632 | 0.337 |
| Victor, et al. (2005) | -0.088 | 0.171 |
| **TOTAL mental health post-treatment** | **0.177** | **0.089** |

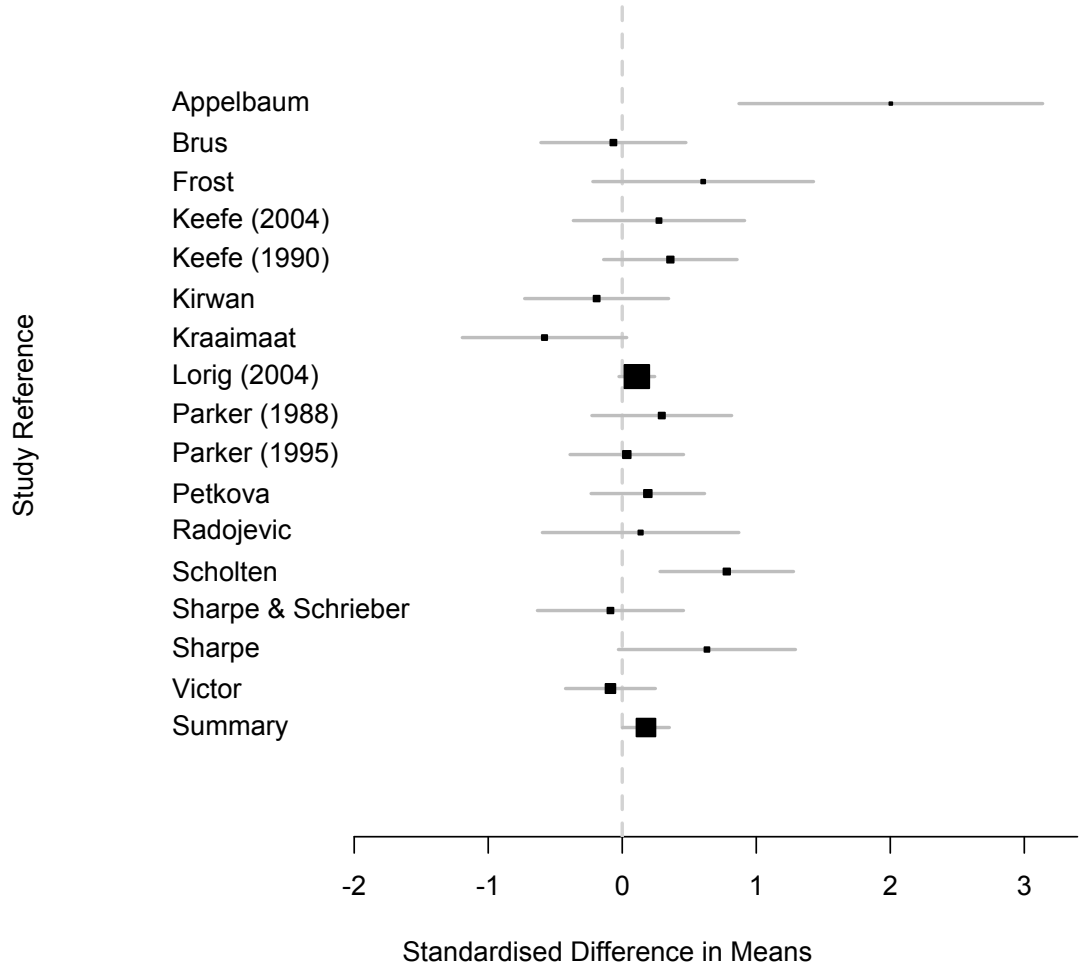


**Figure 2.10** ***Forest plot of the effect sizes of all studies measuring mental health at post-treatment***

Table 2.20 *Effect size (standardised difference in means) and standard error for each study measuring mental health at ≤ 6 months*

| Author | Standardised Difference in Means | Standard Error |
|---|---|---|
| Barlow, et al. (2000) | 0.272 | 0.148 |
| Berge, et al. (2004) | -0.259 | 0.330 |
| Blixen , et al. (2004) | 0.035 | 0.360 |
| Buszewicz, et al. (2006) | 0.076 | 0.085 |
| Crotty, et al. (2009) | -0.068 | 0.162 |
| Evers, et al. (2002) | 0.431 | 0.264 |
| Giraudet-Le Quintrec, et al. (2007) | 0.052 | 0.139 |
| Goeppinger, et al. (2009) | 0.346 | 0.073 |
| Kaplan and Kozin (1981) | 0.007 | 0.426 |
| Kirwan, et al. (2005) | 0.054 | 0.275 |
| Kraaimaat, et al. (1995) | -0.112 | 0.307 |
| Lorig, et al. (1989) | 0.133 | 0.083 |
| Lorig, et al. (1999) | 0.073 | 0.066 |
| Masiero, et al. (2007) | 0.536 | 0.243 |
| Neuberger, et al. (1993) | -0.124 | 0.397 |
| Nuñez, et al. (2006 a) | 0.228 | 0.225 |
| Parker, et al. (1995) | 0.309 | 0.230 |
| Radojevic, et al. (1992) | 0.239 | 0.373 |
| Ravaud, et al. (2009) | 0.053 | 0.111 |
| Riemsma, et al. (1997) | 0.318 | 0.261 |
| Scholten, et al. (1999) | 0.692 | 0.251 |
| Sharpe and Schrieber (in press) | 0.137 | 0.278 |
| Sharpe, et al. (2001) | 0.535 | 0.335 |
| Taal, et al. (1993) | 0.058 | 0.265 |
| Wetzels, et al. (2008) | 0.398 | 0.216 |
| **TOTAL mental health ≤ 6 months** | **0.166** | **0.036** |

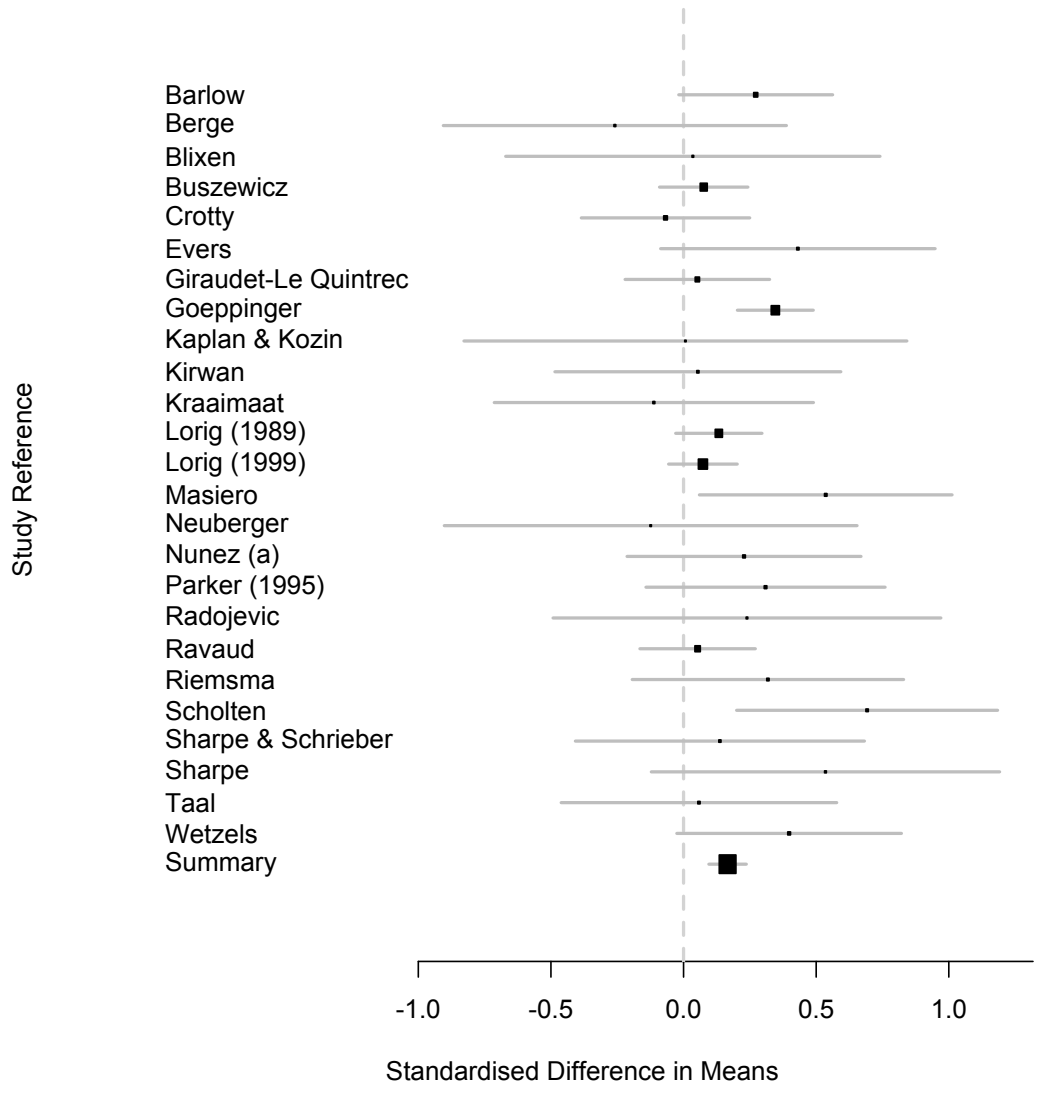


**Figure 2.11** ***Forest plot of the effect sizes of all studies measuring mental health at ≤ 6 months***

Table 2.21 *Effect size (standardised difference in means) and standard error for each study measuring mental health at > 6 months*

| Author | Standardised Difference in Means | Standard Error |
|---|---|---|
| Brus, et al. (1998) | 0.000 | 0.284 |
| Buszewicz, et al. (2006) | 0.045 | 0.087 |
| Evers, et al. (2002) | 0.528 | 0.265 |
| Giraudet-Le Quintrec, et al. (2007) | -0.032 | 0.139 |
| Helliwell, et al. (1999) | 0.293 | 0.246 |
| Kirwan, et al. (2005) | 0.010 | 0.284 |
| Lorig, et al. (2004) | 0.066 | 0.071 |
| Parker, et al. (1988) | 0.251 | 0.266 |
| Scholten, et al. (1999) | 0.589 | 0.249 |
| Taal, et al. (1993) | -0.231 | 0.266 |
| Victor, et al. (2005) | -0.115 | 0.182 |
| **TOTAL mental health > 6 months** | **0.077** | **0.053** |

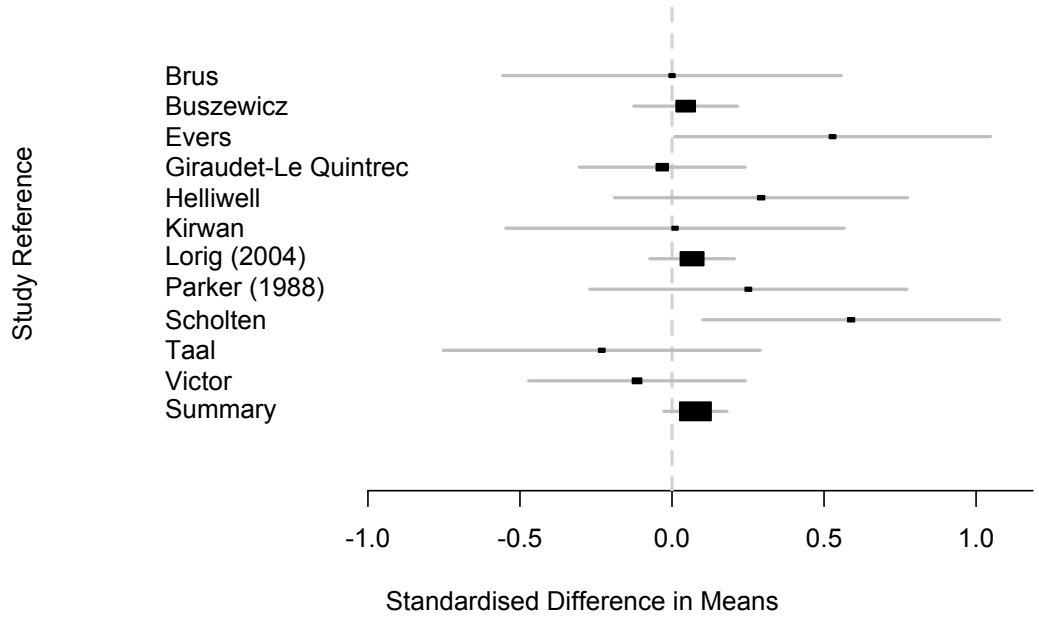


**Figure 2.12** ***Forest plot of the effect sizes of all studies measuring mental health at > 6 months***

Table 2.22 *Results of univariable meta-regressions testing the effects of confounding variables on mental health outcomes*

| Confounder | Effect Size | PT N=16 (924) | ≤ 6 months N=25 (2539) | > 6 months N=11 (1015) |
|---|---|---|---|---|
| INTERVENTION | *d* | -0.001 | -0.013 | -0.021 |
| DURATION | *SE* | 0.013 | 0.004 | 0.012 |
| | 95% CI | -0.027, 0.025 | -0.021,-0.005 | -0.045, 0.003 |
| | *p* | 0.934 | 0.002 | 0.082 |
| DELIVERY SOURCE (relative to HP) | | | | |
| Non-HP | *d* | 0.008 | 0.112 | -0.128 |
| | *SE* | 0.197 | 0.162 | 0.275 |
| | 95% CI | -0.378, 0.395 | -0.206, 0.430 | -0.666, 0.410 |
| | *p* | 0.967 | 0.491 | 0.641 |
| Mixed | *d* | 1.190 | -0.052 | -0.088 |
| | *SE* | 0.322 | 0.161 | 0.359 |
| | 95% CI | 0.560, 1.821 | -0.368, 0.263 | -0.792, 0.615 |
| | *p* | 0.0002 | 0.745 | 0.806 |
| DELIVERY METHOD (relative to Group) | | | | |
| Indiv. | *d* | -0.240 | 0.093 | 0.184 |
| | *SE* | 0.218 | 0.119 | 0.359 |
| | 95% CI | -0.667, 0.187 | -0.140, 0.326 | -0.520, 0.888 |
| | *p* | 0.270 | 0.432 | 0.609 |
| Mixed | *d* | no data | 0.035 | no data |
| | *SE* | no data | 0.281 | no data |
| | 95% CI | no data | -0.516, 0.586 | no data |
| | *p* | no data | 0.900 | no data |
| Unreported | *d* | 0.723 | no data | no data |
| | *SE* | 0.824 | no data | no data |
| | 95% CI | 0.078, 1.367 | no data | no data |
| | *p* | 0.028 | no data | no data |
| # SESSIONS | *d* | 0.005 | -0.017 | 0.010 |
| | *SE* | 0.006 | 0.010 | 0.009 |
| | 95% CI | -0.007, 0.017 | -0.037, 0.003 | -0.008, 0.029 |
| | *p* | 0.421 | 0.091 | 0.268 |
| CO-INTV. | *d* | 0.019 | -0.007 | 0.224 |
| | *SE* | 0.191 | 0.094 | 0.199 |
| | 95% CI | -0.355, 0.392 | -0.192, 0.178 | -0.167, 0.614 |
| | *p* | 0.922 | 0.942 | 0.261 |

*Note: PT = post treatment; HP = health professional; Non-HP = non health professional or lay person; Mixed = both HP and Non-HP; G vs. I = group versus individual delivery; Indiv. = Individual; Mixed = both group and individual sessions; # sessions = number of sessions in intervention; co-intv. = co-interventions; EU = European Union; UK = United Kingdom; US = United States; b. random = block randomization;* ***bold*** *figures indicate statistical significance*

Table 2.22, Continued *Results of univariable meta-regressions testing the effects of confounding variables on mental health outcomes*

| Confounder | Effect Size | PT N=16 (924) | ≤ 6 months N=25 (2539) | > 6 months N=11 (1015) |
|---|---|---|---|---|
| COUNTRY (relative to EU) | | | | |
| UK | *d* | 0.293 | -0.180 | -0.085 |
| | *SE* | 0.245 | 0.196 | 0.384 |
| | 95% CI | -0.186, 0.772 | -0.564, 0.204 | -0.837, 0.667 |
| | *p* | 0.231 | 0.358 | 0.825 |
| US | *d* | 0.756 | -0.152 | -0.094 |
| | *SE* | 0.236 | 0.180 | 0.359 |
| | 95% CI | 0.293, 1.219 | -0.506, 0.201 | -0.798, 0.610 |
| | *p* | 0.001 | 0.399 | 0.794 |
| Other | *d* | 0.853 | -0.167 | no data |
| | *SE* | 0.359 | 0.187 | no data |
| | 95% CI | 0.150, 1.557 | -0.533, 0.199 | no data |
| | *p* | 0.018 | 0.372 | no data |
| B. RANDOM | *d* | -0.293 | -0.024 | -0.024 |
| | *SE* | 0.308 | 0.129 | 0.129 |
| | 95% CI | -0.895, 0.310 | -0.277, 0.228 | -0.277, 0.228 |
| | *p* | 0.342 | 0.851 | 0.851 |
| GENDER | *d* | -0.004 | 0.008 | -0.0006 |
| (relative to Male) | *SE* | 0.013 | 0.003 | 0.006 |
| | 95% CI | -0.030, 0.022 | 0.002, 0.014 | -0.013, 0.011 |
| | *p* | 0.763 | 0.009 | 0.922 |

*Note: PT = post treatment; HP = health professional; Non-HP = non health professional or lay person; Mixed = both HP and Non-HP; G vs. I = group versus individual delivery; Indiv. = Individual; Mixed = both group and individual sessions; # sessions = number of sessions in intervention; co-intv. = co-interventions; EU = European Union; UK = United Kingdom; US = United States; b. random = block randomization;* ***bold*** *figures indicate statistical significance*

### 2.6.4 Summary of Effects

Overall results (see Table 2.23) show a significant improvement in pain ($d$ = 0.19, 95% CI = 0.09, 0.29), disability ($d$ = 0.18, 95% CI = 0.08, 0.29), and mental health ($d$ = 0.18, 95% CI = 0.003, 0.35) immediately after the intervention and at ≤ 6 month follow-up (pain: $d$ = 0.20, 95% CI = 0.12, 0.28; disability: $d$ = 0.15, 95% CI = 0.08, 0.21; mental health: $d$ = 0.17, 95% CI = 0.10, 0.24). These effects remained significant at > 6 month follow-up for disability ($d$ = 0.09, 95% CI = 0.02, 0.16), but were no longer significant for pain ($d$ = 0.07, 95% CI = -0.02, 0.16) or mental health ($d$ = 0.08, 95% CI = -0.03, 0.18) at this time point.

Table 2.23 *Meta-analytic effects of SM on pain, disability, and mental health at post-treatment, ≤ 6 months, and > 6 months follow-up*

| | **Outcome at each time point** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Pain** | | | **Disability** | | | **Mental Health** | | |
| | **PT** | **≤ 6m** | **> 6m** | **PT** | **≤ 6m** | **> 6m** | **PT** | **≤ 6m** | **> 6m** |
| **N** | 24 (1852) | 29 (3005) | 13 (1250) | 31 (2205) | 34 (3219) | 17 (1506) | 16 (924) | 25 (2539) | 11 (1015) |
| ***d*** | 0.19 | 0.20 | 0.07 | 0.18 | 0.15 | 0.09 | 0.18 | 0.17 | 0.08 |
| ***SE*** | 0.05 | 0.04 | 0.04 | 0.05 | 0.03 | 0.04 | 0.09 | 0.04 | 0.05 |
| **95% CI** | 0.09, 0.29 | 0.12, 0.28 | -0.02, 0.16 | 0.08, 0.29 | 0.08, 0.21 | 0.02, 0.16 | 0.003, 0.35 | 0.10, 0.24 | -0.03, 0.18 |
| ***p*** | <0.001 | <0.001 | 0.11 | 0.001 | <0.001 | 0.01 | 0.05 | <0.001 | 0.15 |

Note: PT=immediately post-treatment; ≤6m=follow-up 6 months or less; >6m= follow-up longer than 6 months; N = number of studies (pooled sample size across studies); *d* = standardised mean difference / effect size coefficient; *SE* = standard error; CI = confidence interval

## 2.7 Discussion

The results of this systematic review and meta-analysis suggest that SM interventions can significantly improve disability, pain, and mental health outcomes for people with both rheumatoid arthritis and osteoarthritis. The effects on pain and mental health can endure up to 6 months, while those on disability could last at least 21 months – the longest follow-up period included in the meta-analyses.

### *2.7.1 Systematic Review*

Overall study quality was good, in spite of the wide range of publication dates and the wide range of study methods. Two apparent differences relating to risk of bias between studies published through 2011 (Chapter 2.3) and those published between 2011 and 2017 (Chapter 2.5) were increases in the proportion of studies using block randomisation and allocation concealment procedures amongst those published between 2011 and 2017 compared with the earlier cohort of studies included in the narrative review. Block randomisation methods within the more recent cohort of studies (Chapter 2.5) was often used to control potential covariate differences between participants, while this procedure was generally employed as a tool to randomise participants by hospital or medical setting within the older cohort of studies (Chapter 2.3). In 2010, CONSORT (Schulz, Altman, and Moher, 2010) released guidelines describing allocation concealment as one of two essential components of randomisation procedures (Moher, Hopewell, Schulz, Montori, Gøtzche, Devereaux, Elbourne, Egger, and Altman, 2010). This may explain the sharp increase in the use of allocation concealment methods in SM intervention studies published between 2011 and 2017 when compared with those published prior to 2011. Overall, the most common intervention length was 6 weeks, which is the standard format of the original SM programme and the rate of attrition was lower than the "acceptable" rate of 80% follow up for evidence-based medicine (Altman, 2000). Although the highest attrition rates were more than double the average for both treatment and control groups in this review, even these rates may be reasonable given the nature of the interventions and the population that they target (Fewtrell, Kennedy, Singhal, Martin, Ness, Hadders-Algra, Koletzko, and Lucas, 2008).

However, none of the studies reviewed gave a clear definition of SM and only a few referred to the theory from which the SM intervention derives. A past review dealt with this by simply including studies that use the term "self-management" (Newman, et al., 2004). However, many studies that used the term "self-management" to describe their intervention, either did not describe their methods further or did not do so in enough detail to be replicable. Self-management interventions are complex and

it is recommended that complex interventions should be reported with absolute transparency (Boutron, et al., 2008). In fact, CONSORT (Consolidated Standards of Reporting Trials) guidelines for non-pharmacologic trials state that intervention content should be described in "precise" detail – even when the intervention involves tailoring to the individual (Boutron, et al., 2008).

The WHO has produced ICF core measurement sets for both RA (Stucki, Cieza, Geyh, Battistella, Lloyd, Symmons, Kostanjsek, and Schouten, 2004) and OA (Dreinhofer, Stucki, Ewert, Huber, Ebenbichler, Gutenbrunner, Kostanjsek, and Cieza, 2004). These core measurement sets identify the impairments, activity limitations and participation restrictions of relevance to OA and RA, and whilst there has been some work to develop valid measures of each type of outcome (Pollard, Dixon, Dieppe, and Johnston, 2009) there is currently no guidance on how to measure each outcome. Whilst the present meta-analysis has shown that there are positive changes in outcomes regardless of how they are measured, the use of poorly validated measures adds to the potential for these effect size estimates to be unreliable. Outcome Measures in Rheumatology (OMERACT; Tugwell, Boers, Brooks, Simon, Strand, and Idzerda, 2007) has worked to identify the most reliable and valid outcome measures for use in rheumatology. The American College of Rheumatology (ACR; Felson, Anderson, Boers, Bombardier, Chernoff, Fried, Furst, Goldsmith, Kieszak, Lightfoot, Paulus, Tugwell, Weinblatt, Widmark, Williams, and Wolfe, 1993) and the WHO-International League of Associations for Rheumatology (ILAR; Richards and De Wit, 2016) recommended particular outcomes and core measures for inclusion in all clinical trials of RA and OA (Tugwell, et al., 2007). Core clinical outcomes in RA are listed as acute-phase reactants, disability, joint pain/tenderness, joint swelling, pain, patient global assessment, physician global assessment, physician global assessment, and radiographs for studies of one year or longer, while OA outcomes should include pain, physical function, patient global assessment, and joint images for studies of one year or longer (Brooks and Hochberg, 2001). Some of the measures recommended by OMERACT were employed to assess pain, disability, and mental health (i.e. AIMS; AIMS2; DAS; EuroQol; HAQ) in studies included in this review (Richards and De Wit, 2016).

However, while guidelines for relevant outcomes in RA and OA exist, there is no accompanying guidance regarding the measurement of those outcomes. It would be useful for future research to outline recommended core measures for core outcomes in RA and OA. Doing so might improve the comparability of outcomes in future SM research and in turn, the ease and validity of sythensising results across studies.

A main limitation of this review was the variability in standard care between studies. The inclusion of studies with varied intervention content was deliberate, allowing for an examination of individual SM components and their effects. However, standard care also varied greatly according current guidelines for arthritis treatment across countries and regions as well as according to participants' existing care plans. As the evidence base supporting behavioural interventions for the treatment of arthritis grows, treatment guidelines and health care practices change with it, altering the level of standard care that must be delivered to maintain the ethical treatment of participants. For example, NICE recommends that SM education be offered to patients with OA (NICE, 2014) and RA within one month of diagnosis (2018). The Centers for Disease Control and Prevention (CDC, 2018), recommend arthritis SM programs for adults "when their arthritis has begun to interfere with valued life activities" (p. 1). Therefore, many of the SM studies that were conducted in the UK and the US provided some element of behavioural intervention to standard care control groups. The inclusion of behavioural intervention components into standard care is welcome, however, it might act to reduce differences between usual care control and self-management intervention groups. Thus, the impact of self-management interventions on outcomes might be underestimated in this review.

### *2.7.2 Meta-Analysis*

Meta-analyses indicate that interventions including problem-solving or decision making were the most successful. The findings of this meta-analysis suggest that decision making should be used when aiming to reduce pain, while problem-solving should be used when aiming to improve mental health. Disability decreased whether the full intervention or various combinations of SM components are used.

Given the known associations between depression and problem-solving, it is perhaps unsurprising that problem-solving has a significant effect on mental health for people with a chronic disease. Depression has been linked with a lack of problem-solving skills that results in a perpetual cycle of negative mental health outcomes (Marx, Williams, and Claridge, 1992). This finding led to the development of an effective therapy for depression aiming to instill or enhance a person's problem-solving ability (Nezu and Perri, 1989) which has now been extensively validated (Chambless, Baker, Baucom, Beutler, Calhoun, Crits-Christoph, Daiuto, DeRubeis, Detweiler, Haaga, Johnson, McCurry, Mueser, Pope, Sanderson, Shoham, Stickle, Williams, and Woody, 1998; Chambless and Ollendick, 2001). Although the problem-solving component of SM is aimed at issues associated with an individual's management of their chronic disease (Lorig and Holman, 2003), while problem-solving therapy for depression focuses more on social function within cultural context (Nezu and Perri, 1989), both appear to have significant effects on mental health.

Similarly, chronic pain has been shown to negatively affect a person's decision making skills due to an overburdening of the orbitofrontal cortex of the brain (Apkarian, Sosa, Krauss, Thomas, Fredrickson, Levy, Harden, Chialvo, 2004). The decision making component of the SM intervention model involves educating patients on the various options that are available to them, including how to interpret symptoms and how to evaluate information about their health condition (Lorig and Holman, 2003). If delivering this SM component does result in patients making better disease management choices, this in itself could explain positive effects on pain levels. However, it may also be that detailing options and equipping patients with the means to choose between them simply relieves some of the cognitive burden associated with the experience of a chronic health condition and thus, decreases pain. Similarly, previous findings suggest that health outcomes improve following an SM intervention regardless of behavioural changes related to disease management (Lorig and Holman, 2003). When interviewed, participants suggested that their health improvements were related to increased perceived control or self-efficacy (Lenker, Lorig, and Gallagher, 1984). Changes in self-efficacy may also explain the present finding.

While no effect of the number of SM components included in an intervention was found, sensitivity analyses identified a significant negative effect of more lengthy interventions on mental health. There are a number of potential explanations for this; for example, interventions of longer duration may have simply been less intensive. Some interventions included booster sessions in the form of telephone calls or mail-delivered materials. Thus, a 24 week intervention may have involved a full intervention protocol for the first 4 weeks and then a booster session 20 weeks later. So, in this example, 6 month follow-up measures would be taken 11 months following the end of the more intensive part of the intervention. In contrast, there is a possibility that this finding reflects a negative effect of increased patient burden. This idea is in line with the finding that interventions including more SM components trended towards increased pain, highlighting that certain outcomes, like disability, may benefit from intensive interventions (e.g. longer duration, greater number of components, sessions, or amount of time involved), while others do not. However, no significant effect of the number of sessions in an intervention was found, so the mechanism of this effect could not be identified.

Recent work has aimed to develop a comprehensive, well-defined list of behavior change techniques (BCT) in an effort to allow continued research in the field to be more precise, replicable, and to create a list of intervention components that can be prescribed on a tailored basis according to individual patient needs (Abraham and Michie, 2008). Meta-analytic research has found that one particular BCT, "self-monitoring", was more effective than the others, but the most powerful effects were found when this BCT was combined with any other BCT derived from control theory (Carver and Scheier, 1982) (i.e. prompt intention formation, prompt specific goal-setting, performance feedback, prompt self-monitoring of behaviour, prompt review of behavioural goals) (Michie, Abraham, Whittington, and McAteer, 2009). One aim of the present meta-analyses was to examine SM intervention techniques in in a similar manner to determine whether certain components are more effective than others and whether there are combinations of components that interact to produce particular effects. However, there was a clear lack of studies testing one SM component only. For example, very few studies included a resource utilisation

component and none tested this component's effect on its own. This meta-analysis included studies that varied in content in an effort to calculate effect sizes for each component of the SM intervention, in addition to the interventions' overall effects. This, of course, is a limitation, as this increases heterogeneity between studies. Similarly, intervention content was often poorly defined, making it difficult to determine whether certain SM components were included or not. Thus, although agreement between researchers was high when coding intervention content, it is possible that SM components were included in an intervention, but not described in the publication or that they were not described sufficiently for the reviewers to identify them. SM components were only coded as being present in an intervention if they were clearly identifiable within the intervention description. Future research on SM for chronic disease should focus on clearly defining the intervention and describing its component parts as recommended in CONSORT guidelines (Boutron, et al., 2008). While it would be useful to understand which components or combinations of components are required for effectiveness, a full factorial assessment of this would be impractical. However, an N-of-1 study design might provide a useful method of examining the impact of different component combinations for individual application (Kravitz, Duan, Duan, Eslick, Gabler, Kaplan, Kravitz, Larson, Pace, and Schmid, 2014; March, Irwig, Schwarz, Simpson, Chock, and Brooks, 1994).

This meta-analysis included studies that used a variety of different outcome measures, with individual studies also employing multiple measures of the same outcome. This not only causes problems during the meta-analytic process, but also highlights the need for a consensus surrounding the core health outcomes in this field and the outcome measures that best capture them. Despite the growing use of non-medical treatments in primary care, this issue has been dealt with more effectively in guidelines for pharmacological and surgical interventions (Turk, Dworkin, Allen, Bellamy, Brandenburg, Carr, Cleeland, Dionne, Farrar, Galer, Hewitt, Jadad, Katz, Kramer, Manning, McCormick, McDermott, McGrath, Quessy, Rappaport, Robinson, Royal, Simons, Stauffer, Stein, Tollett, Witter, 2003). There needs to be some agreement on what is meant by 'disability', 'pain', 'mental health', etc. and

subsequent application of the core measures that have been recommended for these outcomes in arthritis.

With self-management interventions now being delivered by healthcare providers throughout the world (Newman, Steed, and Mulligan, 2004), it is particularly important to determine which components or combination of components of SM affect each outcome to allow interventions in primary care to be tailored to meet individual patients' needs. It is also important to determine how long an intervention should be delivered for and how intense it should be in order to produce the desired outcome effects. Doing so could ultimately allow for personalised SM interventions (Michie, et al., 2013) and reduce costs to both the healthcare provider and the patient in terms of time and money. Furthermore, as results suggest that providing a higher number of self-management components may cause negative effects on pain outcomes, but positive effects on other outcomes, it could be especially important to make tailored SM treatment decisions according to patient preferences. Given the heterogeneity of results between individuals included in previous group studies of self-management in chronic disease, it would be valuable to determine whether it is useful and feasible to test SM interventions on an individual level or whether group studies and RCTs are the most appropriate designs.

# Chapter 3: Testing the Effect of Goal Setting and Action Planning on PA: A Series of Randomised, Controlled N-of-1s

## 3.1 Introduction

The government has highlighted a significant concern over adults living sedentary lifestyles, proposing a guideline of at least 2.5 hours of moderate to vigorous exercise per week (Department of Health, 2011). However, 38% of adults report that they are not taking part in any physical activity (PA) at all and this figure is even higher (44%) amongst adults who have arthritis (Shih, Hootman, Kruger, and Helmick, 2006). Ironically, walking at least 1 mile per week can halt the progress of arthritis symptoms and improve existing physical functioning (Miller, Rejeski, Reboussin, Have, and Ettinger, 2000) and, although research has shown that increases in walking behaviour can decrease joint pain, disability, and swollen and tender joint count over time (Kovar, Allegrante, MacKenzie, Peterson, Gutin, and Charlson, 1992; Stenström, 1994), the expectation of pain upon walking is often cited as the reason for choosing to rest instead (Hootman, Macera, Ham, Helmick, and Sniezek, 2003). Arthritis is the most common chronic disease in the United Kingdom (UK; Office for National Statistics, 2011) and so, directing effective behaviour change interventions for PA at this population could reduce pain, improve physical functioning, and reduce the health risks of inactivity in a large population susceptible to disability.

### *3.1.1 Interventions to Promote Physical Activity (PA)*

There is a large research base describing interventions designed to change PA behaviour (Abraham and Michie, 2008). These interventions are complex and often involve multiple components (Craig, Dieppe, Macintyre, Michie, Nazareth, and Petticrew, 2008). Previous reviews of the literature indicated that the content of interventions to change health behaviours have been poorly described (Dombrowski, Sniehotta, Avenell, and Coyne, 2007; Dombrowski, Sniehotta, Avenell, Johnston, MacLennan, and Araújo-Soares, 2012; Michie, et al., 2009). This lack of clarity has

made it difficult to identify the effective components of interventions and therefore, difficult to develop a cumulative evidence base (Michie, Richardson, Johnston, Abraham, Francis, Hardeman, Eccles, Cane, and Wood, 2013). However, researchers have recently developed a detailed taxonomy describing discrete, theory-based techniques that have been used in behaviour change interventions (Michie, Richardson, Johnston, Abraham, Francis, Hardeman, Eccles, Cane, and Wood, 2013). Each behaviour change technique (BCT) is taxonomised such that intervention components are broken down into the smallest units possible without compromising their content (Wood, Richardson, Johnston, Abraham, Francis, Hardeman, and Michie, 2014). To allow for the reliable description of intervention content, a rigorous method of coding, defining, and reporting BCTs has been developed along with a comprehensive set of tools for both the delivery and evaluation of behaviour change interventions, including mobile phone applications, classroom-based, and online training programmes (Crane, 2014; Wood, et al., 2014).

### *3.1.2 Goal-Setting and Action Planning*

Goal-setting and action planning are effective behaviour change techniques commonly included together in interventions aimed to increase PA in healthy populations (Kahn, Ramsey, Brownson, Heath, Howze, Powell, Stone, Rajab, Corso, and the Task Force on Community Preventive Services, 2002; Shilts, Horowitz, and Townsend, 2004). They contribute to one (i.e. 'taking action') of the five components of a self-management intervention designed to improve outcomes in people with chronic health conditions and are core to the Stanford SM programme (Lorig, et al., 1999). According to Lorig and Holman (2003), goal-setting should involve setting a very specific goal that could be achieved within 1 to 2 weeks. Once a realistic goal has been set, an action plan must be made. For example, a goal to increase exercise in the coming week might be paired with an action plan to walk to work instead of driving each day. The person should be confident in their ability to achieve the goal that they have set for themselves. If this is not the case, the goal should be adjusted. This is a gradual process that not only involves setting small

goals that accumulate to build a larger achievement over time, but should also increase self-efficacy through mastery experience over time.

Although the SM programme has been successful in improving disease management (Newman, Steed, and Mulligan, 2004), it is unknown which particular components of the programme are effective. As goal-setting and action planning have most often been tested as one part of a more complex intervention for people living with chronic disease (Conn, Hafdahl, Brown, and Brown, 2008; Greaves, Sheppard, Abraham, Hardeman, Roden, Evans, and Schwarz, 2011; Lorig and Holman, 2003), it is not clear whether this behaviour change technique (i.e. 'taking action') has independent effects on PA (Artinian, Fletcher, Mozaffarian, Kris-Etherton, Van Horn, Lichtenstein, Kumanyika, Kraus, Fleg, Redeker, Meininger, Banks, Stuart-Shor, Fletcher, Miller, Hughes, Braun, Kopin, Berra, Hayman, Ewing, Ades, Durstine, Houston-Miller, Burke, 2010) or whether its effects on PA differ between healthy and physically impaired populations.

Behaviour change theories often involve a link between behavioural intentions and subsequent behaviour, including the Theory of Planned Behaviour (Ajzen, 1991), the Health Action Process Approach (Schwarzer, 1992), and the Transtheoretical Model (Prochaska and DiClemente, 1983). However, there is a well-known gap between what a person intends to do and what they actually do. A recent meta-analysis estimated the intention-behaviour gap for PA to be as large as 46%, with intentions failing to predict subsequent PA behaviour nearly half of the time (Rhodes and de Bruin, 2013). It has been argued that this gap between intention and behaviour could be explained by goal conflict (Abraham and Sheeran, 2003). Goal-setting is a more complex process than simply intending to perform a behaviour and then going on to either achieve the overall goal or not achieve it. People tend to have a large number of co-existing, and sometimes competing, goals ranging in importance, difficulty, and urgency (Presseau, Tait, Johnston, Francis, and Sniehotta, 2012). For example, a person might be aiming to get to work on time, but also to eat a healthy breakfast, ensure their children are ready for school, and that they arrive at school on time. However, if a healthy breakfast requires more preparation time than an unhealthy

one, this individual may have to choose between having a healthy breakfast and getting the children or themselves to school or work on time. These types of dilemmas, which people encounter on a daily basis, involve a complicated set of decision-making processes (Presseau, et al., 2012). Thus, one person may have a number of goals at any one time – some conflicting and others facilitating each another (Presseau, et al., 2012).

People who have a chronic disease are faced with a set of additional, health-related goals that they likely did not face prior to disease onset (Lorig and Holman, 2003). For people who have rheumatoid or osteoarthritis, PA carries not only the usual health benefits, but also has a therapeutic aspect with evidence that regular PA can lessen joint pain over time (Nelson, et al., 2007). For those who experience chronic joint pain, the most highly rated priority is often to minimise pain or prevent pain (ten Klooster, et al., 2007). However, despite the long-term therapeutic effects of PA in joint disease, the short-term effect is usually an increase in pain (Gooberman-Hill, Woolhead, MacKichan, Ayis, Williams, and Dieppe, 2007). Therefore, the goal to be active and the goal to avoid pain in the short-term are in direct conflict for this population (Gooberman-Hill, et al., 2007).

### *3.1.3 N-of-1 RCTs*

Most studies aiming to measure the effects of an intervention on health or behaviour use a randomised controlled trial (RCT) design (Sackett, Rosenberg, Gray, Haynes, and Richardson, 1996). This design is excellent for showing the overall effects of a manipulation across a large, standardised group of people (Davidson, Peacock, Kronish, and Edmondson, 2014). However, the highly controlled nature of these studies often produces results that, whilst only applicable to a very specific group of people, are used to justify more widely prescribed practices (Davidson, et al., 2014; Martin, Bégaud, Latry, Miremont-Salamé, Fourrier, and Moore, 2003). Further, even the most positive findings across randomised groups can include cases where the intervention produced neutral or even negative effects in one or more individual participants and conversely, positive effects in the minority can be overlooked if the

group effect is null (Clay, 2010; Davidson, et al., 2014).

### *3.1.4 Aims*

Based on previous research (Sniehotta, Presseau, Hobbs, and Araújo-Soares, 2012), the present study aimed to test the utility of a randomised, N-of-1 design to evaluate the effects of goal-setting at an individual level. The research on which the present study is based included only healthy participants and tested the effects of both goal-setting and self-monitoring on PA (Sniehotta, et al., 2012). The present study expanded this design to include both healthy participants and participants with chronic joint pain to test the effects of goal-setting and action planning on PA in individuals and between groups of participants (i.e. chronic pain and healthy groups). 'Taking action' (i.e. goal-setting and action planning) was one of the most commonly applied SM components identified in the systematic review of SM interventions included in Chapter 2 of the present thesis. This particular SM component can be delivered at low financial cost (Schippers, Scheepers, and Peterson, 2015) and is often employed to directly affect activity behaviour (Shilts, Horowitz, and Townsend, 2004). Further, activity limitations are one of the three central components of disability within the ICF model of health outcomes (WHO, 2001). Previous research has found that attention to pain can increase disability behaviour, even when pain intensity is controlled for (McCracken, 1997). Additionally, there is evidence that measuring a variable can draw attention to the factor that is being measured, heightening the cognitive accessibility of information relating to it (Morwitz and Fitzsimons, 2004). To control for any potential effects of attention to pain, participants in the present study were randomised to report pain or not to report pain, an important PA-related issue for people who have a chronic joint pain (Gooberman-Hill, et al., 2007). Specifically, the present study set out to determine whether:

1. setting an activity-related goal affects PA levels in individuals,
2. reporting pain affects PA levels in individuals, and

3. there are differences between healthy people and those who have chronic pain in the effects of goal-setting and pain reporting on PA.

## 3.2 Methods

### *3.2.1 Participants*

Participants were recruited from the community in Scotland through social media, chronic disease patient organisations, newspaper, and poster advertisements (Appendices 3 and 5). One group of 18 participants with self-reported chronic hip or knee pain and a group of 17 reportedly healthy participants (i.e. no chronic joint pain) were recruited. One participant from the pain group withdrew from the study due to discomfort whilst wearing the ActiGraph belt (i.e. activity monitor) and this was attributed to an existing co-morbid condition. One participant from the healthy group withdrew due to complications with wearing the ActiGraph monitor to work and another from the pain group stopped responding to study questions without explanation. Five participants' (i.e. 2 joint pain, 3 healthy) data were excluded from analyses due to an equipment fault that resulted in large amounts of missing data. Four participants from the pain group and one participant from the healthy group were missing more than 20% of the data from their PA series through either forgetting or choosing not to wear ActiGraph monitors. This left 10 participants in the pain group and 12 participants in the healthy group for the purposes of analyses. In the pain group, diagnoses varied (i.e. osteoarthritis (OA) = 3; rheumatoid arthritis (RA) = 3; OA and RA = 1; Joint Hypermobility Syndrome (JHS) = 1; RA, JHS, and lupus = 1; lupus = 1; arthritis (non-specific) = 2; trauma = 1; undiagnosed = 1). Overall, there were 19 females and 8 males (i.e. 4 males in the pain group and 4 males in the healthy group). Ages ranged from 19 to 71 in the pain group (M = 49.70, sd = 15.49) and 22 to 43 in the healthy group [M = 26.92, sd = 5.88].

### *3.2.2 Design*

This study used an N-of-1, blinded randomised 2 x 2 factorial design. The two factors, goal setting and joint pain, each had two levels (PA goal vs. fruit and vegetable consumption goal; pain reports vs. no pain reports). Participants served as their own controls. Participants were randomised daily to either the intervention (goal = physical activity; pain = report pain) or control conditions (goal = diet; pain = no report of pain).

It was not possible to conduct a power analysis as independence cannot be assumed in an N-of-1 design. However, Sniehotta, et al. (2012) suggest that 30 participants in each arm are required for 80% power (Cohen, 1992). As this study had only one independent variable and participants served as their own controls, we aimed to recruit 30 participants.

### *3.2.3 Intervention*

#### *3.2.3.1 Content*

During the intervention condition, participants received a text message in the morning asking them to make a PA goal for that day ("Please set yourself a walking goal today. Think about how many steps you would like to take and try to make a plan towards how you might achieve that goal.") In the control condition they were asked to make a goal about fruit and vegetable consumption ("Please set a fruit and vegetable goal today. Think about how much fruit and veg you would like to eat and try to make a plan of how you might achieve that goal.").

On pain report days, participants were asked to reply via text message with a pain score ["What is your pain level? Please reply to this message with a pain rating from 0 (no pain) to 10 (worst pain)."] once in the morning and once in the evening. Participants using analgesics were instructed to continue with their normal medication routines.

*3.2.3.2 Delivery*

Daily goal condition and pain report condition were randomised to each individual upon joining the study, meaning that no one individual received the same random sequence of goal or pain report conditions. An online random number generator (Psychic Science, 2017) recommended for use in random sampling procedures (Bryman and Cramer, 2011; Johnson and Christensen, 2008; Vogt and Johnson, 2011) was used to generate a random number sequence for each condition in each participant. A closed sequence (i.e. each integer appears an equal number of times) of 60 integers between one and two was generated to determine an individual's random allocation to either a walking condition (represented by the number one) or a diet condition (represented by the number two) on each day of the 60 day study period. This produced a series stipulating 30 randomly allocated days in the walking goal condition and 30 randomly allocated days in the diet goal condition. Then, a closed sequence of 30 integers between zero and one was generated to determine the individual's random allocation to either report pain (represented by the number one) or not report pain (represented by a zero) on each day that they were allocated to a walking condition. The sequence that was generated was then matched to the individual's walking condition days only. This procedure was repeated to randomly allocate the individual's pain report condition on each day that they had been allocated to a diet condition, ensuring that each combination of the two conditions appeared an equal number of times (i.e. 15) throughout the study period (Table 3.1).

Text messages were automatically sent to participants via an online text messaging service (Text Local 2.0, 2014). After random allocation to each condition, an individual's text messages were scheduled for all 60 days of the study period prior to the participant's entry into the study. Text messages were scheduled by selecting the relevant message, time, date, and recipient for each text message that would be sent throughout the study period. For example, if a participant began the study on July 1 and were allocated to receive a walking goal and to report pain on their first day of the 60 day study period, a text message containing the walking goal instructions (i.e. "Please set yourself a walking goal today. Think about how many steps you would like to take and try to make a plan towards how you might achieve that goal.") would

be scheduled to send to the individual's mobile phone at 7am on July 1. A separate text message with instructions to report pain [i.e. "What is your pain level? Please reply to this message with a pain rating from 0 (no pain) to 10 (worst pain)."] would also be scheduled to send to the individual at 7am and, separately, to send again at 7pm. Responses to pain report messages were received on a PIN protected mobile phone used solely for this purpose. All text messages sent throughout the study period were scheduled in this way following random allocation to goal and pain report conditions and prior to each participant's entry into the study. Although allocation was not blinded to the investigator, initial meetings with participants and explanation of the study was conducted prior to random allocation. There was no contact between the investigator and participants during the study period unless a participant made contact regarding an issue with the materials. Further, conditions were allocated within, rather than between participants. Therefore, the lack of blinding of condition allocation to the investigator was not expected to affect results. Participants were blinded to their condition allocation, only made aware of a day's goal and pain report condition upon receipt of each text message.

Table 3.1 *Days spent in each treatment condition.*

| **Goal Condition** | **Pain Condition** | | **Total days** |
|---|---|---|---|
| | *Report* | *No report* | |
| *Walking* | 15 | 15 | 30 |
| *Diet* | 15 | 15 | 30 |
| **Total days** | 30 | 30 | 60 |

As participating in this study may have cost participants up to £14 depending on the mobile phone tariff that each individual used, all participants were reimbursed £15 upon completion of the study.

### *3.2.4 Materials*

#### *3.2.4.1 Physical Activity (PA)*

An objective measure of physical activity was obtained using the ActiGraph GT3X accelerometer (ActiGraph LLC, Pensacola FL). The ActiGraph measures step as well as body acceleration on 3 axes – vertical (eg. up and down), anteroposterior (eg. back and forth), and mediolateral (eg. side to side) - in 15 second epochs (Sasaki, John, and Freedson, 2011). The ActiGraph GT3X has been shown to have very high intra-instrument and inter-instrument reliability when used at frequencies between 2.1 Hz and 4.1 Hz (Santos-Lozano, Marín, Torres-Luque, Ruiz, Lucía, and Garatachea, 2012a; Santos-Lozano, Torres-Luque, Marín, Ruiz, Lucia, and Garatachea, 2012b). This was determined to be ideal for use in this study as the frequency of normal human physical activity is expected to be between 0.3 Hz and 3.5 Hz, with only very fast running registering above 4 Hz (Santos-Lozano, et al., 2012a).

Accelerometers were worn on a belt around the waist or torso positioned at the right hand side of the body for 60 days except while bathing or sleeping. The daily activity count was not visible from the accelerometer equipment or available to the participant in any other form. Each device had 4gb of memory, capable of storing up to 240 days of raw data. Expected battery life was approximately one to two weeks and therefore, each participant was supplied with an ActiGraph charging cable and asked to charge their device overnight. The activity scores reported in this study are summed composite scores of vector magnitude as detected on all 3 axes (Sasaki, John, and Freedson, 2011). This allowed for activity to be measured as total activity over the course of a full day rather than as exercise-oriented scores of activity per minute typically used to reflect light, moderate, and vigorous activity.

#### *3.2.4.2 Baseline and Follow-Up Measures*

Participants were asked to complete a series of questionnaires at baseline and again at post-intervention including questions about demographic information (sex, age,

comorbid diseases, use of analgesics, name, and mobile phone number; Appendix 8), disease-related wellbeing (Arthritis Impact Scale version 2 – short form; AIMS2-SF; Meenan, Gertman, and Mason, 1980; Appendix 9), disability (Health Assessment Questionnaire; HAQ; Fries, et al., 1980; Appendix 10), and joint pain (McCaffery, Beebe, Latham, and Ball, 1989; Appendix 11).

The AIMS2-SF (Meenan, Gertman, and Mason, 1980) measures disease-specific well-being using 26 questions (only 24 for unemployed, disabled, or retired participants) (Appendix 5). Questions begin, "During the past four weeks…" and are answered on a 4-point scale (ie. most days, some days, few days, no days). Questions include, "how often were you physically able to drive a car or use public transportation?", "did you need help to get out of bed?", and "how often did your morning stiffness last more than one hour from the time you woke up?". The AIMS2-SF is scored by first recoding items so that low scores indicate more positive health status. Scores for items within each subscale (i.e. physical; symptom; affect; social; work) are then averaged. Because there are a different number of items in each subscale, scores must then be normalised according to the AIMS2-SF normalisation procedure (Quality of Life Group in Rheumatology, 1995) so that all scores range between 0 (best health) and 10 (worst health). The overall AIMS2-SF score ranges from 0 to 60 and is the sum of the normalised scores of all subscales.

The HAQ (Fries, et al., 1980) asks 24 questions assessing disability over the past week on a 4-point scale (without any difficulty, with some difficulty, with much difficulty, unable to do) (Appendix 6). Questions begin, "at the moment, are you able to…" and cover activities of daily living, such as, "shampoo your hair?", "climb up five steps?", "get on and off the toilet?", and "bend down to pick up clothing from the floor?". Each question is scored between 1 and 4 according to the amount of difficulty a person has with a task, with higher scores indicating greater disability. If more than one consecutive response is selected for a single question, the higher score is recorded and if more than one non-consecutive response is selected, no response is recorded. There are eight categories (i.e. dressing and grooming; arising; eating; walking; hygiene; reach; grip; activities) that make up the scale and scores are first

calculated within each category. Participants are also asked whether they need any aids or devices to help them with the first four categories of activities (i.e. dressing and grooming; arising; eating; walking) and with the second four categories of activities (i.e. hygiene; reach; grip; activities). If no assistance is needed, no points are added. But, needing an aid or device adds 1 point, needing help from another person adds 2, and needing both adds 3. The score for each subscale is the highest scored response selected by the individual within the subscale. Points added for aids and assistance can only add to a score of 0 or 1 to create a maximum score of 2. If aids or assistance are required within a category, but the subscale is already scored 2 or 3, then the score remains unchanged. The overall disability score is a mean of the eight scores for each subscale, ranging from 0 to 3 (Fries, Spitz, Kraines, and Holman, 1980).

Pain (McCaffery, et al., 1989) was assessed on an 11-point numerical scale ranging from 0 to 10, with higher scores indicating more pain (Appendix 7). Participants were asked to give separate scores for their current pain, their lowest (best) pain level, and their highest (worst) pain level in the last 24 hours. The average of these 3 scores were taken as an average pain score. This method was used due to the nature of joint pain, which tends to vary across the day.

### *3.2.5 Procedure*

The study was advertised via local newspapers (i.e. Bearsden Herald, Stirling Observer) (n = 2), posters in the community and the University of Strathclyde (n = 5), the University of Strathclyde Health and Social Sciences student mailing list (n = 7), word of mouth (n = 9), Gumtree (n = 1), and the online forums or social media outlets of chronic disease charities (i.e. HealthUnlocked, Arthritis Care, National Rheumatoid Arthritis Society) (n = 11).

Participants registered their interest in the study via telephone, text, or email. Full study (Appendices 4 and 6) and consent (Appendix 7) information was then sent either via post or email. Those who then expressed a willingness to take part

arranged to meet with the researcher (THB) in a convenient, central location of their choice (eg. coffee shop, train station, café) to complete baseline measures (i.e. pain scale, AIMS2, HAQ). THB explained that the accelerometer should be worn upright, around the waist, and to the right hand side upon arising for the day until retiring to bed in the evening. To prevent discomfort, participants were told that the accelerometers did not need to be worn whilst showering or swimming despite their being waterproof. THB met each participant one week following their entry into the study to connect their ActiGraph monitor to a laptop to check that monitors were functioning and recording data properly. During the study period, participants received between one and three text messages per day, depending on the goal and pain report conditions to which they were randomly assigned each day. For example, if assigned to walking goals and pain report, a participant would receive one message about making a walking goal in the morning, one message asking for a pain score in the morning, and one message asking for a pain score in the evening. When asked to provide pain scores, participants simply replied to the text that they received with a number between zero and 10. Finally, participants met THB at the end of the study to return equipment, complete follow-up measures (i.e. pain scale, AIMS2, HAQ), and receive debriefing information (Appendix 12).

All data were retrieved from accelerometers at the end of the study period using ActiLife software version 6.11.5 (ActiGraph Corp, 2014). Data were filtered by hand to identify the start and the end of each participant's daily wear time. These filters were then applied during export to a .csv file that output daily vector magnitude totals. These vector magnitude scores made up the activity scores used in the present study.

Ethical approval for this study was obtained from the University of Strathclyde Ethics Committee.

### *3.2.6 Analyses*

Data were analysed using the open source statistical programme, Gretl (Cottrell and Lucchetti, 2007) for individual analyses and SPSS 22.0 (IBM Corp., 2013) for group analyses. First, missing PA data were imputed using the package 'norm' (Ported to R by Novo. Original by Shafer, 2013). This was done using an open source statistical programme, R version 3.2.1 (R Development Core Team, 2011). Prior to imputation, an appropriate transformation, automatically selected by the 'impute' code, was applied in cases where data were not normally distributed and then removed after imputation was complete. This imputation method involved the random generation of five separate datasets using the Monte Carlo method (Metropolis and Ulam, 1949). The average of the five datasets is then taken as the complete dataset and is transformed back to the original distribution. This method of imputation has been used previously in the analysis of N-of-1 studies (O'Brien, Philpott-Morgan, and Dixon, 2015). Eighteen of 22 participants were missing one or more data points from the PA data series. Two participants (i.e. one pain group, one healthy group) were missing 2% of the possible 60 data points from their PA series; three participants (i.e. two pain group, one healthy group) were missing 3%; two participants (i.e. pain group) were missing 10%; two participants (i.e. one pain group, one healthy group) were missing 18%; one pain group participants was missing 8%; one pain group participant was missing 4%; one healthy group participant was missing 5%; one healthy group participant was missing 15%.

As time series data are derived from sequential measures from an individual over time, there is a risk of serial dependency within each data series. After missing data were imputed, data were checked for significant autocorrelation using the 'variable' function and correlograms in Gretl (Cottrell and Lucchetti, 2007) to calculate autocorrelation and partial autocorrelation functions. A maximum time lag of one week (i.e. seven data points: one data point per day) was applied to each data series with the expectation that cyclical patterns would be weekly at the longest (Hobbs, et al., 2013). Where partial autocorrelations exceeded the 95% confidence level, autocorrelation was assumed to be present.

Tests of individual effects of goal-setting condition and pain report condition on PA were conducted using ARIMA (autoregressive integrated moving average) models in Gretl (Cottrell and Lucchetti, 2007). Each individual was tested separately and all models included a linear time trend of PA to account for any cumulative effects of the intervention. PA was entered as the dependent variable and goal-setting condition, pain report condition, and linear time trend were entered simultaneously as independent variables. Coefficients from these analyses are interpreted in the same way as linear regression analyses, but take into account any significant autocorrelation and non-stationarity present in the PA data series. Thus, the effects of autocorrelation and non-stationarity within the data series are controlled for, rather than removed. ARIMA models are characterised by three values identified by the terms 'p', 'd', and 'q'. 'P' represents the number of autoregressive terms; 'd' represents the number of nonseasonal differences required to achieve stationarity; 'q' represents the number of forecast errors that have been lagged in the regression model (Nau, 2017). A lag was chosen first based on the most significant autocorrelation identified by partial autocorrelation functions (PACF). This lag determined the 'p' value in the ARIMA model and was entered as the autoregressive (AR) component in Gretl's (Cottrell and Lucchetti, 2007) ARIMA interface. The model's residuals were then checked for autocorrelation. If the residuals were determined to be white noise (i.e. no autocorrelation identified by autocorrelation and partial autocorrelation functions), then the model was considered a good fit (Halls-Moore, 2015). If the residuals were not determined to be white noise, lags were entered into the moving average (MA) component of Gretl's (Cottrell and Lucchetti, 2007) ARIMA interface, identified by autocorrelation functions (ACF) and these lags determined the 'q' value in the ARIMA model. If residuals from a model containing both AR and MA lags and was still not determined to be white noise, differencing was applied to achieve stationarity of the PA data series, determining the 'd' value in the ARIMA model. Models that were differenced did not contain a constant, as including a constant in a differenced model assumes that there is a non-zero average trend and the aim of the present study was not to plot expected average trends, but to plot expected average means. Only one ARIMA

model required differencing to achieve residuals containing white noise. Using this procedure and only including one lag component at a time ensured that the simplest model that fit the data was chosen.

Analyses conducted to test for between-subject effects involved mean activity values for each participant and were, therefore, not affected by autocorrelation.

## 3.3 Results

### *3.3.1 Descriptive Statistics*

Tables 3.2 and 3.3 show overall mean(standard deviation) or median(range) PA scores, depending on normality, during intervention and control goal-setting conditions and during pain report and no pain report conditions for participants in the pain group and the healthy group, respectively. Participants are labelled according to whether they were part of the pain group (P) or the healthy group (H) and numbered (e.g. P1, P2; H1, H2).

An independent samples t-test showed that the two groups were significantly different according to age [$t(20) = 4.72$, $p < 0.001$] with the healthy group (M = 26.92, sd = 5.88) over 22 years younger, on average, than the pain group (M = 49.70, sd = 15.49).

However, results of a linear regression analysis show that age did not predict mean activity [$\beta = -0.34$, $p = 0.12$] and an independent samples t-test demonstrated that there were no significant differences in mean activity [$t(20) = -0.98$, $p = 0.34$] between the healthy group (M = 496257, sd = 235385) and the pain group (M = 399747, sd = 222389).

Due to the high rate of attrition in the present study, data were analysed to identify differences between participants according to completion and non-completion of the study. An independent samples t-test found no differences between completers and non-completers according to age [$t(33) = -0.06$, $p = 0.95$]. Chi square tests showed no differences between completers and non-completers according to gender [$x^2(1) = 0.31$, $p = 0.58$] or the presence or absence of chronic pain (i.e. study group) [$x^2(1) = 0.85$, $p = 0.36$].

Table 3.2 *Mean (standard deviation) or median (range) physical activity (PA) scores for each chronic pain participant by goal-setting condition and pain report condition*

| | | | **Mean (sd) Vector Magnitude** | | | |
|---|---|---|---|---|---|---|
| | | | **Goal-Setting Condition** | | **Pain Report Condition** | |
| **Ppt** | **Age** | **Sex** | **Intervention** | **Control** | **Pain report** | **No pain report** |
| P1 | 71 | F | 365611(111521)[a] | 408732(134623)[a] | 391539(125407)[a] | 382804(125521)[a] |
| P2 | 37 | F | 682170(193648)[a] | 670642(863387)[b] | 680198(959553)[b] | 701190(1139187)[b] |
| P3 | 45 | F | 543458(833084)[b] | 571548(872683)[b] | 549622(872683)[b] | 566192(736699)[b] |
| P4 | 19 | M | 392195(198625)[a] | 421330(174999)[a] | 399231(198748)[a] | 414293(175777)[a] |
| P5 | 64 | M | 492133(125910)[a] | 463682(99511)[a] | 497835(110139)[a] | 457980(114987)[a] |
| P6 | 42 | F | 811401(368504)[a] | 568777(1173744)[b] | 761310(343574)[a] | 547617(1293626)[b] |
| P7 | 51 | F | 327719(655109)[b] | 360485(602023)[b] | 35743(489082)[b] | 338247(655461)[b] |
| P8 | 64 | F | 2387(447)[a] | 2412(314)[a] | 2348(2081)[b] | 2411(325)[a] |
| P9 | 45 | M | 161265(636545)[b] | 246545(861441)[b] | 206596(164022)[a] | 209246(861541)[b] |
| P10 | 59 | F | 241622(142544)[a] | 225670(124057)[a] | 253442(142525)[a] | 213849(121310)[a] |

*Note: Ppt = participant; [a] = mean(standard deviation); [b] = median(range)*

Table 3.3 *Mean (standard deviation) or median (range) physical activity (PA) scores for each healthy participant by goal-setting condition and pain report condition*

| | | | **Mean (sd) Vector Magnitude** | | | |
|---|---|---|---|---|---|---|
| | | | **Goal-Setting Condition** | | **Pain Report Condition** | |
| **Ppt** | **Age** | **Sex** | **Intervention** | **Control** | **Pain report** | **No pain report** |
| H1 | 27 | M | 643461(271498)[a] | 665263(281986)[a] | 642563(283274)[a] | 666161(270075)[a] |
| H2 | 29 | F | 334697(189910)[a] | 423394(746180)[b] | 344246(187750)[a] | 424332(746180)[b] |
| H3 | 25 | M | 380025(150710)[a] | 353629(207915)[a] | 363010(184038)[a] | 394300(703407)[b] |
| H4 | 22 | F | 309769(760178)[b] | 305563(582851)[b] | 311593(717683)[b] | 291588(523146)[b] |
| H5 | 43 | M | 328051(1135655)[b] | 270248(934217)[b] | 249599(952064)[b] | 487031(1135655)[b] |
| H6 | 27 | F | 179793(710430)[b] | 230661(650513)[b] | 96917(650278)[b] | 227278(710666)[b] |
| H7 | 32 | M | 514966(719198)[b] | 474815(755730)[b] | 525925(719198)[b] | 491670(755730)[b] |
| H8 | 25 | F | 1055083(365173)[a] | 1130540(216672)[a] | 1187948(1445382)[b] | 1057905(300404)[a] |
| H9 | 24 | F | 751814(332040)[a] | 689185(919087)[b] | 740900(249374)[a] | 657380(346930)[a] |
| H10 | 25 | F | 587574(1222789)[b] | 539147(202157)[a] | 498266(167208)[a] | 608635(1110912)[b] |
| H11 | 22 | F | 401695(162036)[a] | 412060(131504)[a] | 412831(134242)[a] | 400925(159635)[a] |
| H12 | 22 | F | 396471(748782)[b] | 418574(96780)[a] | 402317(93095)[a] | 409399(748782)[b] |

*Note: Ppt = participant; [a] = mean(standard deviation); [b] = median(range)*

Figure 3.1 presents the daily PA scores for each participant in the pain group over the 60 day study period. Variability can be seen in all 10 time plots. Participant P8 had much lower maximum PA scores in comparison with other participants and the time plot in this individual had to be given on a 1/100 scale (i.e. maximum 18,000 instead of 1,800,000) for the series to be visible. Downward time trends are visible in participants P2, P3, P7, and P9 while an upward trend is visible in participant P4.

Figure 3.2 presents the daily PA scores in each participant in the healthy group over the 60 day study period. Variability can be seen in all 12 time plots. Downward time trends were visible in data series for participants H2, H3, H4, H6, and H11. The data series for participant H5 appeared to have an upward trend.

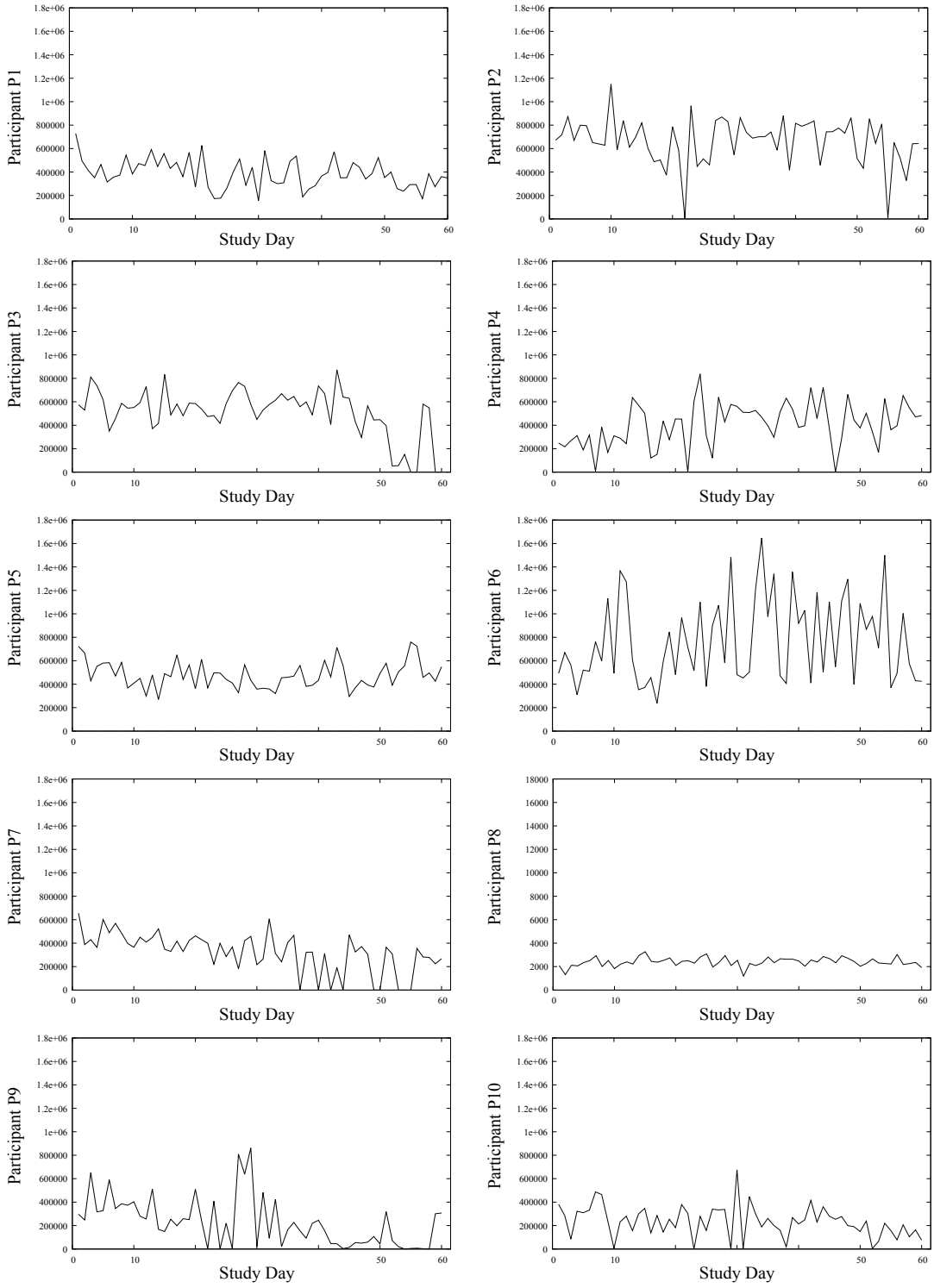


**Figure 3.1** ***Time plots of PA data series in pain group participants***

*Note: The time plot for participant P8 is shown on a 1/100 scale because this individual's maximum PA levels were too low to be visible on a scale large enough to accommodate the PA levels of all other participants*

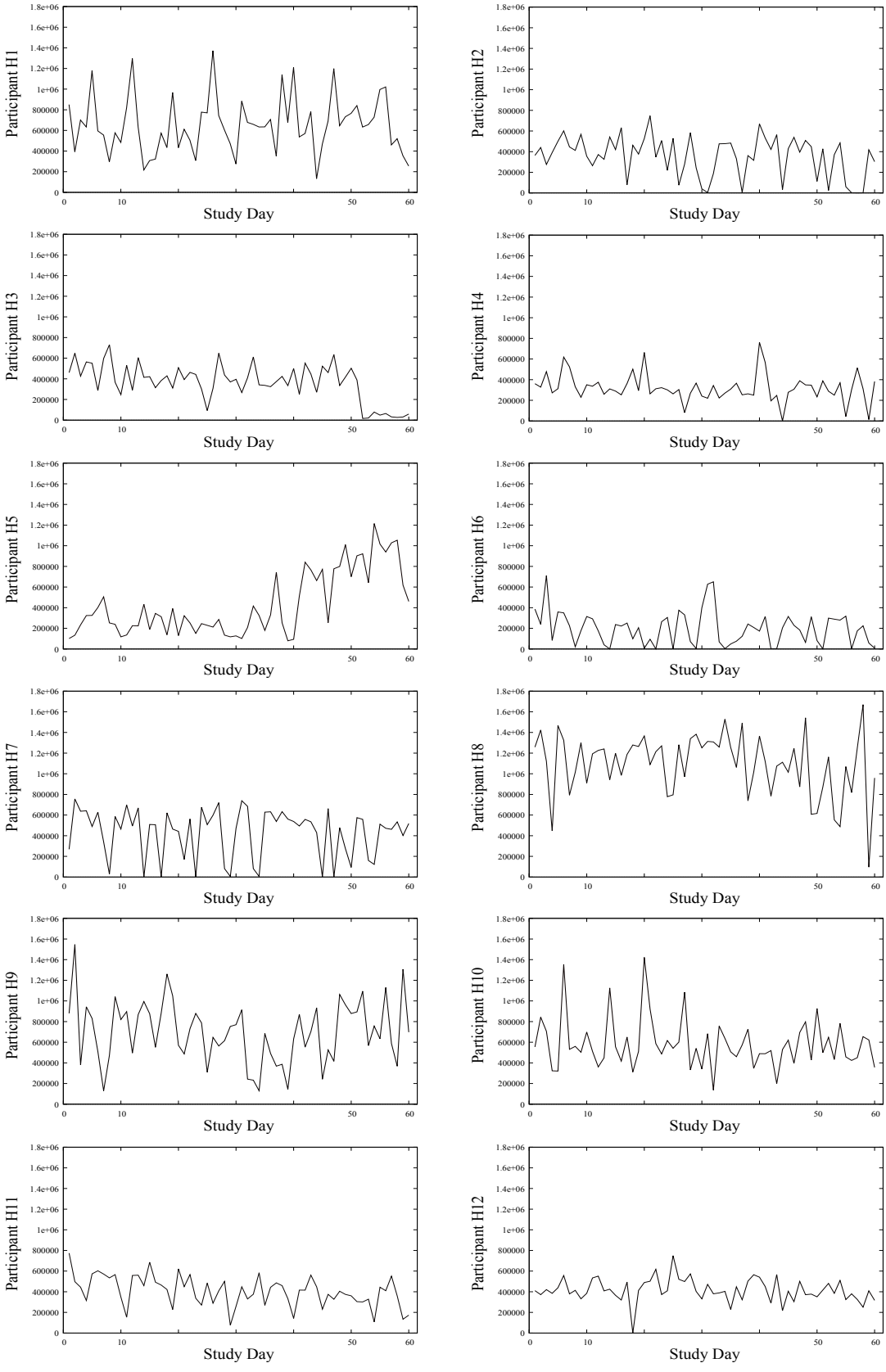


**Figure 3.2** ***Time plots of PA data series in healthy group participants***

### *3.3.2 Individual Analyses*

All 22 PA data series were judged to have sufficient variability to allow for time series analyses. ARIMA models were fit to activity in each individual to test the effects of goal-setting condition and pain report condition on PA. A linear time trend was included in each model to account for cumulative effects of the intervention. PA was entered as the dependent variable and goal-setting condition, pain report condition, and the linear time trend were entered simultaneously as independent variables. Table 3.4 shows the results of ARIMA analyses for each participant.

Significant effects of goal-setting condition on PA were found in one participant from the healthy group, H7 (B = -117872.0, $p = 0.03$). Participant H7 engaged in more activity on days when asked to set a walking goal.

Significant effects of pain report condition were found in one participant from the pain group, P4 (B = -99782.2, $p = 0.002$) and four participants from the healthy group, H4 (B = 71313.8, $p = 0.03$) H6 (B = -70299.8, $p = 0.02$), H10 (B = -148963.0, $p = 0.01$), and H12 (B = -41868.4, $p < 0.001$). Participant H4 engaged in more PA when they were asked to report pain, while participants P4, H6, H10, and H12 engaged in less PA when asked to report pain.

Significant effects of time were identified in six participants from the pain group and six participants from the healthy group. P1 (B = -2360.2, $p = 0.009$), P3 (B = -5928.2, $p = 0.0005$), P7 (B = -6365.0, $p < 0.001$), P9 (B = −5858.3, $p < 0.001$), P10 (B = -2348.2, $p = 0.01$), H2 (B = -3345.2, $p = 0.02$), H3 (B = -6332.7, $p = 0.005$), H6 (B = -1362.6, $p = 0.03$), and H8 (B = -4256.2, $p = 0.046$) decreased PA levels over time. P4 (B = 3882.4, $p = 0.01$), H1 (B = 2613.7, $p < 0.001$), and H5 (B = 11651.6, $p < 0.001$) increased PA levels over time.

Table 3.4 *Main effects of goal condition and pain report condition by single case with linear time trend*

| | Goal-Setting | | | | Pain Report | | | | Time Trend | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ppt (p, d, q)** | **B** | **SEB** | ***p*** | **95% CI** | **B** | **SEB** | ***p*** | **95% CI** | **B** | **SEB** | ***p*** | **95% CI** |
| P1 (0, 0, 0) | 32263.3 | 30899.4 | 0.30 | -28298.4, 92825.0 | 238.2 | 30792.5 | 1.00 | -60113.9, 60590.3 | −2360.2 | 897.0 | **0.009** | -4118.3, -602.2 |
| P2 (0, 0, 0) | −41394.0 | 52286.6 | 0.43 | -143874.0, 61086.0 | −29981.4 | 53490.3 | 0.58 | -134820.0, 74857.6 | −2073.5 | 1551.6 | 0.18 | -5114.5, 967.4 |
| P3 (1, 0, 1) | 19528.8 | 41771.9 | 0.64 | -62342.7, 101400.0 | 28691.8 | 36344.2 | 0.43 | -42541.6, 99925.2 | −5928.2 | 1691.4 | **0.0005** | -9243.4, -2613.1 |
| P4 (0, 0, 6) | 51513.3 | 35765.7 | 0.15 | -18586.3, 121613.0 | −99782.2 | 26433.2 | **0.002** | -151590.0, -47974.1 | 3882.4 | 1531.1 | **0.01** | 881.5, 6883.2 |
| P5 (0, 0, 0) | −31729.3 | 30115.3 | 0.30 | -90754.2, 27295.5 | 41931.2 | 29619.6 | 0.16 | -16122.1, 99984.5 | 409.7 | 878.9 | 0.64 | -1312.9, 2132.4 |
| P6 (0, 0, 0) | −72795.9 | 94608.9 | 0.44 | -258226.0, 112634.0 | −26926.2 | 94572.1 | 0.78 | -212284.0, 158432.0 | 3442.3 | 2744.8 | 0.21 | -1937.3, 8821.9 |
| P7 (4, 0, 4) | 26572.5 | 27170.0 | 0.33 | -26679.8, 79824.8 | −8189.8 | 36222.3 | 0.82 | -79184.3, 62804.6 | −6365.0 | 170.3 | **<0.001** | -6698.8, -6031.1 |
| P8 (0, 0, 0) | 16.9 | 101.7 | 0.87 | -182.4, 216.2 | −6.8 | 103.4 | 0.95 | -209.5, 195.9 | 2.2 | 3.0 | 0.47 | -3.7, 8.1 |
| P9 (1, 0, 0) | 60056.4 | 44956.1 | 0.18 | -28056.1, 148169.0 | −48509.1 | 45368.7 | 0.29 | -137430.0, 40411.9 | −5858.3 | 1362.8 | **<0.001** | -8529.3, -3187.3 |
| P10 (0, 0, 0) | −12194.4 | 33010.1 | 0.71 | -76893.1, 52504.2 | 44289.5 | 33030.0 | 0.18 | -20448.1, 109027.0 | −2348.2 | 954.6 | **0.01** | -4219.3, -477.1 |
| H1 (3, 0, 7) | −50906.5 | 63973.4 | 0.43 | -176292.0, 74479.1 | 6053.0 | 49412.8 | 0.90 | -90794.3, 102900.0 | 2613.7 | 539.6 | **<0.001** | 1556.1, 3671.2 |
| H2 (5, 0, 0) | 41398.4 | 40758.7 | 0.31 | -38487.2, 121284.0 | −16975.3 | 44995.4 | 0.71 | -105165.0, 71214.0 | −3345.2 | 1393.1 | **0.02** | -6075.5, -614.8 |
| H3 (1, 0, 4) | 24285.7 | 36792.9 | 0.51 | -47827.0, 96398.3 | −43597.3 | 39764.4 | 0.27 | -121534.0, 34339.5 | −6332.7 | 2251.0 | **0.005** | -10744.5, -1920.9 |
| H4 (0, 0, 0) | 22637.9 | 33430.0 | 0.50 | -42883.8, 88159.5 | 71313.8 | 33452.9 | **0.03** | 5747.4, 136880.0 | −1692.2 | 966.5 | 0.08 | -3586.5, 202.0 |
| H5 (1, 0, 0) | −23391.1 | 43863.0 | 0.59 | -109361.0, 62578.8 | −21823.5 | 48873.9 | 0.66 | -117615.0, 73967.6 | 11651.6 | 2690.3 | **<0.001** | 6378.7, 16924.4 |
| H6 (1, 0, 7) | 29092.5 | 26965.7 | 0.28 | -23759.3, 81944.3 | −70299.8 | 30098.8 | **0.02** | -129292.0, -11307.3 | −1362.6 | 615.4 | **0.03** | -2568.8, -156.3 |
| H7 (3, 0, 0) | −117872.0 | 52813.1 | **0.03** | -221384.0, -14360.1 | 26825.7 | 55095.4 | 0.63 | -81159.4, 134811.0 | −1479.0 | 1088.0 | 0.17 | -3611.3, 653.4 |
| H8 (3, 0, 0) | 88181.6 | 63843.6 | 0.17 | -36949.6, 213313.0 | 61450.4 | 61966.7 | 0.32 | -60002.2, 182903.0 | −4256.2 | 2137.6 | **0.046** | -8445.8, -66.5 |
| H9 (0, 0, 0) | −104315.0 | 79521.1 | 0.19 | -260173.0, 51543.9 | 72062.2 | 78713.5 | 0.36 | -82213.4, 226338.0 | −1670.5 | 2277.4 | 0.46 | -6134.2, 2793.2 |
| H10 (0, 0, 0) | −74938.0 | 63655.7 | 0.24 | -199701.0, 49824.9 | −148963.0 | 61023.8 | **0.01** | -268568.0, -29358.9 | −2659.0 | 1771.5 | 0.13 | -6131.0, 813.0 |
| H11 (5, 1, 0) | 18142.9 | 31242.4 | 0.56 | -43091.0, 79376.8 | 4202.4 | 38021.8 | 0.91 | -70319.0, 78723.9 | −238.9 | 3788.2 | 0.95 | -7663.5, 7185.8 |
| H12 (7, 0, 7) | 8046.5 | 14266.5 | 0.57 | -19915.3, 36008.2 | −41868.4 | 9611.9 | **<0.001** | -60707.4, -23029.5 | −656.9 | 885.1 | 0.46 | -2391.7, 1077.9 |

*Note: Ppt = participant; p = number of autoregressive terms (Nau, 2017); d = number of nonseasonal differences added to the model to achieve stationarity (Nau, 2017); q = number of forecast errors lagged in the model (Nau, 2017); B = unstandardised B; SE B = standard error of B; p = p-value; CI = confidence interval.*

### *3.3.3 Do the Effects of Goal-Setting / Action Planning and Reporting Pain on PA Differ Between Groups?*

A mixed analysis of variance (ANOVA) was used to evaluate whether the effects of goal-setting condition (i.e. walking goal; diet goal) and pain report condition (i.e. reporting pain; not reporting pain) on PA differed between groups (i.e. pain group; healthy group). Mean activity scores for each possible combination of goal and pain report conditions (i.e. walking goal and reporting pain; diet goal and reporting pain; walking goal and not reporting pain; diet goal and not reporting pain) were calculated for each participant, creating one activity variable for each of the four combinations of study conditions. A four level within-subject factor was created, with the four activity variables making up the four levels of this factor. Group (i.e. pain group; healthy group) was entered as the between-subjects factor.

Overall, the pain group had higher activity levels on days that they were asked to set a diet goal, regardless of whether they were also asked to report pain (M = 405245.93, sd = 213532.84) or were not asked to report pain (M = 400559.0805 , sd = 210320.95) compared with conditions that involved making a walking goal (pain report: M = 395782.57, sd = 233354.50; no pain report: M = 397402.48, sd = 240113.93). The healthy group had higher activity levels when they were not asked to report pain, regardless of whether they were asked to make a walking goal (M = 518969.93, sd = 233370.18) or a diet goal (M = 496587.11, sd = 230357.87) compared with conditions during which they were asked to report pain (walking goal: M = 487614.96, sd = 243238.60; diet goal: M = 482861.46, sd = 260819.89). The healthy group had higher activity scores in comparison with the pain group under each combination of goal and pain report conditions. However, no significant differences in activity were found between the four goal and pain reporting conditions [$F(3) = 0.41$, $p = 0.75$], between the four conditions according to group [$F(1) = 0.97$, $p = 0.34$], or the interaction between condition and group [$F(3) = 0.64$, $p = 0.59$].

### *3.3.4 Changes in Outcomes Between Groups*

Finally, three mixed ANOVAs were used to identify any differences between baseline and post-intervention health (AIMS2), disability (HAQ), and pain (VAS) between the pain group and the healthy group. Time was entered as a within-subjects factor with two levels (i.e. baseline; post-intervention) and group was entered as the between subjects factor (i.e. pain group; healthy group) for each test. Scores for baseline and post-intervention health, disability, and pain in each group are shown in Table 3.5.

A significant effect of time [$F(1) = 12.85$, $p = 0.002$], group [$F(1) = 40.70$, $p < 0.001$] and the interaction between time and group [$F(1) = 11.95$, $p = 0.003$] was found on health, with the pain group having more negative health scores at both baseline and post-intervention, but also showing greater improvements in health over time.

There were no significant effects of time [$F(1) = 1.43$, $p = 0.25$] or the interaction between time and group [$F(1) = 0.24$, $p = 0.63$] on disability. However, disability was found to be significantly different according to group [$F(1) = 25.16$, $p < 0.001$], with disability levels in the pain group twice as high as those in the healthy group at both baseline and post-intervention.

Similarly, there were no significant effects of time [$F(1) = 0.16$, $p = 0.69$] or the interaction between time and group [$F(1) = 0.16$, $p = 0.69$] on pain but, there was a significant effect of group [$F(1) = 29.38$, $p < 0.001$] on pain. Pain scores were higher in the pain group compared to the healthy group at both baseline and post-intervention.

Table 3.5 *AIMS, HAQ, and pain scores in each group at baseline and post-intervention*

| | AIMS2 | | HAQ | | Pain VAS | |
|---|---|---|---|---|---|---|
| | **Pre** | **Post** | **Pre** | **Post** | **Pre** | **Post** |
| **Pain Group** | 18.71(8.28) | 14.66(5.17) | 1.90(0.61) | 1.80(0.59) | 2.73(1.55) | 2.73(1.62) |
| **Healthy Group** | 5.13(2.24) | 5.04(1.98) | 1.04(0.14) | 1.00(0.00) | 0.33(0.65) | 0.19(0.41) |

*Note: AIMS2 = Arthritis Impact Measurement Scales 2; HAQ = Health Assessment Questionnaire; VAS = visual analogue scale*

## 3.4 Discussion

This study found an overall effect of goal setting in only one participant from the healthy group, who engaged in more activity when asked to make a walking goal compared with when they were asked to make a diet goal. An effect of reporting pain on PA was found in five participants (i.e. one pain group, four healthy group), four of whom engaged in less activity when asked to report pain and one of whom (from the healthy group) engaged in more activity when asked to report pain. Six participants from the pain group and six participants from the healthy group were also found to have had significant time trends in their activity levels, only three of which (two from the healthy group, 1 from the pain group) were upward trends; the remaining nine participants for whom there were effects of time decreased their activity levels over the course of the study period. The pain group and the healthy group were significantly different in health (i.e. AIMS2-SF), disability (i.e. HAQ), and pain scores, with the pain group reporting more negative health, disability, and higher levels of pain. The pain group saw significant improvements in health between baseline and follow-up, but there were no significant changes in disability or pain over the study period. Results showed that participants in the healthy group were significantly younger than participants in the chronic pain group. While a statistical analyses indicated that age did not predict activity and that there were no

significant differences in activity levels between the two groups, this age difference may have affected the results of this study. Similarly, males made up only 32% of the overall participant population. Survey data suggests that men are more active than women and that activity decreases with age (Troiano, Berrigan, Dodd, Mâsse, Tilert, and McDowell, 2008). Women are known to have more attitudinal barriers to PA, while the number of perceived barriers and increased age decreases the odds of PA regardless of gender (Sørensen and Gill, 2008). Future research should aim to control for age and gender differences in PA behaviour change by ensuring that both participant groups are matched according to age and gender.

### *3.4.1 Goal-setting and Action Planning*

Goal-setting and action planning affected PA levels in only one individual in the present study. This person was part of the healthy group and was found to engage in more activity when asked to create walking goals, in support of previous research findings that goal-setting and action planning to take part in PA increases the amount of PA participants carry out (Shilts, Horowitz, and Townsend, 2004; Sniehotta, Scholz, and Schwarzer, 2005; Sniehotta, Scholz, and Schwarzer, 2006). However, no other participant in the present study showed effects of goal-setting and action planning on PA, indicating that although the intervention positively affected PA in one individual, this was not true for the majority of participants in the present study, regardless of whether or not they had joint pain.

A meta-analysis of educational interventions for adults with chronic disease found that, of 107 studies, 55 included a goal-setting component asking participants to make PA related goals (Conn, et al., 2008). Findings suggested that studies that incorporated a behavioural intervention component such as goal-setting, feedback, and self-monitoring, had larger effects on PA than interventions that did not include behavioural strategies (Conn, et al., 2008). However, meta-regression analyses did not find the presence of goal-setting to independently influence effect sizes (Conn, et al., 2008). Further, intervention components included in each study were not reported and it was clear that most, if not all studies included more than one intervention

component as 88 involved supervised exercise, 66 involved self-monitoring, 65 gave individualised exercise prescriptions, along with twenty other intervention components identified across the 107 studies included in meta-analyses (Conn, et al., 2008). Therefore, while educational interventions that included goal-setting components were found to positively affect PA in chronically ill participants, these findings do not provide direct support for an intervention based solely on goal-setting and action planning, but support including goal-setting and action planning as part of a more complex intervention (Conn, et al., 2008). These findings are supported by two other meta-analyses of behavioural interventions on PA in obese participants (Dombrowski, et al., 2012) and those at risk of type 2 diabetes (Greaves, et al., 2011). Positive effects of interventions overall were found on PA, but not individual effects of goal-setting (Dombrowski, et al., 2012; Greaves, et al., 2011). Even when individual effects of goal-setting are found, there tends to be at least one other intervention component present, such as self-monitoring (e.g. use of pedometers for step-count feedback), that could be interacting with goal-setting to influence its affects, (Bravata, Smith-Spangler, Sundaram, Gienger, Lin, Lewis, Stave, Olkin, and Sirard, 2007; Greaves, et al., 2011). Self-monitoring is a common PA related behavioural intervention technique with established individual effects on PA (Conn, et al., 2008; Greaves, et al., 2011). Indeed, Lorig and Holman (2003) have suggested that goal-setting be employed in conjunction with action planning to form the 'taking action' self-management technique but ideally, self-management interventions should include all five intervention components (i.e. problem-solving, decision making, communication with healthcare professionals, resource utilisation, and taking action). The American Heart Association (Artinian, et al., 2010) and US Association of Diabetes Educators (Parkin, Hinnen, Valentine, Rice, Turner, Haas, Mensing, Lumber, Fitner, Stetson, McKnight, Ernst, Compton, Nelson, Seley, Letassey, and Rosenthal, 2009) also recommend pairing goal-setting with self-monitoring when targeting PA outcomes in adults at risk of heart disease or diabetes. Behaviour change interventions have been commonly criticised for under-describing intervention content, making it difficult to identify individual effects of intervention components or specific combinations of intervention components (Dombrowski, et al., 2012; Dombrowski, et al., 2007). However, many recent reviews of behaviour

change interventions have adopted the behaviour change taxonomy developed by Michie, et al. (2013; Dombrowski, et al., 2012; Greaves, et al., 2011; Michie, Abraham, Whittington, and McAteer, 2009). Future research might usefully set out to design intervention studies using the behaviour change taxonomy (Michie, et al., 2013) to better define intervention components. Studies including goal-setting and action planning alone and in conjunction with other well-defined behaviour change techniques could help to determine whether the mechanism of effect of goal-setting and action planning are reliant on the presence of other behavioural intervention components, or whether a simple goal-setting intervention can affect PA depending on individual characteristics (Artinian, et al., 2010; Dombrowski, et al., 2012).

It may also be that the effects of goal-setting and action planning on PA are part of a larger theoretical framework and each component of that framework is necessary to explain changes in PA. Certainly, goal-setting and action planning have been used to explain the well-documented gap between intentions and behaviour (Sniehotta, Scholz, and Schwarzer, 2005), despite the proposed direct link between the Theory of Planned Behaviour's (Ajzen, 1991) intention and behaviour constructs. Goal-setting and action planning have also been associated with the effects of other cognitions, such as self-efficacy (Bodenheimer, and Handley, 2009; Sniehotta, Scholz, and Schwarzer, 2005; Zimmerman, Bandura, and Martinez-Pons, 1992): the main mechanism of effect in self-management interventions (Lorig and Holman, 2003). If goal-setting and action planning are best placed as part of an existing psychological model of behaviour, particularly where there are known gaps in a model's ability to explain behaviour, it would be advantageous to ascertain the role of these intervention components within that model as doing so could help to inform future interventions and identify factors that should be consistently included in combination with goal-setting and action planning. A theoretical framework specifically aimed at conceptualising the necessary components of a successful goal-setting intervention has been devised by a multidisciplinary team (Scobbie, Dixon, and Wyke, 2011) and while this framework has been cited as part of existing research in stroke rehabilitation (Hersh, Worrall, Howe, Sherratt, and Davidson, 2012; Scobbie, McLean, Dixon, Duncan, and Wyke, 2013) and prospective research

in joint pain (Kjeken, Berdal, Bø, Dager, Dingsør , Hagfors, Hamnes, Eppeland, Fjerstad, Mowinckel, Nielsen, Rørstad, Sand-Svartrud, Slungaard, Wigers, and Hagen, 2014), more work needs to be done to incorporate this framework into practice and test the effects of goal-setting as part of a complete, theory-based intervention on behaviour in chronic disease.

Additionally, the research on which the present study was based found that goal-setting and action planning had a significant effect on PA in only two of ten individuals (Sniehotta, et al., 2012) and suggested that the lack of effect in most participants may be due to a lack of statistical power. However, that study, like the present study, included 60 data points in each data series (Sniehotta, et al., 2012). Although some have suggested that 60 data points are required for adequate statistical power in time series analyses, it has been suggested that as few as 36 data points could be sufficient as long as data are not seasonal in nature or, the seasonality of a data series can be captured by 36 data points (Yaffee and McGee, 2000). Nonetheless, these are arbitrary projections of adequate power to find a model with goodness of fit in time series analysis. Tests of the accuracy of diagnostic tests in time series analyses using varying sample sizes have found that statistical power tends to decrease as a model becomes more complex (Yaffee and McGee, 2000). Therefore, it is likely that a definitive test of statistical power must be developed to ensure that a sufficient number of data points are included in N-of-1 studies according to the complexity of the model under test (Sniehotta, et al., 2012).

### *3.4.2 Reporting Pain*

An effect of reporting pain on PA was found in five participants (i.e. one pain group, four healthy group), four of whom engaged in less activity when asked to report pain and one of whom (from the healthy group) who engaged in more activity when asked to report pain. These findings suggest that a greater number of individuals who took part in the present study experienced effects of reporting pain on PA than effects of goal-setting and action planning on PA. Reporting pain was expected to cause participants to attend to pain and in turn, decrease PA when pain was present based

on evidence that attention to pain in those who have chronic pain increases disability behaviour (McCracken, 1997). While an effect of reporting pain on PA was found in the expected direction (i.e. decreased activity when reporting pain), this effect was mainly found in healthy participants reporting low or no pain throughout the study period. Pain was chosen as the appropriate conflicting goal for participants with chronic pain based on previous research (Gooberman-Hill, et al., 2007). The lack of an effect of pain reporting on activity in the chronic pain group suggests that pain and activity were not conflicting goals for the chronic pain participants in this study. Alternatively, it is possible that the constant presence of pain rendered the intervention to report pain ineffective, i.e. that participants were already attentive to their pain and so the request to report their pain did not increase the already present interference between pain and activity. Thus, it may be more appropriate to elicit specific goals that conflict with PA in each individual with chronic pain and measure the presence or absence of those factors on an individual level. Conversely, an effect of reporting pain was observed in healthy participants. It is possible to suggest that the pain reporting condition drew the attention of healthy participants to bodily sensations otherwise overlooked and that this process of noticing pain impacted on their activity levels. Future research should look to determine whether the results of the current study are replicable. Much of the evidence for the effects of pain on PA is based on group findings (Vlaeyen and Linton, 2000). Using an N-of-1 design would allow for the measurement of pain and activity as they occur rather than retrospectively using follow-up measures (Lillie, Patay, Diamant, Issell, Topol, and Schork, 2011). Future research could also aim to determine whether attention to pain levels can have negative effects on PA in the absence of pain and whether these effects differ between healthy and chronic pain individuals in real-world settings.

### *3.4.3 Effects of Time*

Time trends were included in ARIMA models primarily to control for non-stationarity within PA data series and account for any cumulative effect of the intervention. Results suggested that nine participants (i.e. five pain group, four healthy group) decreased PA over time and three participants (i.e. one pain group,

two healthy group) increased PA over time. While these findings may represent cumulative effects of the intervention, they were not consistent between participants. That the majority of significant time trends in individuals indicated decreasing PA over time suggests that there may have been an aspect of the intervention that negatively affected participants' motivation to engage over time or that a component necessary to maintaining participant motivation throughout the intervention period was missing. It may have been that entering a PA-related study resulted in an initial increase in PA and this increased PA tapered off over time as the initial motivation of entering the study waned. The present study did not measure PA prior to the intervention or prior to entry into the study and so this is a speculative interpretation of the observed effect of time. However, adherence to an exercise programme is known to be problematic in chronic disease (Jordan, Holden, Mason, and Foster, 2010) and healthy populations (Cox, Burke, Gorely, Beilin, and Puddey, 2003) and is thought to partially explain instances when effects of complex interventions on PA are suboptimal (Jordan, et al., 2010). Nonetheless, similar research in healthy participants found an overall increase in PA over time, although among individuals, one person decreased and three increased PA over the study period (Sniehotta, et al., 2012). Therefore, inconsistent effects of time have been found previously. Nonetheless, effects of time found by Sniehotta, et al. (2012) tended to be more positive than negative and the main difference between this previous study and the present study was the inclusion of a self-monitoring condition (Sniehotta, et al., 2012). Although the effect of self-monitoring on PA was, like goal-setting, only found to be significant in two individuals (Sniehotta, et al., 2012), self-monitoring has been found to independently predict increased PA in meta-analyses of behavioural intervention while goal-setting did not (Conn, et al., 2008; Greaves, et al., 2011). Self-monitoring sometimes involves keeping detailed records of daily PA and reporting them to intervention providers (Gleeson-Kreig, 2006), but can also be as simple as including a step-count display on a participant's pedometer (Sniehotta, et al., 2012; Normand, 2008). Accelerometers used in the present study did not provide any step-count or other PA information to participants and data could only be retrieved when the researcher connected monitors to a computer with access to ActiLife software (ActiGraph Corp, 2014). This was done to ensure that the

intervention tested only the effects of goal-setting and action planning. However, many goal-setting interventions use pedometers that include a step-count display as standard, but do not describe the intervention as including self-monitoring (Bravata, et al., 2007). It may be that this element of self-monitoring included in many goal-setting studies could explain the heterogeneity in effects between behavioural interventions involving goal-setting (Conn, et al., 2008). Participants have intimated that self-monitoring (Gleeson-Kreig, 2006) and feedback from intervention providers had helped them meet their PA goals (Normand, 2008). Feedback has also been recommended as part of a framework for goal-setting interventions (Scobbie, Dixon, and Wyke, 2011) and by the American Heart Association for inclusion in goal-setting interventions aimed at reducing cardiovascular risk (Artinian, et al., 2010). A simple intervention involving only goal-setting and action planning is missing a key component proposed to facilitate the cycle of completing a short-term goal and setting a new one to progress towards a long-term goal: performance evaluation (Scobbie, Dixon, and Wyke, 2011). Social Cognitive Theory describes feedback as a way of moving people to action (Bandura, 1989); performance feedback tends to be delivered by a health professional or intervention provider, while pedometer-based self-monitoring can be viewed as a form of objective feedback (Xiao and Menon, 2014). Future research on goal-setting and action planning to increase PA should look to include components known to compliment these intervention components, such as self-monitoring and performance feedback, as goal-setting and action planning do not seem to have reliable effects on PA in isolation. It would be useful to determine whether participants lose interest in PA-related goals over time in the absence of feedback systems or whether there are negative cumulative effects of a simple goal-setting intervention over time.

### *3.4.4 Summary*

The results of the present study offer little support to the use of a simple goal-setting and action planning intervention to increase PA in either healthy participants or participants with chronic joint pain; only one participant showed increases in PA related to goal-setting. More evidence of an effect of reporting pain was found,

regardless of joint health status; five participants' PA was affected by pain report condition, although the direction of the effects were not consistent between individuals. There was also evidence of effects of time on PA, with 12 participants' PA showing time trends, the majority of which were negative. Although there were no differences between the healthy group and the pain group in relation to the effects of goal-setting, reporting pain, changes in disability over time, or changes in pain over time, there were significant improvements in health (i.e. AIMS2-SF) in the pain group. There was no effect of time on health in the healthy group, but this can likely be accounted for by these participants' positive baseline health scores. Future research should determine whether these results are replicable and if so, aim to ensure that goal-setting and action planning are included in interventions alongside intervention components known to compliment their effects, such as self-monitoring and performance feedback (Conn, et al., 2008; Greaves, et al., 2011; Scobbie, Dixon, and Wyke, 2011).

The effects of attention to pain have previously been found to lead to decreases in PA in those with chronic pain, either directly or through participants' fear of pain (McCracken, 1997; Vlaeyen and Linton, 2000). The results of the present study suggest that drawing attention to pain can negatively affect PA levels even when pain levels are low or when pain is absent. Future research might aim to replicate this finding and determine whether there are PA-related effects of measuring pain in both pain-free participants and in chronic pain participants. It may also be advantageous to determine whether having a fear of pain mediates or moderates the effect of attention to pain on PA in healthy individuals and those with chronic pain as it has been suggested that fear of pain is one of the main factors that determines the strength of the effect of pain on PA engagement (Vlaeyen, Kole-Snidjers, Boeren, and van Eek, 1995; Vlaeyen and Linton, 2000).

Although it was estimated that 30 participants would be necessary to ensure statistical power for these analyses and more would be required to look at any interaction effects, only 22 participants were successfully recruited and retained. And although attrition analyses found no differences according to age, gender, or chronic

pain status (i.e. pain group vs. healthy group) between those who completed the study and those who did not, the study was likely underpowered. The study period of 60 days paired with the burden of daily accelerometer use was a common complaint. Whilst some participants reported becoming 'attached' to their accelerometer as a positive daily routine of putting the device on in the morning, others found the waist belt uncomfortable and unattractive. It might be useful to discuss preferences with individual participants prior to the start of a study period to ensure that these types of issues can be addressed before they become troublesome. This might increase wear time and help to prevent participant attrition. Previous research has found monetary incentives to increase survey uptake, with uptake doubling when the incentive was doubled (Perez, Nie, Ardern, Radhu, and Ritvo, 2013). Monetary incentives have also been found to influence attrition from follow-up, with groups offered the highest incentives representing the lowest attrition rates (Khadjesari, Murray, Kalaitzaki, White, McCambridge, Thompson, Wallace, and Godfrey, 2011). Participants in the present study were reimbursed for the cost of using their mobile phones throughout the study period, but were otherwise not offered an incentive for completion of the study. Future research might seek to determine whether a monetary incentive can significantly affect attrition rates in complex behavioural interventions using n-of-1 designs. Difficulty recruiting and retaining a sufficient cohort of participants with chronic pain reduced statistical power. Methods were originally designed to test the effects of goal-setting, action planning, and attention to pain in participants with chronic pain only. After reaching the end of the initially proposed recruitment period without recruiting or retaining a sufficient number of participants, an amended application was submitted to the University of Strathclyde ethics committee seeking approval for a second group comprised of healthy participants to be added to this study. This allowed for a larger group of participants overall and additionally, the comparison of study effects between healthy participants and those with chronic pain. Similar research conducted in future should account for the potential difficulties in recruiting and retaining participants with chronic pain over extended study periods and with budget restrictions when designing study methods.

It is also possible that participants did not follow the instructions delivered via text each day regarding goal-setting, potentially affecting intervention fidelity. Participants were not asked to record their goals and so, it was not possible to assess the fidelity of this aspect of the intervention protocol. Similar studies might weigh the cost of any added participant burden of including daily diaries to avoid this potential issue of intervention fidelity. Daily diaries have been included as part of N-of-1 designs for behaviour change before with success (McCrae, Tierney, and McNamara, 2005; O'Brien, Philpott-Morgan, and Dixon, 2016) and are considered cost-effective tools for recording data on the individual level (McDonald, Quinn, Vieira, O'Brien, White, Johnston, and Sniehotta, 2017).

The present study found a randomised, controlled N-of-1 design to be a feasible method of testing a simple behavioural intervention in both healthy participants and in those with chronic pain. However, if N-of-1 methods are to be implemented in behavioural research, it must be determined whether existing models of disability and behaviour can be applied at an individual level, as these models have traditionally been tested using group designs (Dixon, et al., 2008; Dixon, Johnston, Elliott, and Hannaford, 2012; Geyh, et al., 2012; Quinn, et al., 2012; Stacey, James, Chapman, Courneya, and Lubans, 2015).

# Chapter 4: Testing the Utility of an Integrated Biobehavioural Model of Disability for Predicting Physical Activity and Participation in Chronic Joint Pain: A Series of N-of-1 Studies

## 4.1 Introduction

The WHO's (2001) International Classification of Functioning, Disability and Health (ICF) model describes disability as being influenced by impairment ("problems in body function (ie. physiological functions of body systems, including psychological functions) or structure (i.e. anatomical parts of the body such as organs, limbs, or their components) such as a significant deviation or loss"), activity or activity limitation ("difficulties an individual may have in executing activities"), participation or participation restriction ("problems an individual may experience in involvement in life situations"), environmental factors ("the physical, social and attitudinal environment in which people live and conduct their lives"), and personal factors, with activity at the centre of the framework (Figure 4.1; WHO, 2002, p.10).

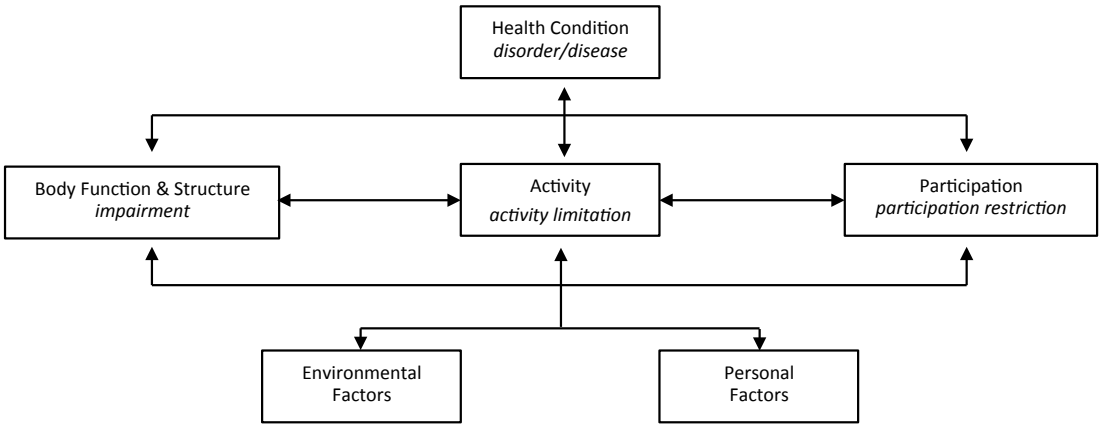


**Figure 4.1** ***WHO's (2001) ICF model of disability***

Impairment has been found to be a weak predictor of activity limitations and participation restriction (Summers, et al., 1988; Woby, Roach, Ermston, and Watson,

2007). As an international model that is recommended for use at not only the individual and institutional level, but also at the social level as a tool for determining eligibility for access to government regulated benefits, healthcare, and other services (WHO, 2002), it is imperative that it accurately represent disability as a whole. There is a large evidence base suggesting that cognitive factors affect disability and can be intervened upon to affect behaviour change (Flor and Turk, 1988; Lorig and Holman, 2003; Newman, Steed and Mulligan, 2004; Riemsma, et al., 2003; Warsi, et al., 2004). The ICF includes two behavioural concepts (i.e. activity and participation) and the 'environmental' and 'personal' components of the model allow for the inclusion of cognitive and affective factors in disability behaviour (WHO, 2002).

It was first posited in 1996 that the International Classification of Impairments, Disabilities, and Handicaps, which was primarily a biological model of disability (WHO, 1980) could usefully be integrated with psychological models of behaviour to create a more complete description of disability (Johnston, 1996). We now have a model of disability in the form of the ICF that defines disability as behaviour through the inclusion of behavioural components (i.e. 'activity' and 'participation') and contextual factors that describe a role for both personal and environmental factors in disability, creating an opportunity to more easily integrate the ICF with psychological models of behaviour (Johnston and Dixon, 2014). Including model components known to account for variations in behaviour could help to explain known gaps in the ICF model and better describe its 'activity' and 'participation' components (Johnston and Dixon, 2014). Indeed, one study of participants with spinal cord injuries found no significant associations between impairment and participation (i.e. ICF constructs), while self-esteem and self-efficacy (i.e. cognitive constructs) explained 41% of the variance in participation as defined by the ICF (Geyh, Nick, Stirnimann, Ehrat, Michel, Peter, and Lude, 2012). In another study of participants awaiting joint replacement surgery, impairment accounted for 28% while perceived control cognitions accounted for 48% of the variance in activity limitations (Dixon, Johnston, Rowley, and Pollard, 2008). However, when psychological constructs were integrated into the ICF to form a model within which control cognitions partly mediated the relationship between impairment and activity

limitation, 57% of the variance in activity limitation was explained (Dixon, et al., 2008). The finding that integrating cognitive behavioural constructs into the ICF increases the amount of explained variance in behaviour has been replicated in healthy, chronic pain, and chronic disease populations (Dixon, et al., 2012; Johnston and Dixon, 2014; Schröder, Johnston, Teunissen, Notermans, Helders, and van Meeteren, 2007; Quinn, Johnston, Dixon, Johnston, Pollard, and Rowley, 2012; Quinn, Johnston, and Johnston, 2013).

However, many previous studies using the integrated biobehavioural model employed group designs and so the findings describe differences between individuals. Disability exists on a spectrum with potentially infinite combinations of physical, psychological, and environmental factors that could co-occur as part of any one individual's experience of disability (Centers for Disease Control and Prevention, 2010). The complexity of disability behaviour change is made clear not only by the modest effect sizes of self-management interventions, but in the considerable heterogeneity in outcome effects between studies of the same behavioural interventions when trialled using group designs (Conn, Hafdahl, Brown, and Brown, 2008; Riemsma, et al., 2003). The concept of personalised medicine suggests that, when heterogeneity is consistently present in gold-standard RCTs of a treatment or intervention, these findings may not represent a lack of application of the treatment itself, but the complexity of the target outcome or population (Davidson, et al., 2014). An RCT is excellent at determining the generalisability of a treatment. But even when a treatment is found to be effective, there are likely to be participants who experienced no benefit and occasionally some who experienced harm. An RCT is designed to treat such individual variability in response to an intervention as error variance (Davidson, et al., 2014). In chronic disease management, it is important that we aim to account for these differences, as patients often respond to the same disease and the same treatments in very different ways (Steiner, Ryser, Huber, Uebelhart, Aeschlimann, and Stucki, 2002).

In instances where conventional group-based designs produce too much variability in between-subject outcomes to allow generalisable conclusions to be drawn, it is

appropriate to test the treatment or intervention on an individual level (Davidson, et al., 2014). By generating single case studies (also known as N-of-1 studies) across many individuals, the aim of a personalised medicine approach would essentially be to create a database of unique patient profiles and matching outcomes from which clinicians can draw to treat patients with complex cases and to whom group-based RCT findings might not apply (Davidson, et al., 2014).

Medical Research Council (MRC) guidance on complex interventions describes behaviour change as "highly" complex (p. 980) and specifically recommends the use of N-of-1 designs to account for individual responses to these interventions (Craig, et al., 2008). Further, N-of-1 studies were listed by the Evidence-Based Medicine Working Group as providing the best evidence for clinicians making decisions in the treatment of individual patients (Guyatt, Rennie, Meade, and Cook, 2008). Despite these recommendations and the wide application of N-of-1 designs to the field of education (Lillie, et al., 2011), much less has been done to test behavioural interventions on disability in individuals (Shaffer, Falzon, Cheung, and Davidson, 2015).

Similarly, much of the existing body of work on integrating psychological constructs with the ICF to explain disability behaviour has been conducted using group based designs (Dixon, et al., 2008; Dixon, et al., 2012; Geyh, et al., 2012; Quinn, et al., 2012). If behavioural interventions are to be designed using integrated biobehavioural models of disability and if there are to be more N-of-1 trials of these interventions, then the utility of integrated biobehavioural models for predicting behaviour on an individual level must also be assessed. This has been done using Theory of Planned Behaviour (Ajzen, 1991) constructs integrated with the ICF (Hobbs, Dixon, Johnston, and Howie, 2013; O'Brien, Philpott-Morgan, and Dixon, 2016; Quinn, Johnston, and Johnston, 2013), but less N-of-1 research on integrated biobehavioural modeling has been conducted using psychological constructs from Social Cognitive Theory (SCT; Bandura, 1989). Further, although cognition and emotion are both known to affect behaviour (Bandura, 1989; Lorig and Holman, 2003; Salovey, Rothman, Detweiler, and Steward, 2000; Strine, Mokdad, Dube,

Balluz, Gonzalez, Berry, Manderscheid, and Kroenke, 2008) and although the field of psychology includes complex behavioural models of emotion (Baumeister, DeWall, Vohs, and Alquist, 2010; Smith and Ellsworth, 1985), emotion has not yet been included in a biobehavioural model of disability behaviour. Integrating psychological models into the ICF may improve the predictive utility of the ICF by theoretically accounting for physical, cognitive, and emotional factors that affect disability behaviour (Johnston, 1996; Johnston, 1997; Dixon, et al. 2012). Integrating theory-based psychological models of behaviour with the ICF, rather than individual psychological constructs, allows for an account of more complex relationships between variables and mechanisms of observed effects (Johnston and Dixon, 2014).

Social cognitive theory describes two psychological cognitions that are posited to both directly affect behaviour: self-efficacy and outcome expectancies. Bandura (1989) asserts that self-efficacy "plays a central role in human agency" (p. 59), informing an individual's perceived capabilities based on judgements of their own physical, mental, and emotional abilities to carry out a particular task while also taking into account personal and environmental circumstances. Making these judgements accurately is important, as behaviour based on misjudged self-efficacy could lead to adverse events (Bandura, 1989). Outcome expectancies are based on previous experience, observed experience, and self-efficacy regarding particular behaviours (Bandura, 1989). However, the same behaviour can produce different effects in different situations, taking influence from a variety of external factors, many of which are unknown at any given time (Bandura, 1989). The unreliable nature of personal experiences of cause and effect can lead to misjudgements about the effects of a behaviour (Bandura, 1989). When this occurs, outcome expectancies can be weaker predictors of behaviour until gains in experience with the behaviour and its outcomes help to form more accurate beliefs about the behaviour (Bandura, 1989). Learning which outcomes to expect from particular behaviours from personal and vicarious experience are also posited to lead an individual to settle on adequate behaviours rather than optimum behaviours (Bandura, 1989). Once a person experiences an adequate outcome in response to a behaviour, they may suffice to repeat this behaviour in appropriate situations to continue producing adequate results

rather than searching for behaviours that produce better results, forming a barrier to behaviour change (Bandura, 1989). Older individuals are known to experience a course of revaluation, making adjusted appraisals of self-efficacy throughout the aging process as perceived capabilities change (Holahan and Holahan, 1987a; Holahan and Holahan, 1987b). This can lead to decreased self-efficacy where misjudgements are made regarding changes in personal abilities – changes that older people tend to overestimate (Bandura, 1989). One of the main sources of self-efficacy information is an individual's physiological state and this source is particularly salient for people with arthritis (Scharloo, Kaptein, Weinman, Hazes, Willems, Bergman, and Rooijmans, 1998), a disease that involves salient symptomology i.e. pain and joint stiffness (Dieppe and Lohmander, 2005; Scott, Wolfe, and Huizinga, 2010) and is closely associated with aging (Centers for Disease Control and Prevention, 2010). If self-efficacy influences outcome expectancies to affect behaviour and self-efficacy is altered throughout the aging process and in response to changing physiological states, then self-efficacy and outcome expectancies may be important cognitive factors in modelling the disability behaviour of individuals with arthritis. As an established cognitive theory, SCT (Bandura, 1989) could offer a theoretical explanation for any effects that self-efficacy and outcome expectancies might have on behaviour as part of an integrated biobehavioural model of disability.

A range of emotions have also been found to affect behaviour in people with chronic health conditions, including fear avoidance (Vlaeyen and Linton, 2000), anxiety and depression (Strine, et al., 2008), personality (Raynor and Levine, 2009), mood (Salovey, et al., 2000), and stress (Rod, Grønbæk, Schnohr, Prescott, and Kristensen, 2009). It has been suggested that emotion directly affects behaviour and contrarily, that behaviour affects emotion first and, in turn, affects future behavioural outcomes through feedback and learning processes (Baumeister, et al., 2010). However, the appraisal model of emotion (Smith and Ellsworth, 1985) suggests that both are true: emotions arise in response to situations and these emotions then affect the current situation. According to this theory, an individual will experience an emotion in response to a situation that they have evaluated as being important to personal

wellbeing or a personal goal(s) (Ellsworth and Scherer, 2003). These emotions are experienced cognitively and physiologically, causing changes in the individual's experience of the situation and their response to the situation. However, emotion is malleable, allowing for flexibility in a person's interpretation of a situation, their subsequent behaviour (Scherer, 1984) and so could potentially be intervened upon and modified to produce different effects on behaviour. Experiencing chronic illness is known to have emotional consequences (Affleck, Tennen, Keefe, Lefebvre, Kashikar-Zuck, Wright, Starr, and Caldwell, 1999; Newth and Delongis, 2004) and emotions are known to affect behaviour (Baumeister, et al., 2010; Frijda, 1988; Smith and Ellsworth, 1985). Further, emotional appraisals and processes are posited to occur on an individual level (Ellsworth and Scherer, 2003), lending the study of the effects of emotional appraisal on behaviour to the use of an N-of-1 design. Therefore, the present study set out to determine how well an integrated ICF / SCT model (Figure 4.2) and an integrated ICF / emotion model (Figure 4.3) predicts physical activity and participation as described by the ICF and whether either of these models explain more variance in activity and participation than the ICF, SCT, or emotion model alone. Based on group study findings, that integrating the ICF with cognitive factors affecting behaviour explains more variance in disability-related outcomes than either model alone (Dixon, et al., 2008; Dixon, et al., 2012; Geyh, et al., 2012; Quinn, et al., 2012) and evidence that emotion plays an important role in both disability and behaviour, this study was designed to examine whether these integrated biobehavioural models are predictive of day-to-day variability in disability behaviour using an N-of-1 design. Making this determination could aid in the development and assessment of behavioural interventions for disability in individuals (Hobbs, Dixon, Johnston, and Howie, 2013; Quinn, Johnston, and Johnston, 2013).

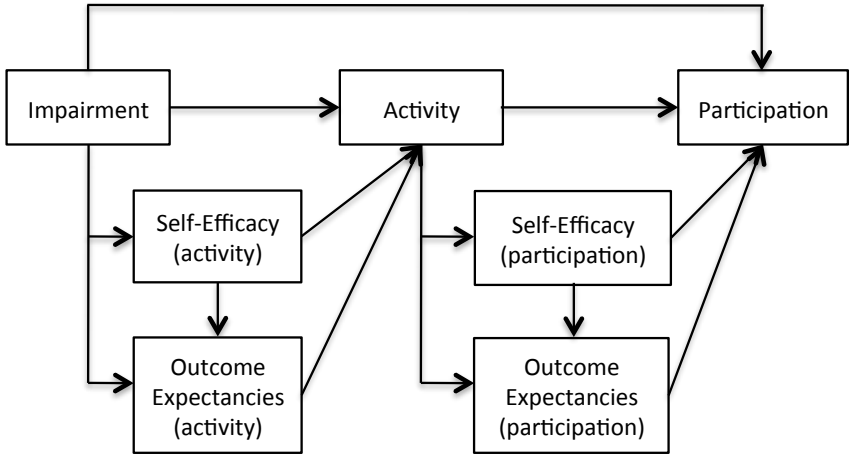


**Figure 4.2** ***Integrated ICF / SCT model***

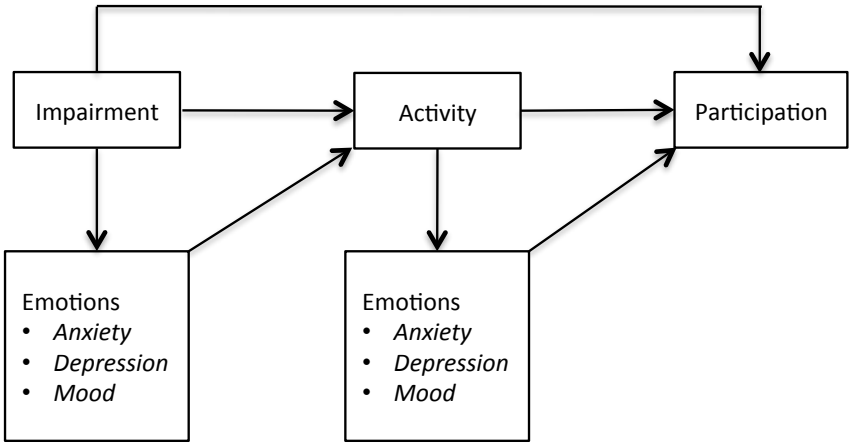


**Figure 4.3** ***Integrated ICF / emotion model***

The SCT cognitions of self-efficacy and outcome expectancies were chosen for integration with the ICF due to the straightforward application of SCT to intervention development (Johnston and Dixon, 2014), the robust evidence that self-efficacy and outcome expectancies explain significant variance in disability behaviour (Lorig and Holman, 2003; Marks, Allegrante, and Lorig, 2005a; Marks, Allegrante, and Lorig, 2005b), and its application in very many self-management interventions (Allen, et al., 2010; Arnold and Faulkner, 2010; Barlow, Turner, and Wright, 2000; Buszewicz, et al., 2006; Giraudet-Le Quintrec, et al., 2007; Hewlett, et al., 2011; Hill, Bird, and Johnson, 2001; Hughes, et al., 2004; Kovar, et al., 1992; Laforest, et al., 2008; Lorig, Gonzalez, and Ritter, 1999; Lorig, et al., 1999; Lorig and Holman, 2003; Marks, Allegrante, and Lorig, 2005a; Marks, Allegrante, and Lorig, 2005b; Peterson, et al., 1993; Yip, et al., 2007), including all studies testing Lorig's (1982) original self-management programme. Mood, anxiety, and depression were chosen for integration with the ICF to represent emotion due to the known prevalence of anxiety and depression in those who have arthritis (Covic, Cumming, Pallant, Manolios, Emery, Conaghan, and Tennant, 2012; Matcham, Rayner, Steer, and Hotopf, 2013; Murphy, et al., 2012) and the daily variations that can occur in an individual's mood (Larsen, 1987; Röcke, Li, and Smith, 2009), anxiety levels, and depressive symptoms (Bunce, Handley, and Gaines Jr., 2008). Participants with arthritis were chosen as the focus of this series of N-of-1s due to the chronic nature of the disease (Lorig and Fries, 2006), its impact on mobility (Dieppe and Lohmander, 2005; Scott, Wolfe, and Huizinga, 2010), its prevalence in the UK (Arthritis Research UK, 2008; Office for National Statistics, 2011), and the extensive application of behavioural interventions to outcomes in arthritis (Riemsma, et al., 2003; Warsi, et al., 2003). Therefore, the present study set out to determine:

1. Does the ICF, SCT, or emotional variables alone predict activity and participation in individuals with arthritis?
2. Does an integrated ICF / SCT model or an integrated ICF / emotions model predict activity and participation in individuals with arthritis?
3. Do integrated models explain more variance in activity and participation in individuals than the ICF, SCT, or emotional variables alone?

## 4.2 Methods

### *4.2.1 Participants*

Individuals aged 18 years or older who reported having rheumatoid or osteoarthritis were eligible to participate in this study. Individuals who were unable to walk or who were unable to give informed consent were excluded as they would not have been capable of completing study measures. Participants with comorbidities that did not render them unable to walk were not excluded as arthritis is often age-related and older individuals often have diagnoses of more than one disease. Fulfilment of inclusion and exclusion criteria was determined through self-report.

Six participants with self-reported rheumatoid or osteoarthritis were recruited from the community. One participant withdrew from the study due to time constraints and another completed the study, but was excluded from analyses due to a technical problem with the accelerometer resulting in the loss of all physical activity data.

### *4.2.2 Design*

This was a series of four, longitudinal n-of-1 case studies. Data were recorded twice daily for 60 days, with measures each morning, each evening, and PA measured objectively over the course of each day.

### *4.2.3 Measures*

Surveys were hosted online via Qualtrics (Qualtrics, 2015). Cronbach's alpha was used to measure internal consistency of multi-item scales and are reported in the results section of each participant. Each day was treated as one data point and tests of internal consistency were performed on relevant data series prior to any transformations related to time series analyses. The method of testing for internal consistency of multi-item measures has been used previously in N-of-1 designs (Quinn, Johnston, and Johnston, 2013).

#### *4.2.3.1 ICF Measures*

*Impairment (I)*

I was measured in the morning using two questions: “What is your pain like today?” and “What is your joint stiffness like today?” answered on an 11-point likert scale and ranging from 0 to 10 anchored by “no pain / joint stiffness” and “worst possible pain / joint stiffness”.

Scores from these two questions were averaged to create one I score for the purposes of analyses, with high scores reflecting greater impairment. Impairment scores for participant 2 were found to be negatively associated and so, were analysed separately.

*Activity (A)*

An objective measure of activity was obtained using the Actigraph GT3X accelerometer (Actigraph LLC, Pensacola FL). The Actigraph measures steps as well as body acceleration on 3 axes – vertical (eg. up and down), anteroposterior (eg. back and forth), and mediolateral (eg. side to side) - in 15 second epochs (Sasaki, John, and Freedson, 2011). The Actigraph GT3X has very high intra-instrument and inter-instrument reliability when used at frequencies between 2.1 Hz and 4.1 Hz (Santos-Lozano, Marín, Torres-Luque, Ruiz, Lucía, and Garatachea, 2012a; Santos-Lozano, Torres-Luque, Marín, Ruiz, Lucia, and Garatachea, 2012b). This was determined to be ideal for use in this study as the frequency of normal human physical activity is expected to be between 0.3 Hz and 3.5 Hz, with only very fast running registering above 4 Hz (Santos-Lozano, et al., 2012a). Accelerometers were worn on a belt around the waist or torso positioned at the right hand side of the body for 60 days except while bathing or sleeping. Each device had 4Gb of memory, capable of storing up to 240 days of raw data. Expected battery life was approximately one to two weeks and therefore, each participant was supplied with an Actigraph charging cable and asked to charge their device each night. The reported activity scores are summed composite scores of vector magnitude as detected on all 3 axes (Sasaki, John, and Freedson, 2011). This allowed for activity to be measured as

total activity over the course of a full day rather than as exercise-oriented scores of activity per minute typically used to reflect light, moderate, and vigorous activity.

*Participation (P)*

Participation as described by the ICF encompasses both a person's *capability* of participating in society and their *performance* of participation in society. However, it has been suggested that the only way to measure participation is through observation of performance, meaning that capability is ignored and only a portion of the participation construct can be quantified (Hemmingsson and Jonsson, 2005). To overcome this, two different participation measures were used in the present study.

The question "How difficult or easy do you find it to take part in social activities today?" was asked in the morning to measure the 'capability' component of participation. The question "How much socialising did you do today?" was asked in the evening to measure the 'performance' component of participation. As these items were viewed as separate measures of distinct components of participation rather than two parts of a multi-item participation scale, no test of internal reliability was performed. Rather, the capability measure was used to weight the performance measure and create an overall performance score.

These questions employed an 11-point likert scale ranging from 0 to 10. The response scale for the morning questions were anchored with "very difficult" and "very easy", and the evening questions with "less than usual" and "more than usual". Scores were transformed to 1 to 11 scales prior to analyses to avoid multiplicative scores of 0. Finally, perceived difficulty scores were multiplied with scores for actual participation engagement. This created a participation score ranging between 1 and 121, where a score of 1 reflected very high perceived difficulty with participation combined with much less engagement in participation than usual and a score of 121 reflected a perception that participation would be very easy combined with much more engagement in participation than usual.

#### *4.2.3.2 SCT Measures*

*Self-Efficacy (SE) and Outcome Expectancy (OE)*

A standard method of developing SE and OE measures was used (Francis, Eccles, Johnston, Walker, Grimshaw, Foy, Kaner, Smith, & Bonetti, 2004). This method enables items to be personalised for each individual. Upon entry into the study, each participant took part in an elicitation interview in which they identified the three most prominent symptoms of their arthritis. Participant 1 gave weight bearing limitations, pain, and joint stiffness as the three most prominent symptoms of their arthritis while participants 2, 3, and 4 all gave pain, joint stiffness, and fatigue as their most prominent symptoms.

SE for activity (SEA), with activity operationalised as walking was measured in the morning using the questions, "How confident do you feel about walking today?" and "How confident do you feel about walking while your symptoms are present today". Participants were reminded to think of pain, joint stiffness, and weight bearing limitations (i.e. participant 1) or pain, joint stiffness, and fatigue (i.e. participants 2, 3, and 4) as their "symptoms" when answering. Each question was answered on an 11-point likert scale and ranging from 0 to 10 anchored by "not at all confident" and "very confident". Scores for these two questions were averaged to create one score for SEA, with high scores reflecting high levels of self-efficacy.

SE for participation (SEP), with participation operationalised as taking part in social activities was measured in the morning using the questions, "How confident do you feel about taking part in social activities today?" and "How confident do you feel about socialising while your symptoms are present today". Participants were reminded to think of pain, joint stiffness, and weight bearing limitations (i.e. participant 1) or pain, joint stiffness, and fatigue (i.e. participants 2, 3, and 4) as their "symptoms" when answering. Each question was answered on an 11-point likert scale and ranging from 0 to 10 anchored by "not at all confident" and "very confident". Scores for these two questions were averaged to create one score for SEP, with high scores reflecting high levels of self-efficacy.

OE for physical activity (OEA) were measured in the morning using the statements, "Walking today will be painful", "Walking today will make my joints stiffer", and "Walking today will make my fatigue (i.e. participants 2, 3, and 4) / weight bearing limitations (i.e. participant 1) worse" answered on an 11-point likert scale and ranging from 0 to 10 anchored by "strongly disagree" and "strongly agree". Scores for the three OEA questions were averaged to create a mean score for this variable, with high scores reflecting more negative outcome expectancies.

During the elicitation interview, participants expressed a general difficulty with social participation rather than participation being affected by any particular symptom. Therefore, OE for participation (OEP) was measured in the same way, but using only one statement: "Socialising today will be difficult", with higher scores reflecting more negative outcome expectancies.

#### *4.2.3.3 Emotion Measures*

Anxiety (i.e. How anxious are you now?), depression (i.e. How depressed do you feel now?), and mood (i.e. How is your mood now?) were measured once in the morning and once in the evening on an 11-point likert scale and ranging from 0 to 10. The anxiety measure was anchored by "not at all anxious" and "extremely anxious", with higher scores indicating more anxiety. The depression measure was anchored by "not at all depressed" and "extremely depressed", with higher scores indicating more depression. The mood measure was anchored by "very negative" and "very positive", with higher scores indicating more positive mood. Scores for the two questions measuring each emotion were averaged to create a mean score for each variable, with higher scores indicating more anxiety, more depression, and more positive mood.

### *4.2.4 Procedure*

Participants were recruited via posters in the community, on the internet via health group forums and social media, as well as advertisements in local newspapers (Appendix 13). Participants were volunteers who contacted the researcher in the first

instance, by telephone or email, to express an interest in taking part in the study. Study objectives and requirements were then explained in full (Appendix 14). Written, informed consent (Appendix 15) was obtained from each participant prior to beginning the study and all participants were made aware of their right to terminate their participation at any time. Upon completion of the study, all participants were fully debriefed and provided with information on study rationale (Appendix 19). Debriefing information included contact details for mental health and arthritis charities. Ethical approval for this study was obtained from the University of Strathclyde Ethics Committee.

Participants took part in the present study over the course of 60 days. At baseline, participants were asked to meet with THB in a place that was convenient for them. Once consent was given by the participant, instructions for the use of accelerometers were given and elicitation interviews were audio recorded. Study variables were measured twice daily throughout the study period. This was done via online Qualtrics surveys personalised for each participant (Appendices 17 and 18). Prompts to complete these surveys were emailed to each participant each morning, containing a link to the participant's morning survey and each evening, containing a link to the participant's evening survey.

All data were retrieved from accelerometers at the end of the study period using ActiLife software version 6.11.5 (ActiGraph Corp, 2014). Data were filtered by hand to identify the start and the end of each participant's daily wear time. These filters were then applied during export to a .csv file that output daily vector magnitude totals. These vector magnitude scores made up the activity (A) data series used in the present study.

### *4.2.5 Analyses*

First, missing data were imputed using the package 'norm' (Ported to R by Novo. Original by Shafer, 2013). This was done using an open source statistical programme, R version 3.2.1 (R Development Core Team, 2011). Prior to imputation,

an appropriate transformation was applied in cases where data were not normally distributed and then removed after imputation was complete. This imputation method involved the random generation of five separate datasets using the Monte Carlo method (Metropolis and Ulam, 1949). The average of the five datasets is then taken as the complete dataset and is transformed back to the original distribution. This method of imputation has been used previously in the analysis of N-of-1 studies (O'Brien, Philpott-Morgan, and Dixon, 2016). Missing data were minimal. Participant 1 was missing six data points (10%) from A. Participant 2 was missing one data point (1.7%) from A, four data points (3.3%) from the 120 available for SEP (ie. one data series for each of the two questions averaged to make up the SEP variable), one data point (1.7%) from the 'performance' measure of P, one data point (0.8%) from the 120 available for anxiety, one data point (0.8%) from the 120 available for depression, and one data point (0.8%) from the 120 available for mood. Participant 3 was missing nine data points (15%) from A. Participant 4 was missing eight data points (6.7%) from the 120 available for I (i.e. one data series for each of the two questions averaged to make up the I variable), 8 data points (6.7%) from the 120 available for SEA, 12 data points (6.7%) from the 180 available for OEA (i.e. one data series for each of the three questions averaged to make up the OEA variable), four data points (6.7%) from the 'capacity' measure of P, 12 data points (6.7%) from the 180 available for OEP, three data points (5%) from the 'performance' measure of P, seven data points (5.8%) from the 120 available for anxiety, seven data points (5.8%) from the 120 available for depression, and seven data points (5.8%) from the 120 available for mood.

There were a total of 76 data series in total across the four participants: four objectively measured series (one series of A, as measured by accelerometer, for each participant), and 72 self-report series (two I, two P, two SEA, two SEP, three OEA, one OEP, two anxiety, two depression, and two mood in each of the four participants). Tests of normality of each data series identified variability in 74 of 76 series. Where multiple data series measured a single variable, those series were either averaged or multiplied to create one data series for each variable for each participant as described in the measures section above. The pain and joint stiffness data series

for participant 2 were found to be negatively associated a so, were analysed separately. This produced 37 cognition and emotion series (nine for participants 1, 3, and 4; 10 for participant 2). Tests of normality of each of these new data series (I, P, SEA, SEP, OEA, anxiety, depression, and mood for each of the four participants) identified non-normal distributions in 27 of 36 averaged series. Mean (standard deviation) is reported where variables were normally distributed, while median (interquartile range) is reported where variables were not normally distributed.

As time series data are derived from sequential measures from an individual over time, there is a risk of serial dependency within each data series. Adjusting for this "autocorrelation" allows for tests that normally assume independence between data points to be applied to times series data (Box, Jenkins, Reinsel, and Ljung, 2015; Hobbs, et al., 2013). After missing data were imputed, data were checked for significant autocorrelation using the 'forecasting' function and partial autocorrelation analyses in SPSS, version 22 (IBM Corp, 2013). A maximum time lag of one week (i.e. seven data points: one data point per day) was applied to each data series with the expectation that cyclical patterns would be weekly at the longest (Hobbs, et al., 2013). Where partial autocorrelations exceeded the 95% confidence level, autocorrelation was assumed to be present. First, the data point with autocorrelation of the strongest significance within the allotted time period (in this case, one week or seven data points) was identified within each data series using this method. Then, data were lagged using the 'transform' > 'create time series' function in SPSS (IBM Corp, 2013) to the appropriate lag (e.g. if the strongest autocorrelation in a data series was found at the first data point, the series was lagged to the order of one). The lagged series was then regressed onto the original data series, saving residuals. Residuals were checked for significant autocorrelation using the 'forecasting' function in SPSS (IBM, Corp, 2013) and, if autocorrelation had been successfully removed, no longer being present at a significant level within the series, the residual was then used for all further analyses as the "prewhitened" variable (Hobbs, et al., 2013; Quinn, Johnston, and Johnston, 2013).

In the present study, 24 data series (59%) showed significant autocorrelation and were prewhitened prior to analyses. Of these, 83% showed first-order autoregressive relationships (i.e. lag 1), indicating that the score was most highly correlated with the immediately preceding score (i.e. the score given 24 hours prior). A further 8.3% were autocorrelated at lag 5, and 8.3% were autocorrelated at lag 7. All but two (8.3%) of these variables were successfully "prewhitened" after the removal of the largest autocorrelation. These two data series were, therefore, lagged once at lag 1 and again at the lag that remained significantly autocorrelated (i.e. one at lag 4 and one at lag 7) before the series were successfully prewhitened.

Cross correlations were then used to identify activity-related associations specified by the integrated ICF / SCT model shown in Figure 4.2 (i.e. between I and A; I and SEA; I and OEA; SEA and OEA; SEA and A; and OEA and A) and those specified by the integrated ICF / emotion model shown in Figure 4.3 (i.e. between I and A; I and mood; I and anxiety; I and depression; mood and A; anxiety and A; depression and A). Cross-correlations were also used to identify participation-related association specified by the integrated ICF / SCT model (i.e. between I and P; A and P; A and SEP; A and OEP; SEP and OEP; SEP and P; and OEP and P) and those specified by the integrated ICF / emotion model (i.e. between I and P; A and P; A and mood; A and anxiety; A and depression; mood and P; anxiety and P; depression and P). A positive lag indicates that changes in the first construct preceded changes in the second construct, for example, changes in I preceded changes in A or SEA; changes in SEA preceded changes in OEA or A; changes in OEA preceded changes in A. Conversely, a negative lag indicates that changes in the second construct preceded changes in the first construct, for example, changes in A or SEA preceded changes in I; changes in OEA or A preceded changes in SEA and changes in A preceded changes in OEA. A lag of zero indicates that the two measures were related concurrently. Cross-correlations with an effect size of 0.4 or greater were considered to potentially explain a reasonable amount of variance (Cohen, 1988). The three largest cross-correlations for each pair of variables up to a maximum time lag of one week (i.e. 7 data points) are shown in tables, while the single largest cross-correlation is also described in more detail in the text.

Forced entry linear regression analyses were employed to determine whether there were any predictive effects of the ICF only, the SCT only, the emotion model only, the integrated ICF / SCT model, and the integrated ICF / emotion model on A and on P. Therefore, for participants 1, 3, and 4, five regression models were fit with A as the dependent variable and five regression models were fit with P as the dependent variable. For participant 2, eight regression models were fit with A as the dependent variable and eight regression models were fit with P as the dependent variable, as the two measures of impairment were analysed separately in this individual (i.e. pain, joint stiffness). Standardised residuals were saved and tested to determine whether the regression errors of each model were normally or non-normally distributed. Where the Shapiro-Wilk suggested errors were not normally distributed, the model was bootstrapped using the bias corrected accelerated (BCa) simple bootstrapping function in SPSS (IBM, Corp, 2013) with 1000 samples. Three of the 10 models in participant 1 were non-normally distributed; all three were models of participation behaviour. Seven of the 16 models in participant 2 were non-normally distributed; all seven were models of activity behaviour. Six of the 10 models in participant 3 were non-normally distributed; five were models of activity behaviour and one was a model of participation behaviour. None of the 10 models in participant 4 were non-normally distributed.

## 4.3 Participant 1 Results

### *4.3.1 Descriptive Statistics*

Participant 1 was a 63 year old female with osteoarthritis of the knee and hip. This participant reported that pain, joint stiffness, and weight bearing limitations (i.e. increased pain and joint stiffness when putting weight on her joints) were their most prominent symptoms affecting A. Questions about self-efficacy and outcome expectancies regarding A asked specifically about these symptoms in this participant's survey.

Cronbach's alpha indicated that measures of I ($\alpha = 0.60$), SEA ($\alpha = 0.92$), OEA ($\alpha = 0.81$), SEP ($\alpha = 0.93$), anxiety ($\alpha = 0.77$), depression ($\alpha = 0.56$), and mood ($\alpha = 0.75$) had acceptable to high internal reliability. Table 4.1 shows either mean (SD) or median (range) scores, depending on normality, for each variable for participant 1 and the lag applied to each variable during the prewhitening process.

Table 4.1 *Mean (standard deviation)[a] or median (range)[b] score and lag applied to each variable from Participant 1*

| **Variable** | **Mean (sd)[a] / Median (range)[b]** | **Applied Lag** |
|---|---|---|
| Activity (A; vector magnitude) | 86358(25509)[a] | 7 |
| Participation (P) | 22.50(70.00)[b] | None |
| Impairment (I) | 6.50(5.50)[b] | None |
| Activity Self-Efficacy (SEA) | 4.75(6.00)[b] | None |
| Activity Outcome Expectancy (OEA) | 6.07(0.83)[a] | None |
| Participation Self-Efficacy (SEP) | 4.25(7.50)[b] | None |
| Participation Outcome Expectancy (OEP) | 7.00(7.00)[b] | None |
| Mood | 4.50(5.50)[b] | None |
| Anxiety | 6.50(7.50)[b] | 1 |
| Depression | 5.75(5.50)[b] | None |

*Note: [a] = mean(standard deviation); [b] = median(range); None = no significant autocorrelation present in data series; higher scores = higher levels of activity, more positive participation scores (scale of 1 – 121), greater impairment (scale of 0 – 10), higher self-efficacy (scale of 0 – 10), more negative outcome expectancies (scale of 0 – 10), more anxiety (scale of 0 – 10), more depression (scale of 0 – 10), and more positive mood (scale of 0 – 10).*

Figure 4.4 presents the daily activity, participation, impairment, SEA, OEA, SEP, OEP, mood, anxiety, and depression scores over the 60 day study period. Day to day variability can be seen in all 10 time plots.

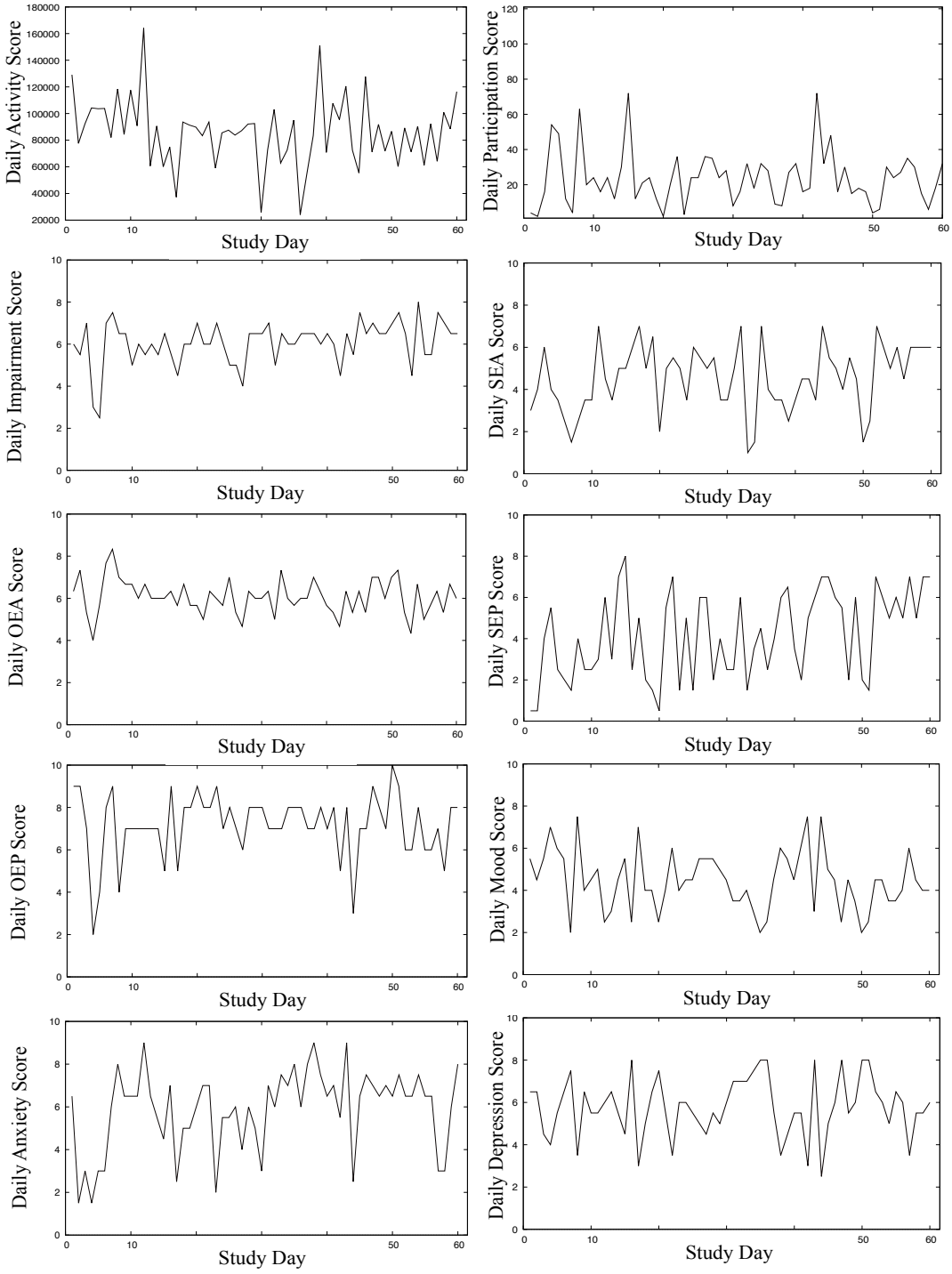


**Figure 4.4** ***Time plots of daily scores for all variables from Participant 1***

*4.3.2 Cross-Correlations – The Integrated ICF / SCT Model and Activity*

Variability could be seen in all data series (Figure 4.4), allowing for time series analysis. The three largest activity-related cross-correlations between each pair of variables as indicated by the integrated ICF / SCT model (Figure 4.2) are shown in Table 4.2.

Four of these six theoretically possible cross-correlations exceeded the 95% CI. All four involved psychological constructs: either self-efficacy or outcome expectancy towards walking (i.e. I and OEA; SEA and A; OEA and A; SEA and OEA). Of these four cross-correlations, only two exceeded the criterion correlation value of 0.4 (i.e. I and OEA; SEA and OEA).

The two cross-correlations meeting both criteria for significance had a lag of zero, indicating no temporal ordering between the constructs. Thus, participant 1 experienced greater impairment at the same time as expressing more negative outcome expectancies in relation to walking ($r = 0.53$). In addition, they expressed higher self-efficacy towards walking when they also were experiencing more positive outcome expectancies towards walking ($r = -0.46$).

Both self-efficacy towards walking (SEA) and outcome expectancies about walking (OEA) exceeded the 95% CI at positive lags indicating that changes in cognitions preceded changes in walking behaviour. However, both cross-correlation were below the criterion value of 0.4 and thus should be interpreted with caution.

Table 4.2 *Activity-related cross-correlations of ICF and SCT model components for Participant 1.*

| | | **First Variable** | | |
|---|---|---|---|---|
| | | **I** | **SEA** | **OEA** |
| **Second Variable** | **A** | -0.25 (0.15) lag -7<br>0.25 (0.14) lag -1<br>-0.21 (0.14) lag 0 | 0.32 (0.14) lag 4*<br>-0.31 (0.14) lag -1*<br>0.27 (0.15) lag -6 | 0.36 (0.14) lag 3*<br>-0.29 (0.15) lag -7<br>-0.26 (0.14) lag 4- |
| | **SEA** | -0.19 (0.13) lag 0<br>0.17 (0.13) lag -3<br>0.16 (0.13) lag 3 | | |
| | **OEA** | **0.53 (0.13) lag 0*§**<br>0.23 (0.13) lag -1<br>-0.21 (0.14) lag 6 | **-0.46 (0.13) lag 0*§**<br>-0.22 (0.13) lag 1<br>0.14 (0.13) lag 3 | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; A = activity; I = impairment; SEA = self-efficacy for activity; OEA = outcome expectancy for activity*

*4.3.3 Cross-Correlations – The Integrated ICF / Emotion Model and Activity*

Variability could be seen in all data series (Figure 4.4), allowing for time series analysis. The three largest activity-related cross-correlations between each pair of variables as indicated by the integrated ICF / emotion model (Figure 4.3) are shown in Table 4.3.

Five of seven theoretically possible cross-correlations exceeded the 95% level of confidence and all five involved emotional constructs (i.e. mood and A; anxiety and A; depression and A; I and mood; I and depression). Three of these also met the 0.4 meaningful effect size criterion (i.e. mood and A; anxiety and A; depression and A).

Two of the cross-correlations meeting both criteria for meaningful effects were found at negative lags of one, indicating that participant 1 experienced more negative mood ($r$ = -0.51) and depression ($r$ = 0.46) one day following engagement in activity. Anxiety ($r$ = 0.43) was related to activity at lag six, indicating that low levels of anxiety preceded activity by six days.

Two further cross-correlations exceeding the 95% confidence interval were found at lag zero, suggesting that changes in impairment were concurrent with changes in mood and depression in this individual. However, these findings did not meet the 0.4 effect size criterion and so, should be interpreted with caution.

Table 4.3 *Activity-related cross-correlations of ICF and emotion model components for Participant 1*

| | | **First Variable** | | | |
|---|---|---|---|---|---|
| | | **I** | **Mood** | **Anx** | **Dep** |
| **Second Variable** | **A** | -0.25 (0.15) lag -7<br>0.25 (0.14) lag -1<br>-0.21 (0.14) lag 0 | **-0.51 (0.14) lag -1*§**<br>0.27 (0.14) lag 4<br>-0.23 (0.14) lag -5 | **0.43 (0.15) lag 6*§**<br>-0.34 (0.14) lag 1*<br>0.27 (0.14) lag 2 | **0.46 (0.14) lag -1*§**<br>-0.27 (0.14) lag 4<br>0.25 (0.14) lag 3 |
| | **Mood** | -0.39 (0.13) lag 0*<br>-0.17 (0.13) lag 4<br>-0.15 (0.13) lag 1 | | | |
| | **Anx** | 0.26 (0.13) lag 3<br>0.24 (0.13) lag -1<br>0.23 (0.13) lag 1 | | | |
| | **Dep** | 0.28 (0.13) lag 0*<br>-0.14 (0.13) lag -3<br>-0.12 (0.14) lag -6 | | | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; A = activity; I = impairment; Anx = anxiety; Dep = depression*

*4.3.4 Cross-Correlations – The Integrated ICF / SCT Model and Participation*

Variability could be seen in all data series (Figure 4.4), allowing for time series analysis. The three largest participation-related cross-correlations between each pair of variables as indicated by the integrated ICF / SCT model (Figure 4.2) are shown in Table 4.4.

The integrated ICF / SCT model identifies seven possible cross-correlations involving either participation or cognitions about participation (SEP or OEP) and all seven cross-correlations exceeded the 95% confidence interval. Six of the seven also met or exceeded the additional 0.4 criterion value for significance; only the relationship between activity and self-efficacy towards participation failed to meet this criterion.

Four cross-correlations meeting both criteria for significance had a lag of zero, indicating no temporal ordering between the constructs. Thus, participant 1 experienced less impairment at the same time as reporting more positive participation scores (r = -0.49). This individual also expressed higher self-efficacy towards participation while also having a more positive experience of participation (*r* = 0.54). Similarly, participant 1 had more positive outcome expectancies about participation concurrently with positive participation scores (*r* = -0.70). In addition, they expressed higher self-efficacy towards participation when they also were experiencing more positive outcome expectancies towards participation (*r* = -0.45). Two further cross-correlations that met both criteria for significance had a lag of negative four, indicating that changes in activity followed changes in P and OEP. Therefore, participant 1 engaged in more activity four days following an experience of positive participation (*r* = 0.40). They also had higher activity levels four days following positive outcome expectancies about participation (*r* = -0.40). Activity exceeded the 95% confidence interval at a negative lag indicating that changes in activity followed changes in self-efficacy towards participation. However, this cross-correlation fell below the criterion value of 0.4 and should, therefore, be interpreted with caution.

Table 4.4 *Participation-related cross-correlations of interacting model components for Participant 1.*

| | | **First Variable** | | | |
|---|---|---|---|---|---|
| | | **I** | **A** | **SEP** | **OEP** |
| **Second Variable** | **P** | **-0.49 (0.13) lag 0*§**<br>0.26 (0.13) lag -3<br>0.13 (0.13) lag 6 | **0.40 (0.14) lag -4*§**<br>0.29 (0.15) lag -7<br>-0.27 (0.14) lag 1 | **0.54 (0.13) lag 0*§**<br>-0.20 (0.14) lag 6<br>-0.16 (0.13) lag 2 | **-0.70 (0.13) lag 0*§**<br>0.19 (0.14) lag 6<br>0.14 (0.13) lag 3 |
| | **SEP** | | 0.29 (0.14) lag -4*<br>-0.27 (0.14) lag 1<br>-0.26 (0.14) lag 2 | | |
| | **OEP** | | **-0.40 (0.14) lag -4*§**<br>0.39 (0.14) lag 1*<br>-0.32 (0.14) lag -2* | **-0.45 (0.13) lag 0*§**<br>0.17 (0.14) lag -6<br>0.17 (0.14) lag 7 | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; I = impairment; A = activity; P = participation; SEP = self-efficacy for participation; OEP = outcome expectancy for participation*

*4.3.5 Cross-Correlations – The Integrated ICF / Emotion Model and Participation*

Variability could be seen in all data series (Figure 4.4), allowing for time series analysis. The three largest participation-related cross-correlations between each pair of variables as indicated by the integrated ICF / emotion model (Figure 4.3) are shown in Table 4.5.

All eight theoretically possible cross-correlations between pairs of variables involving participation, ICF constructs (i.e. impairment; activity), and emotional constructs (i.e. mood; anxiety; depression) were found to exceed the 95% level of confidence. Only the association between anxiety and participation fell below the 0.4 criterion for meaningful effect sizes.

Three of the seven cross-correlations meeting both criteria for meaningful effect sizes were found at lag zero, indicating that participant 1 experienced positive mood ($r$ = 0.55) and low levels of depression ($r$ = -0.54) and impairment ($r$ = -0.49) at the same time as more positive participation scores. Two of these seven cross-correlations were found at lag one, indicating that this individual engaged in activity one day prior to experiencing more negative mood ($r$ = -0.51) and higher levels of depression ($r$ = 0.46). The final two cross-correlations meeting both criteria for meaningful effect sizes were found at negative lags, indicating that participant 1 engaged in activity four days following positive participation scores ($r$ = 0.40) and six days following higher levels of anxiety ($r$ = 0.43).

Anxiety exceeded the 95% confidence interval at a negative lag suggesting that changes in anxiety followed changes in participation scores. However, this finding fell below the 0.4 effect size criterion and so should be interpreted with caution.

Table 4.5 *Participation-related cross-correlations of ICF and emotion model components for Participant 1.*

| | | First Variable | | | | |
|---|---|---|---|---|---|---|
| | | **I** | **A** | **Mood** | **Anx** | **Dep** |
| **Second Variable** | **P** | **-0.49 (0.13) lag 0*§**<br>0.26 (0.13) lag -3<br>0.13 (0.13) lag 6 | **0.40 (0.14) lag -4*§**<br>0.29 (0.15) lag -7<br>-0.27 (0.14) lag 1 | **0.55 (0.13) lag 0*§**<br>0.24 (0.13) lag 2<br>-0.18 (0.14) lag 6 | -0.27 (0.13) lag -3*<br>0.23 (0.14) lag -5<br>-0.21 (0.13) lag 1 | **-0.54 (0.13) lag 0*§**<br>-0.22 (0.13) lag 4<br>0.20 (0.13) lag -1 |
| | **Mood** | | **-0.51 (0.14) lag 1*§**<br>0.27 (0.14) lag -4<br>-0.23 (0.14) lag 5 | | | |
| | **Anx** | | **0.43 (0.15) lag -6*§**<br>-0.34 (0.14) lag -1*<br>0.27 (0.14) lag -2 | | | |
| | **Dep** | | **0.46 (0.14) lag 1*§**<br>-0.27 (0.14) lag -4<br>0.25 (0.14) lag -3 | | | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; I = impairment; A = activity; P = participation; Anx = anxiety; Dep = depression*

*4.3.6 Regression Analyses – Activity*

Table 4.6 displays the results of the regression analyses assessing the utility of the ICF, SCT and emotion model for the prediction of activity.

Neither the ICF, SCT, nor emotion model predicted activity. That is to say impairment did not predict activity; neither self-efficacy nor outcome expectancy towards walking predicted activity; mood, anxiety, and depression did not predict activity.

Table 4.6 *Forced entry regression analyses testing the predictive effects of the ICF only, SCT only, and emotions on activity in Participant 1*

| **Variable** | **B(SE B)** | ***β*(*t*- value)** | **adj. $R^2$(F)** |
|---|---|---|---|
| ***ICF predicting A*** | | | |
| I | -6618.87(4271.04) | -0.21(-1.55)*ns* | 0.03(2.40)*ns* |
| ***SCT predicting A*** | | | |
| SEA | 2448.08(2608.90) | 0.15(0.94)*ns* | |
| OEA | 369.12(5716.56) | 0.01(0.07)*ns* | -0.02(0.51)*ns* |
| ***Emotion model predicting A*** | | | |
| Mood | -41.30(6596.07) | -0.002(-0.006)*ns* | |
| Anxiety | 2121.44(2278.29) | 0.13(0.93)*ns* | |
| Depression | -951.02(6405.93) | -0.05(-0.15)*ns* | -0.04(0.38)*ns* |

*Note: B = unstandardised B; $\beta$ = standardised B; SE B = standard error of B; t-value = t statistic of standardised B; p = p-value; adj. = adjusted; A = activity; I = impairment; SEA = self-efficacy for activity; OEA = outcome expectancies for activity*

*4.3.7 Regression Analyses – Participation*

Table 4.7 displays the results of the regression analyses assessing the utility of the ICF, SCT, emotions and the integrated ICF / SCT and ICF / emotion models for the prediction of participation. Applying a lag of seven data points to the activity series meant that regression analyses including activity excluded the first seven data points of each series in the model. To allow for the results of regressing participation onto SCT constructs and emotions alone to be directly compared with the results of regressing participation onto models integrated with ICF constructs, the first seven data points were removed prior to analyses of models that did not include activity (i.e. SCT constructs alone, emotions alone). The regression errors of the model of ICF constructs alone and both integrated models were found to be non-normally distributed. Bootstrapping methods were applied to each of these models and adjusted standard errors of B and *p*-values are reported in Table 4.7.

The ICF, SCT, emotion model, and both the integrated ICF / SCT and ICF / emotion models were significantly predictive of participation in participant 1. Specifically, low impairment and high activity levels predicted more participation; high self-efficacy and more positive outcome expectancies towards participation predicted more participation; more positive mood, but also more anxiety and depression predicted more participation; low impairment, high self-efficacy, and more positive outcome expectancies towards participation together predicted more participation; and low impairment, more positive mood, more anxiety, and less depression together predicted more participation.

All models explained more variance in participation than impairment alone. The integrated ICF / SCT model explained more variance in participation than SCT alone and the integrated ICF / emotions models explained more variance in participation than emotions alone. However, models containing cognitions explained more variance in participation than any other model tested.

Table 4.7 *Forced entry regression analyses testing the predictive effects of the ICF only, SCT only, emotions only and the integrated ICF / SCT and ICF / emotion models on participation in Participant 1*

| Variable | B(SE B) | $\beta$(*t*-value) | adj. $R^2$(F) |
|---|---|---|---|
| ***ICF predicting P*** | | | |
| I | -6.85(2.66†) | -0.38(-2.89)*† | |
| A | 2.39(0.00†) | 0.04(0.32)*ns*† | 0.12(4.61)* |
| ***SCT predicting P*** | | | |
| SEP | 2.17(0.86) | 0.30(2.52)* | |
| OEP | -5.45(1.33) | -0.48(-4.11)*** | 0.43(20.58)*** |
| ***Emotion model predicting P*** | | | |
| Mood | 6.10(3.14) | 0.56(1.94)*ns* | |
| Anxiety | 0.46(1.09) | 0.05(0.42)*ns* | |
| Depression | 0.05(3.05) | 0.005(0.02)*ns* | 0.28(7.71)*** |
| ***Integrated ICF / SCT model predicting P*** | | | |
| I | -3.12(2.73†) | -0.18(-1.54)*ns*† | |
| A | 4.99(7.59†) | 0.09(0.82)*ns*† | |
| SEP | 2.32(0.80†) | 0.32(2.71)*† | |
| OEP | -4.52(2.16†) | -0.40(-3.23)*ns*† | 0.45(11.55)*** |
| ***Integrated ICF / emotion model predicting P*** | | | |
| I | -4.25(2.24†) | -0.24(-1.91)*ns*† | |
| A | 2.21(9.28†) | 0.04(0.33)*ns*† | |
| Mood | 5.05(3.42†) | 0.46(1.61)*ns*† | |
| Anxiety | 0.04(0.75†) | 0.004(0.03)*ns*† | |
| Depression | -0.30(2.90†) | -0.03(-0.10)*ns*† | 0.31(5.65)*** |

*Note: † = bootstrapped values; B = unstandardised B; $\beta$ = standardised B; SE B = standard error of B; t-value = t statistic of standardised B; p = p-value; adj. = adjusted; P = participation; I = impairment; SEP = self-efficacy for physical participation; OEP = outcome expectancies for participation; * p < 0.05; ** p < 0.01; *** p < 0.001*

### *4.3.8 Participant 1 Discussion*

Variability was found to be present in all data series for participant 1, allowing for within-person investigation of the effects of changes in one variable on changes in another. Neither impairment, cognitions, nor emotions alone were significantly predictive of activity in participant 1. However, all five models were significantly predictive of participation. SCT constructs predicted 31% more variance in participation and emotion 16% more variance in participation than ICF constructs (i.e. impairment and activity) alone.

Cross-correlations of activity-related model components showed that changes in impairment and self-efficacy towards activity were concurrent with changes in outcome expectancies about activity. This finding supports the proposal that impairment and cognitions would be directly related within an integrated ICF / SCT model. Changes in both mood and depression followed changes in activity, while changes in anxiety preceded changes in activity. This supports the idea that emotions could be related to behaviour in the form of feedback following behaviour and as factors that relate to future behaviour. Cross-correlations of participation-related model components showed that changes in impairment, self-efficacy towards participation, outcome expectancies about participation, mood, and depression were concurrent with changes in participation. Changes in self-efficacy towards participation were also concurrent with changes in outcome expectancies about participation. Changes in activity followed changes in participation, outcome expectancies about participation, and anxiety, but preceded changes in mood and depression. Therefore, cognitions and emotions were found to have similar temporal ordering in relation to both activity and participation in this individual.

Together, impairment and activity were predictive of participation. However, activity was not a significant predictor of participation when impairment was taken into account. Participation-related self-efficacy and outcome expectancies also predicted participation. Within the integrated ICF / emotion model, mood was the strongest predictor of participation, followed by impairment. Therefore, impairment,

cognitions, and mood predicted participation, with models including cognitions explaining the greatest amount of variance in this individual's participation scores.

No model tested in the present study was predictive of activity. This finding may, in part, be due to the way that activity was measured. Previous studies have found cognitive models to be better at predicting variables measured by self-report than those measured objectively both in individuals (Hobbs, et al., 2013; Quinn, Johnston, and Johnston, 2013) and in groups (Dixon, et al., 2012; McEachan, Conner, Taylor, and Lawton, 2011). In fact, meta-analytic findings suggest that the Theory of Planned Behaviour (Ajzen, 1991) explains more than double the variance in self-reported activity than in objectively measured activity (McEachan, et al., 2011). Another issue pertaining to measurement that may have affected the present findings is that of cognition-behaviour correspondence. Activity-related cognitions were measured in relation to walking behaviour, while activity itself was measured objectively by accelerometer. Ajzen and Fishbein (1977) state that both cognitions and behaviours have a target element and an action element and cognitions can only effectively predict behaviours when these elements correspond closely. Their review found that when neither element corresponds, cognitions very rarely predict behaviour at all. When only one element corresponds, the connection between cognitions and behaviour is unreliable or weak, but when both correspond closely, cognitions explain up to 20% more variance in behaviour (Ajzen and Fishbein, 1977; Jaccard, King, Pomazal, 1977). In the present study, the target element was not defined; the individual was asked about walking in general, rather than walking on a treadmill or in their neighbourhood. Further, the cognitive entity's action element (i.e. walking) only referred to one possible element of the behavioural entity's action element (i.e. objectively measured activity). Therefore, measures of the cognitive and behavioural entities of activity corresponded weakly in the present study, which could have led to a weaker estimate of the relationship between activity-related cognitions and activity than may exist in reality. Measures of participation-related cognitive and behavioural entities were more closely related, with the action element for both being 'socialising'. This closer correspondence between participation-

related cognitive and behavioural entities might explain the increased predictive validity of cognitions on participation compared with cognitions on activity.

The differences between purely psychological models and the integrated models are very small, while psychological models explained much more variance in participation than ICF constructs alone. Those predicting the largest proportion of the variance in participation in participant 1 were models involving cognitions (i.e. SCT constructs alone and the integrated ICF / SCT model). That cognitions explained more variance in participation than emotions explained may simply suggest that cognitions are more closely related to participation than emotions are, but this finding might also lend support to the theory that emotion mediates or moderates cognitions to affect behaviour (Schwarz, 2000). If emotions do interact with cognitions, it is possible a more complex model that places cognitions as direct predictors and emotions as indirect predictors of behaviour might explain more variance in behaviour than cognitions or emotions alone. These findings lend some support to the integration of psychological models and the ICF, with some caveats. In particular, no model predicted activity and activity did not predict participation. Future research might seek to determine whether this is related to the measurement of activity, the correspondence between activity-related cognitions and behaviour measures, or the personal salience of activity engagement in an individual.

## 4.4 Participant 2 Results

### *4.4.1 Descriptive Statistics*

Participant 2 was a 64 year old male with osteoarthritis of the hip. This participant reported that pain, joint stiffness, and fatigue were their most prominent symptoms affecting A. Questions about SEA and OEA were specifically about these symptoms in this participant's survey.

Cronbach's alpha indicated that the pain and joint stiffness components of I were negatively associated in this individual ($\alpha = -0.22$) and were therefore included in analyses as two separate measures of impairment. Measures of SEA ($\alpha = 0.92$), OEA ($\alpha = 0.61$), SEP ($\alpha = 0.84$), anxiety ($\alpha = 0.84$), depression ($\alpha = 0.81$), and mood ($\alpha = 0.73$) had acceptable to high internal reliability. Table 4.8 shows either mean(standard deviation) or median(range) scores, depending on normality, for each and the lag applied each variable during the prewhitening process.

Table 4.8 *Mean (standard deviation)[a] or median (range)[b] score and lag applied to each variable from Participant 2*

| **Variable** | **Mean(sd)[a] / Median(range)[b]** | **Applied Lag** |
|---|---|---|
| Activity (A; vector magnitude) | 338954(767818)[b] | None |
| Impairment (Pain) | 8.00(4.00)[b] | 1 |
| Impairment (JS) | 7.00(4.00)[b] | 1 |
| Participation (P) | 40.70(21.37)[a] | None |
| Activity Self-Efficacy (SEA) | 5.25(7.00)[b] | 1 |
| Activity Outcome Expectancy (OEA) | 7.00(3.33)[b] | 1 |
| Participation Self-Efficacy (SEP) | 5.50(6.00)[b] | None |
| Participation Outcome Expectancy (OEP) | 5.00(7.00)[b] | 1 |
| Mood | 7.00(7.50)[b] | 1 |
| Anxiety | 3.00(8.50)[b] | 1 |
| Depression | 2.00(6.50)[b] | 1 |

*Note: [a] = mean(standard deviation); [b] = median(range); None = no significant autocorrelation present in data series; JS = joint stiffness; higher scores = higher levels of activity, more positive participation scores (scale of 1 – 121), greater impairment (scale of 0 – 10), higher self-efficacy (scale of 0 – 10), more negative outcome expectancies (scale of 0 – 10), more anxiety (scale of 0 – 10), more depression (scale of 0 – 10), and more positive mood (scale of 0 – 10).*

Figure 4.5 presents the daily activity, participation, pain, joint stiffness, SEA, OEA, SEP, OEP, mood, anxiety, and depression scores over the 60 day study period. Day to day variability can be seen in all 11 time plots.

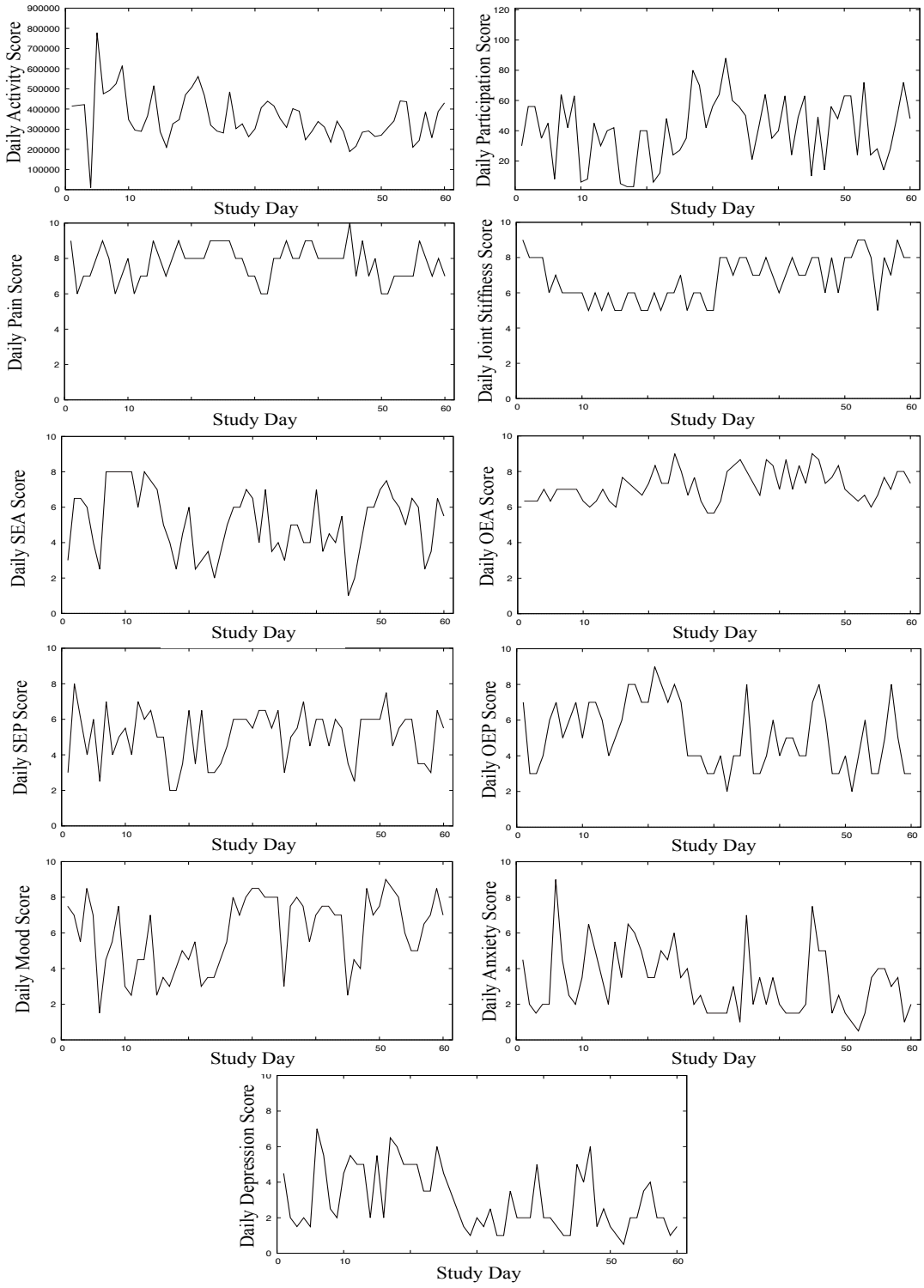


**Figure 4.5** ***Time plots of daily scores for all variables from Participant 2***

*4.4.2 Cross-Correlations – The Integrated ICF / SCT Model and Activity*

Variability could be seen in all data series (Figure 4.5), allowing for time series analysis. The three largest activity-related cross-correlations between each pair of variables as indicated by the integrated ICF / SCT model (Figure 4.2) are shown in Table 4.9.

Six of the eight theoretically possible cross-correlations involving activity or cognitions about walking (i.e. SEA, OEA) exceeded the 95% CI. All six involved psychological constructs: either self-efficacy or outcome expectancy towards activity (walking) (i.e. pain and SEA; pain and OEA; joint stiffness and SEA; joint stiffness and OEA; SEA and A; SEA and OEA). Of these six cross-correlations, only one exceeded the criterion correlation value of 0.4 (i.e. pain and SEA).

The cross-correlation meeting both criteria for significance had a lag of zero, indicating no temporal ordering between the constructs. Thus, participant 2 experienced less impairment at the same time as more self-efficacy towards walking ($r = -0.46$).

Both pain and joint stiffness (i.e. impairment) exceeded the 95% CI at negative lags indicating that changes in impairment followed changes in outcome expectancies toward walking. Joint stiffness (i.e. impairment) also exceeded the 95% confidence interval at a positive lag indicating that changes in impairment preceded changes in self-efficacy towards walking. Self-efficacy towards walking exceeded the 95% level of confidence at a negative lag and at a lag of zero, indicating that changes in self-efficacy both followed changes in activity and were concurrent with changes in outcome expectancies towards walking, respectively. However, these four cross-correlations were below the criterion value of 0.4 and thus should be interpreted with caution.

Table 4.9 *Activity-related cross-correlations of ICF and SCT model components for Participant 2*

| | | **First Variable** | | | |
|---|---|---|---|---|---|
| | | **I (Pain)** | **I (JS)** | **SEA** | **OEA** |
| **Second Variable** | **A** | -0.21 (0.13) lag 2<br>0.19 (0.14) lag -6<br>0.13 (0.14) lag -5 | -0.16 (0.14) lag -7<br>-0.15 (0.13) lag -1<br>-0.15 (0.14) lag -5 | 0.27 (0.13) lag -3*<br>0.19 (0.14) lag -7<br>-0.15 (0.14) lag 7 | -0.24 (0.14) lag 5<br>-0.22 (0.13) lag -1<br>-0.21 (0.13) lag 2 |
| | **SEA** | **-0.46 (0.13) lag 0*§**<br>-0.30 (0.13) lag -2*<br>0.23 (0.14) lag -7 | -0.28 (0.14) lag 7*<br>-0.26 (0.13) lag 0<br>0.18 (0.14) lag 5 | | |
| | **OEA** | -0.29 (0.14) lag -5*<br>0.24 (0.13) lag 0<br>-0.24 (0.14) lag 5 | 0.39 (0.14) lag -7*<br>-0.26 lag (0.14) -6<br>0.24 (0.13) lag 0 | -0.38 (0.13) lag 0*<br>-0.21 (0.13) lag 3<br>0.16 (0.14) lag 5 | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; A = activity; I = impairment; JS = joint stiffness; SEA = self-efficacy for activity; OEA = outcome expectancy for activity*

*4.4.3 Cross-Correlations – The Integrated ICF / Emotion Model and Activity*

Variability could be seen in all data series (Figure 4.5), allowing for time series analysis. The three largest activity-related cross-correlations between each pair of variables as indicated by the integrated ICF / emotion model (Figure 4.3) are shown in Table 4.10.

Six of eleven theoretically possible cross-correlations involving activity or emotions as specified by the integrated ICF / emotion model (Figure 4.3) exceeded the 95% level of confidence. All six involved emotional constructs (i.e. mood, anxiety, depression). Of these six cross-correlations, only one met the 0.4 effect size criterion (i.e. pain/impairment and anxiety).

The cross-correlation meeting both criteria for meaningful effects was found at lag zero, indicating that participant 2 experienced more pain (i.e. impairment) when they also reported higher levels of anxiety ($r = 0.42$).

Pain (i.e. impairment) exceeded the 95% confidence interval at lag zero suggesting that changes in pain occurred concurrently with changes in both mood and depression. Joint stiffness (i.e. impairment) also exceeded the 95% level of confidence, but at negative lags, suggesting that changes in joint stiffness followed changes in mood, anxiety, and depression. However, these cross-correlations fell below the 0.4 criterion for meaningful effect sizes and should, therefore, be interpreted with caution.

Table 4.10 *Activity-related cross-correlations of ICF and emotion model components for Participant 2*

| | | **First Variable** | | | | |
|---|---|---|---|---|---|---|
| | | **I (Pain)** | **I (JS)** | **Mood** | **Anx** | **Dep** |
| **Second Variable** | **A** | -0.21 (0.13) lag 2<br>0.19 (0.14) lag -6<br>0.13 (0.14) lag -5 | -0.16 (0.13) lag -3<br>-0.16 (0.14) lag -7<br>-0.15 (0.13) lag -1 | -0.24 (0.14) lag -4<br>-0.22 (0.13) lag 1<br>-0.18 (0.13) lag -2 | 0.27 (0.14) lag 7<br>0.23 (0.13) lag -2<br>0.22 (0.14) lag -5 | 0.23 (0.14) lag 6<br>0.22 (0.14) lag -5<br>0.21 (0.13) lag 0 |
| | **Mood** | -0.33 (0.13) lag 0*<br>0.31 (0.14) lag -5*<br>0.25 (0.14) lag 2 | 0.27 (0.13) lag -2*<br>0.27 (0.14) lag -5<br>0.25 (0.14) lag -4 | | | |
| | **Anx** | **0.42 (0.13) lag 0*§**<br>-0.26 (0.14) lag 4<br>-0.23 (0.14) lag -5 | -0.27 (0.13) lag -2*<br>-0.25 (0.14) lag -4<br>-0.20 (0.14) lag -5 | | | |
| | **Dep** | 0.39 (0.13) lag 0*<br>-0.18 (0.14) lag -5<br>-0.16 (0.14) lag 4 | -0.33 (0.13) lag -2*<br>-0.24 (0.13) lag 2<br>-0.23 (0.14) lag -4 | | | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; I = impairment; JS = joint stiffness; A = activity; Anx = anxiety; Dep = depression*

*4.4.4 Cross-Correlations – The Integrated ICF / SCT Model and Participation*

Variability could be seen in all data series (Figure 4.5), allowing for time series analysis. The three largest participation-related cross-correlations between each pair of variables as indicated by the integrated ICF / SCT model (Figure 4.2) are shown in Table 4.11.

All eight theoretically possible cross-correlations involving participation or cognitions about participation (i.e. SEP, OEP) exceeded the 95% CI. Of these eight cross-correlations, only two exceeded the criterion correlation value of 0.4 (i.e. SEP and P; SEP and OEP).

Of the two cross-correlations meeting both criteria for significance, both involved cognitions about participation. One was found at lag zero, indicating that participant 2 had more self-efficacy about participation at the same time as positive participation scores ($r = 0.54$); the other was found at lag one, indicating that high self-efficacy about participation today was associated with higher outcome expectancies about participation tomorrow ($r = -0.55$).

Both pain and joint stiffness (i.e. impairment) exceeded the 95% CI at negative lags indicating that changes in impairment followed changes in participation. Outcome expectancies regarding participation also exceeded the 95% level of confidence at a negative lag, indicating that changes in this cognition followed changes in participation. Activity exceeded the 95% confidence interval at positive lags suggesting that changes in this behaviour followed changes in participation and participation-related cognitions (i.e. SEP, OEP). However, these six cross-correlation were below the criterion value of 0.4 and should, therefore, be interpreted with caution.

Table 4.11 *Participation-related cross-correlations of ICF and SCT model components for Participant 2*

| | | First Variable | | | | |
|---|---|---|---|---|---|---|
| | | **I (Pain)** | **I (JS)** | **A** | **SEP** | **OEP** |
| **Second Variable** | **P** | -0.31(0.13)lag -1*<br>0.28 (0.14) lag 7<br>0.25 (0.14) lag 5 | 0.30 (0.14) lag -6*<br>-0.21 (0.13) lag 3<br>0.20 (0.14) lag 4 | -0.34 (0.13) lag 3*<br>-0.18 (0.13) lag 4<br>0.17 (0.14) lag 6 | **0.54 (0.13) lag 0*§**<br>0.24 (0.13) lag -1<br>0.17 (0.14) lag -7 | -0.32 (0.13) lag -2*<br>-0.32 (0.13) lag -1*<br>-0.21 (0.13) lag -3 |
| | **SEP** | | | -0.28 (0.13) lag 3*<br>0.24 (0.14) lag 7<br>-0.20 (0.13) lag -2 | | |
| | **OEP** | | | 0.31 (0.14) lag 5*<br>0.26 (0.14) lag 4<br>0.25 (0.14) lag -7 | **-0.55 (0.13) lag 1*§**<br>-0.33 (0.13) lag 2*<br>0.11 (0.13) lag 0 | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; I = impairment; JS = joint stiffness; A = activity; P = participation; SEP = self-efficacy for participation; OEP = outcome expectancy for participation*

*4.4.5 Cross-Correlations – The Integrated ICF / Emotion Model and Participation*

Variability could be seen in all data series (Figure 4.5), allowing for time series analysis. The three largest participation-related cross-correlations between each pair of variables as indicated by the integrated ICF / emotion model (Figure 4.3) are shown in Table 4.12.

Six of the nine theoretically possible cross-correlations between participation, impairment, and emotions exceeded the 95% confidence interval. Of the six cross-correlations that exceeded the 95% level of confidence, three also met the 0.4 effect size criterion, all of which involved emotional constructs (i.e. mood, anxiety, depression).

All three cross-correlations meeting both criteria for meaningful effects were found at negative lags of one, indicating that participant 2 experienced more positive mood ($r$ = 0.55), less anxiety ($r$ = -0.50), and less depression ($r$ = -0.43) one day following more positive participation scores.

Pain (i.e. impairment) and joint stiffness (i.e. impairment) exceeded the 95% confidence interval and were both found at negative lags suggesting that changes in pain and joint stiffness followed changes in participation. Activity also exceeded the 95% confidence interval at a positive lag, suggesting that changes in activity preceded changes in participation for this individual. However, these cross-correlations did not meet the criterion for meaningful effects and should, therefore, be interpreted with caution.

Table 4.12 *Participation-related cross-correlations of ICF and emotion model components for Participant 2.*

| | | **First Variable** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **I (Pain)** | **I (JS)** | **A** | **Mood** | **Anx** | **Dep** |
| **Second Variable** | **P** | -0.31(0.13)lag -1*<br>0.28 (0.14) lag 7<br>0.25 (0.14) lag 5 | 0.30 (0.14) lag -6*<br>-0.21 (0.13) lag 3<br>0.20 (0.14) lag 4 | -0.34 (0.13) lag 3*<br>-0.18 (0.13) lag 4<br>0.17 (0.14) lag 6 | **0.55 (0.13) lag -1*§**<br>0.35 (0.13) lag -3*<br>0.18 (0.13) lag -2 | **-0.50 (0.13) lag -1*§**<br>-0.31 (0.13) lag -3*<br>-0.27 (0.13) lag -2 | **-0.43 (0.13) lag -1*§**<br>-0.37 (0.13) lag -3*<br>-0.25 (0.13) lag -2 |
| | **Mood** | | | -0.24 (0.14) lag 4<br>-0.22 (0.13) lag -1<br>-0.18 (0.13) lag 2 | | | |
| | **Anx** | | | 0.27 (0.14) lag -7<br>0.23 (0.13) lag 2<br>0.22 (0.14) lag 5 | | | |
| | **Dep** | | | 0.23 (0.14) lag -6<br>0.22 (0.14) lag 5<br>0.21 (0.13) lag 0 | | | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; I = impairment; JS = joint stiffness; A = activity; P = participation; Anx = anxiety; Dep = depression*

*4.4.6 Regression Analyses – Activity*

Table 4.13 displays the results of the regression analyses assessing the utility of the ICF, SCT and emotion model for the prediction of activity. The regression errors for all models of activity behaviour, except for the integrated model of ICF (pain) and emotions, were found to be non-normally distributed. Bootstrapping methods were applied to each of these models and adjusted standard errors of B and *p*-values are reported in Table 4.13.

Neither the ICF nor SCT models predicted activity. That is impairment (whether operationalised as pain or as joint stiffness) did not predict activity; self-efficacy and outcome expectancy towards activity did not predict activity. However, the emotion model did predict activity. Specifically, more positive mood, less anxiety, and more depression predicted more activity, explaining 9% of the variance in this behaviour.

Table 4.13 *Forced entry regression analyses testing the predictive effects of the ICF only, SCT only, and emotions on activity in Participant 2.*

| Variable | B(SE B) | *β*(*t*-value) | adj. $R^2$(F) |
|---|---|---|---|
| ***ICF (pain) predicting A*** | | | |
| I (Pain) | -14409.58(16074.71†) | -0.11(-0.87)*ns*† | -0.004(0.76)*ns* |
| ***ICF (joint stiffness) predicting A*** | | | |
| I (JS) | 12986.74(16828.90†) | 0.12(0.88)*ns*† | -0.004(0.78)*ns* |
| ***SCT predicting A*** | | | |
| SEA | 5105.36(10825.02†) | 0.07(0.49)*ns*† | |
| OEA | 13115.28(20823.49†) | 0.09(0.59)*ns*† | -0.03(0.22)*ns* |
| ***Emotion model predicting A*** | | | |
| Mood | 31073.43(23178.00†) | 0.46(1.94)*ns*† | |
| Anxiety | -769.37(21055.67†) | -0.12(-0.04)*ns*† | |
| Depression | 41784.59(15698.38†) | 0.56(2.62)*† | 0.09(2.94)* |

*Note: † = bootstrapped values; SEB = standard error of B; A = activity; I = impairment; SEA = self-efficacy for activity; OEA = outcome expectancies for activity; JS = joint stiffness; * p < 0.05; ** p < 0.01; *** p < 0.001*

*4.4.7 Regression Analyses – Participation*

Table 4.14 displays the results of the regression analyses assessing the utility of the ICF, SCT and emotion model for the prediction of participation.

Neither the ICF nor emotion model were predictive of participation. That is impairment (whether operationalised as pain or as joint stiffness) did not predict participation; mood, anxiety, and depression did not predict participation. The SCT model alone did predict participation. Namely, high self-efficacy and more positive outcome expectancies towards participation predicted more participation.

Table 4.14 *Forced entry regression analyses testing the predictive effects of the ICF only, SCT only, and emotions only on participation in Participant 2*

| **Variable** | **B(SE B)** | ***β*(*t*-value)** | **adj. $R^2$(F)** |
|---|---|---|---|
| ***ICF (pain) predicting P*** | | | |
| I (Pain) | 0.09(3.04) | 0.004(0.03)*ns* | |
| A | 1.95(0.00) | 0.11(0.81)*ns* | -0.02(0.33)*ns* |
| ***ICF (joint stiffness) predicting P*** | | | |
| I (JS) | 1.37(2.69) | 0.07(0.51)*ns* | |
| A | 1.80(0.00) | 0.10(0.75)*ns* | -0.02(0.46)*ns* |
| ***SCT predicting P*** | | | |
| SEP | 8.22(1.63) | 0.56(5.04)*** | |
| OEP | -2.68(1.48) | -0.20(-1.80)*ns* | 0.30(13.48)*** |
| ***Emotion model predicting P*** | | | |
| Mood | 2.55(3.09) | 0.21(0.83)*ns* | |
| Anxiety | 1.32(3.38) | 0.11(0.39)*ns* | |
| Depression | 0.45(3.08) | 0.03(0.15)*ns* | -0.04(0.26)*ns* |

*Note: SEB = standard error of B; P = participation; I = impairment; SEP = self-efficacy for participation; OEP = outcome expectancies for participation; * p < 0.05; ** p < 0.01; *** p < 0.001*

*4.4.8 Participant 2 Discussion*

All data series for participant 2 were found to be sufficiently variable for within-person analyses of the effects of changes in one variable on changes in another. The impairment measures of pain and joint stiffness were analysed separately because this individual's experience of these two symptoms were negatively associated and therefore, incompatible as two items of the same measure. Whether impairment was operationalised as pain or joint stiffness, neither the ICF construct of impairment, nor SCT constructs (i.e. self-efficacy and outcome expectancies) were significantly predictive of activity. However the emotion model did predict activity. SCT constructs were predictive of participation. No other model tested was predictive of participation in participant 2.

Meaningful changes in pain (i.e. impairment) were concurrent with changes in self-efficacy towards activity and anxiety, while changes in self-efficacy towards participation were concurrent with changes in participation scores. Feeling efficacious towards participation one day led to positive outcome expectancies about participation the next. This temporal ordering supports the integrated ICF / SCT framework in that, self-efficacy should theoretically have direct effects on both outcome expectancies and participation, with additional indirect affects on participation via outcome expectancies. Positive changes in mood, decreasing anxiety, and reduced depression all followed increases in participation, supporting the idea that behaviour impacts on emotions.

For this individual, emotions were clearly most closely associated with activity while cognitions were most closely associated with participation. Studies of chronically ill children have found that positive emotions (Gil, Carson, Porter, Ready, Valrie, Redding-Lallinger, and Daeschner, 2003) and increased variability in negative mood states (Schanberg, Gil, Anthony, Yow, and Rochon, 2005) predict activity and activity limitations, suggesting that, along with emotion, emotion regulation (i.e. how a person controls their emotions, their experience of emotions, and their reactions to emotions (Cole, Michel, and Teti, 1994)) may play an important role in predicting

activity. Studies in adults with arthritis suggest that when participants engaged in emotion regulation, they experienced a decrease in pain the following day (Connelly, Keefe, Affleck, Lumley, Anderson, and Waters, 2007). It may be that intervening upon emotion regulation strategies in adults with arthritis positively impacts activity. Future research might aim to test the reliability of the present findings and evaluate whether the direction of emotions (e.g. negative or positive) or the day-to-day variability of emotions are more important factors in the prediction of behaviour.

## 4.5 Participant 3 Results

### *4.5.1 Descriptive Statistics*

Participant 3 was a 55 year old female with rheumatoid arthritis affecting both hips and knees. This participant reported that pain, joint stiffness, and fatigue were their most prominent symptoms affecting A. Questions about SEA and OEA asked specifically about these symptoms in this participant's survey.

Cronbach's alpha indicated, scales of I (α = 0.66), SEA (α = 0.79), OEA (α = 0.63), SEP (α = 0.75), anxiety (α = 0.64), depression (α = 0.76), and mood (α = 67) had acceptable to high internal reliability. As all data series were non-normally distributed, Table 4.15 shows median(range) scores and the lag applied to each variable during the prewhitening process.

Table 4.15 *Median(range) score and lag applied to each variable from Participant 3*

| **Variable** | **Median(range)** | **Applied Lag** |
|---|---|---|
| Activity (A; vector magnitude) | 660738(774633) | None |
| Impairment (I) | 4.50(3.00) | None |
| Participation (P) | 35.50(38.00) | 1 |
| Activity Self-Efficacy (SEA) | 4.50(3.00) | 1, 5 |
| Activity Outcome Expectancy (OEA) | 4.33(2.00) | None |
| Participation Self-Efficacy (SEP) | 3.50(3.50) | 1 |
| Participation Outcome Expectancy (OEP) | 6.00(5.00) | 1 |
| Mood | 5.50(2.50) | 1 |
| Anxiety | 5.00(3.00) | 1 |
| Depression | 4.00(4.00) | 1 |

*Note: None = no significant autocorrelation present in data series; higher scores = higher levels of activity, more positive participation scores (scale of 1 – 121), greater impairment (scale of 0 – 10), higher self-efficacy (scale of 0 – 10), more negative outcome expectancies (scale of 0 – 10), more anxiety (scale of 0 – 10), more depression (scale of 0 – 10), and more positive mood (scale of 0 – 10).*

Figure 4.6 presents the daily activity, participation, impairment, SEA, OEA, SEP, OEP, mood, anxiety, and depression scores over the 60 day study period. Day to day variability was evident in each of the 10 time plots.

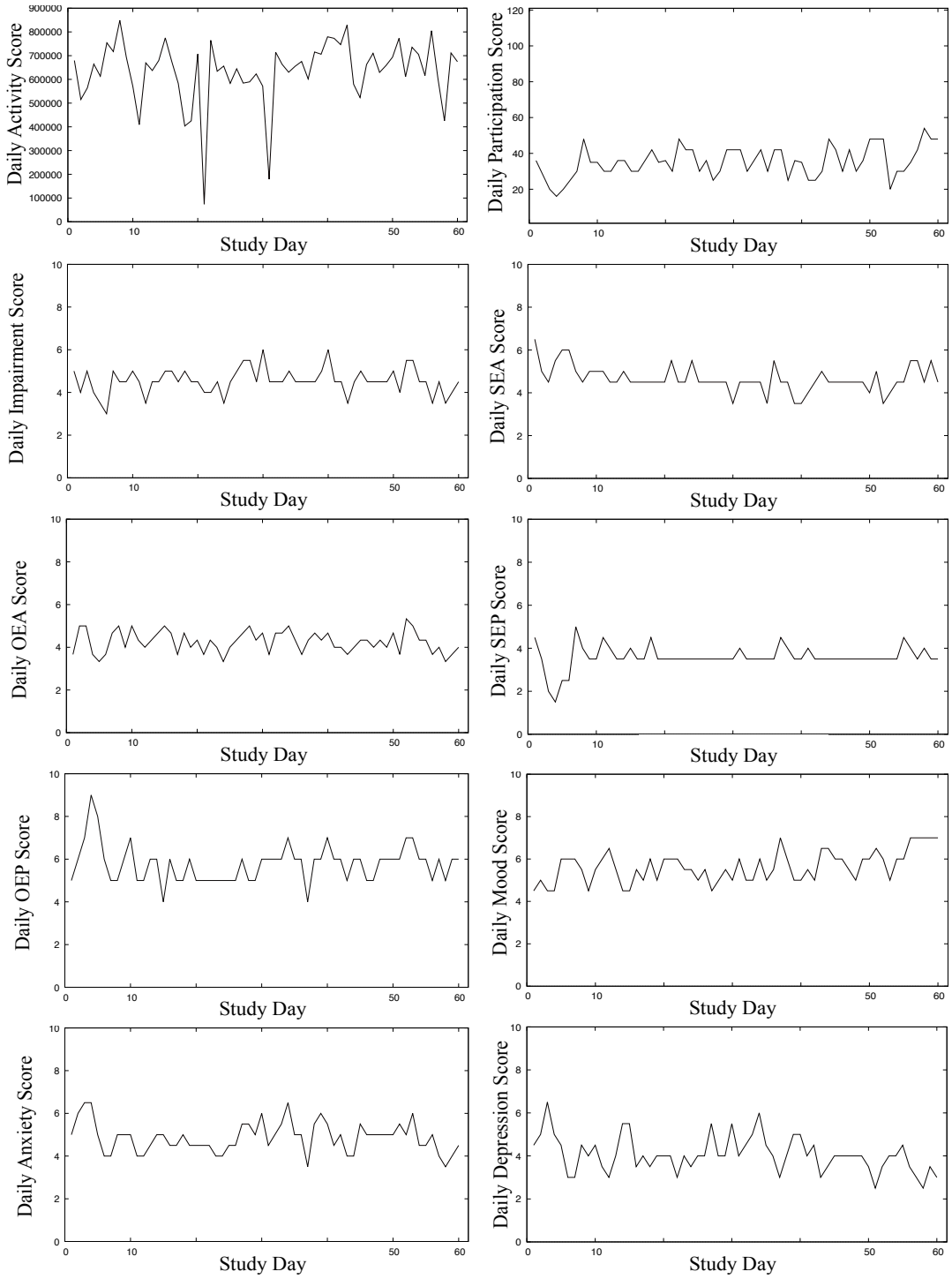


**Figure 4.6** ***Time plots of daily scores for all variables from Participant 3***

*4.5.2 Cross-Correlations – The Integrated ICF / SCT Model and Activity*

Variability could be seen in all data series (Figure 4.6), allowing for time series analysis. The three largest activity-related cross-correlations between each pair of variables as indicated by the integrated ICF / SCT model (Figure 4.2) are shown in Table 4.16.

Of six theoretically possible cross-correlations between activity, impairment, and cognitions about walking (i.e. SEA, OEA) three cross-correlations exceeded the 95% confidence interval, but none at the 0.4 effect size criterion level.

Two were found at positive lags, indicating that changes in outcome expectancies about activity preceded changes in activity, while changes in self-efficacy for activity preceded changes in outcome expectancies regarding activity. As neither of these cross-correlations met the 0.4 effect size criterion, these findings should be interpreted with caution.

Table 4.16 *Activity-related cross-correlations of interacting ICF and SCT model components for Participant 3*

| | | **First Variable** | | |
|---|---|---|---|---|
| | | **I** | **SEA** | **OEA** |
| **Second Variable** | **A** | 0.24 (0.13) lag 7<br>-0.20 (0.13) lag 3<br>0.16 (0.13) lag -1 | -0.26 (0.14) lag 4<br>-0.16 (0.14) lag 1<br>-0.13 (0.14) lag -6 | -0.30 (0.13) lag 3*<br>-0.15 (0.14) lag -7<br>0.12 (0.13) lag 0 |
| | **SEA** | -0.36 (0.14) lag 6*<br>0.30 (0.14) lag 2*<br>0.25 (0.14) lag 0 | | |
| | **OEA** | -0.26 (0.13) lag 0<br>-0.23 (0.13) lag -1<br>-0.18 (0.14) lag -6 | -0.31 (0.14) lag -6*<br>0.31 (0.14) lag -2*<br>0.24 (0.14) lag 3 | |

*Note: * denotes cross-correlations that exceeded 95% confidence intervals; A = activity; I = impairment; SEA = self-efficacy for activity; OEA = outcome expectancy for activity*

*4.5.3 Cross-Correlations – The Integrated ICF / Emotion Model and Activity*

Variability could be seen in all data series (Figure 4.6), allowing for time series analysis. The three largest activity-related cross-correlations between each pair of variables as indicated by the integrated ICF / emotion model (Figure 4.3) are shown in Table 4.17.

Three of seven theoretically possible cross-correlations involving activity, impairment, and emotional constructs exceeded the 95% confidence interval. All three involved emotional constructs (i.e. mood, anxiety, depression). However, only one met the 0.4 effect size criterion (i.e. impairment and depression).

The cross-correlation meeting both criteria for meaningful effects was found at lag one, indicating that participant 3 experienced more impairment one day prior to higher levels of depression ($r = 0.42$).

Both mood and anxiety were also found to exceed the 95% level of confidence at lag one, suggesting that changes in impairment preceded changes in mood and anxiety in this individual. However, neither of these findings met the 0.4 effect size criterion and so, should be interpreted with caution.

Table 4.17 *Activity-related cross-correlations of interacting ICF and emotion model components for Participant 3*

| | | **First Variable** | | | |
|---|---|---|---|---|---|
| | | **I** | **Mood** | **Anx** | **Dep** |
| **Second Variable** | **A** | 0.24 (0.13) lag 7<br>-0.20 (0.13) lag 3<br>0.16 (0.13) lag -1 | 0.23 (0.13) lag 1<br>0.23 (0.13) lag 3<br>0.21 (0.14) lag -5 | 0.19 (0.13) lag 3<br>0.16 (0.14) lag 4<br>0.15 (0.14) lag -7 | 0.22 (0.14) lag 4<br>-0.16 (0.14) lag -4<br>-0.15 (0.14) lag -5 |
| | **Mood** | -0.33 (0.13) lag 1*<br>0.26 (0.14) lag 5<br>-0.20 (0.13) lag 2 | | | |
| | **Anx** | 0.37 (0.13) lag 1*<br>-0.29 (0.13) lag -2*<br>0.24 (0.13) lag 2 | | | |
| | **Dep** | **0.42 (0.13) lag 1*§**<br>-0.21 (0.13) lag -1<br>0.17 (0.14) lag -4 | | | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; I = impairment; A = activity; Anx = anxiety; Dep = depression*

*4.5.4 Cross-Correlations – The Integrated ICF / SCT Model and Participation*

Variability could be seen in all data series (Figure 4.6), allowing for time series analysis. The three largest participation-related cross-correlations between each pair of variables as indicated by the integrated ICF / SCT model (Figure 4.2) are shown in Table 4.18.

Only two of seven theoretically possible cross-correlations relating to participation, ICF constructs (i.e. impairment, activity), and cognitions about participation (i.e. SEP, OEP) exceeded the 95% level of confidence, both involving psychological constructs (i.e. A and SEP; SEP and OEP). However, only one met both criteria for meaningful effects (i.e. SEP and OEP).

This cross-correlation was found at a lag of zero, indicating that participant 3 had more self-efficacy for participation when they also had more positive outcome expectancies about participation ($r$ = -0.58).

Results also suggested that changes in activity followed changes in self-efficacy towards activity in this individual, but this cross-correlation fell below the 0.4 meaningful effect size criterion and so must be interpreted with caution.

Table 4.18 *Participation-related cross-correlations of interacting ICF and SCT model components for Participant 3*

| | | First Variable | | | |
|---|---|---|---|---|---|
| | | **I** | **A** | **SEP** | **OEP** |
| **Second Variable** | **P** | 0.25 (0.14) lag -7<br>0.21 (0.13) lag 0<br>-0.17 (0.13) lag 3 | -0.18 (0.14) lag 4<br>0.17 (0.14) lag 5<br>-0.16 (0.13) lag 0 | -0.21 (0.14) lag 4<br>0.21 (0.13) lag 0<br>-0.20 (0.14) lag 5 | -0.23 (0.13) lag 0<br>-0.23 (0.13) lag 1<br>0.21 (0.14) lag -5 |
| | **SEP** | | -0.32 (0.13) lag -2*<br>-0.14 (0.13) lag 1<br>0.14 (0.14) lag 4 | | |
| | **OEP** | | -0.25 (0.13) lag -2<br>0.21 (0.13) lag -1<br>0.13 (0.14) lag 7 | **-0.58 (0.13) lag 0*§**<br>0.29 (0.13) lag 3*<br>0.22 (0.13) lag -3 | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; I = impairment; A = activity; P = participation; SEP = self-efficacy for participation; OEP = outcome expectancy for participation*

*4.5.5 Cross-Correlations – The Integrated ICF / Emotion Model and Participation*

Variability could be seen in all data series (Figure 4.6), allowing for time series analysis. The three largest participation-related cross-correlations between each pair of variables as indicated by the integrated ICF / emotion model (Figure 4.3) are shown in Table 4.19.

Two of eight theoretically possible cross-correlations involving participation, ICF constructs (i.e. impairment, activity), and emotional constructs (i.e. mood, anxiety, depression) were found to exceed the 95% confidence interval (i.e. mood and participation; depression and participation). However, only one met the 0.4 effect size criterion (i.e. mood and participation).

The cross-correlation meeting both effect size criteria was found at a lag of zero, indicating that participant 3 reported more positive mood concurrently with more positive participation scores ($r = 0.40$).

Depression exceeded the 95% level of confidence at lag one, suggesting that changes in depression preceded changes in participation. However, this finding fell below the 0.4 meaningful effects criterion and should, therefore, be interpreted with caution.

Table 4.19 *Participation-related cross-correlations of interacting ICF and emotion model components for Participant 3*

| | | **First Variable** | | | | |
|---|---|---|---|---|---|---|
| | | **I** | **A** | **Mood** | **Anx** | **Dep** |
| **Second Variable** | **P** | 0.25 (0.14) lag -7<br>0.21 (0.13) lag 0<br>-0.17 (0.13) lag 3 | -0.18 (0.14) lag 4<br>0.17 (0.14) lag 5<br>-0.16 (0.13) lag 0 | **0.40 (0.13) lag 0*§**<br>-0.23 (0.14) lag 4<br>0.23 (0.13) lag 2 | -0.24 (0.14) lag -7<br>-0.23 (0.13) lag 0<br>0.18 (0.14) lag 5 | -0.32 (0.13) lag 1*<br>-0.22 (0.13) lag 0<br>0.18 (0.14) lag 5 |
| | **Mood** | | 0.23 (0.13) lag -1<br>0.23 (0.13) lag -3<br>0.21 (0.14) lag 5 | | | |
| | **Anx** | | 0.19 (0.13) lag -3<br>0.16 (0.14) lag -4<br>0.15 (0.14) lag 7 | | | |
| | **Dep** | | 0.22 (0.14) lag -4<br>-0.16 (0.14) lag 4<br>-0.15 (0.14) lag 5 | | | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; I = impairment; A = activity; P = participation; Anx = anxiety; Dep = depression*

*4.5.6 Regression Analyses – Activity*

Table 4.20 displays the results of the regression analyses assessing the utility of the ICF, SCT, and emotion models for the prediction of activity. Applying lags of one and five data points to the SEA series meant that regression analyses including SEA excluded the first six data points of each series in the model. To allow for the results of regressing activity onto SCT constructs to be directly compared with the results of regressing activity onto impairment, the first six data points were removed prior to analysis of impairment alone. The regression errors of all five models of activity behaviour were found to be non-normally distributed. Bootstrapping methods were applied to each of these models and adjusted standard errors of B and *p*-values are reported in Table 4.20.

Neither the ICF, SCT, nor emotion model predicted activity. Namely, impairment did not predict activity; self-efficacy and outcome expectancy towards activity did not predict activity; mood, anxiety, and depression did not predict activity.

Table 4.20 *Forced entry regression analyses testing the predictive effects of the ICF only, SCT only, and emotions on activity in Participant 3.*

| **Variable** | **B(SE B)** | ***β*(*t*-value)** | **adj. $R^2$(F)** |
|---|---|---|---|
| ***ICF predicting A*** | | | |
| I | -382.61(347854.31$^{\dagger}$) | -0.002(-0.01)*ns*$^{\dagger}$ | -0.02(0.00)*ns* |
| ***SCT predicting A*** | | | |
| SEA | -15187.54(35684.16$^{\dagger}$) | -0.06(-0.41)*ns*$^{\dagger}$ | |
| OEA | 65314.89(51855.99$^{\dagger}$) | 0.22(1.56)*ns*$^{\dagger}$ | -0.008(1.22)*ns* |
| ***Emotion model predicting A*** | | | |
| Mood | 7593.15(29947.72$^{\dagger}$) | 0.04(0.21)*ns*$^{\dagger}$ | |
| Anxiety | -29919.55(32676.38$^{\dagger}$) | -0.14(-0.79)*ns*$^{\dagger}$ | |
| Depression | 16680.76(27009.28$^{\dagger}$) | 0.09(0.47)*ns*$^{\dagger}$ | -0.04(0.25)*ns* |

*Note: $^{\dagger}$ = bootstrapped values; SEB = standard error of B; A = activity; I = impairment; SEA = self-efficacy for activity; OEA = outcome expectancies for activity*

*4.5.7 Regression Analyses – Participation*

Table 4.21 displays the results of the regression analyses assessing the utility of the ICF, SCT, and emotion models for the prediction of participation. The regression errors were found to be non-normally distributed for the model of ICF constructs alone. Bootstrapping methods were applied to this model and adjusted standard errors of B and *p*-values are reported in Table 4.21.

Neither the ICF nor SCT alone predicted participation. Specifically, impairment did not predict participation; self-efficacy and outcome expectancy towards participation did not predict participation. The emotion model was predictive of participation; more positive mood, less anxiety, and more depression predicted more participation. However, only mood explained a significant amount of variance and independently predicted participation.

Table 4.21 *Forced entry regression analyses testing the predictive effects of the ICF only, SCT only, and emotions only on participation in Participant 3*

| **Variable** | **B(SE B)** | ***β*(*t*-value)** | **adj. $R^2$(F)** |
|---|---|---|---|
| ***ICF predicting P*** | | | |
| I | 2.66(7.92†) | 0.21(1.61)*ns*† | |
| A | -8.79(1.59†) | -0.16(-1.21)*ns*† | 0.04(2.10)*ns* |
| ***SCT predicting P*** | | | |
| SEP | 1.70(2.43) | 0.11(0.70)*ns* | |
| OEP | -1.58(1.50) | -0.17(-1.05)*ns* | 0.03(1.84)*ns* |
| ***Emotion model predicting P*** | | | |
| Mood | 4.98(1.91) | 0.41(2.61)* | |
| Anxiety | -1.12(1.96) | -0.09(-0.57)*ns* | |
| Depression | 0.89(1.83) | 0.09(0.49)*ns* | 0.12(3.60)* |

*Note: † = bootstrapped values; SEB = standard error of B; P = participation; I = impairment; SEP = self-efficacy for participation; OEP = outcome expectancies for participation; * p < 0.05; ** p < 0.01; *** p < 0.001*

### *4.5.8 Participant 3 Discussion*

All data series for participant 3 were judged to show sufficient variability for within-person analyses of the effects of changes in one variable on changes in another. None of the models tested in the present study were predictive of activity in participant 3. However, emotions alone were predictive of participation.

Meaningful changes in self-efficacy towards participation were found to take place concurrently with changes in outcome expectancies about participation in this individual; increases in self-efficacy were experienced on the same day as more positive outcome expectancies. The close temporal nature of this association and the direction of this relationship is supportive of the direct pathway between these constructs that is posited by SCT. Also, changes in mood were concurrent with changes in participation; mood was more positive when participation scores were higher. Meaningful changes in impairment were found to precede changes in depression by one day; depression increased one day following increased impairment. Both of those associations support the framework of an integrated ICF / emotion model, where there are direct relationships between impairment (i.e. physiological state) and emotion and between emotion and participation (i.e. behaviour).

Emotions alone predicted participation in participant 3, with mood most strongly associated with participation. This is in support of previous findings that mood was more predictive of participation restriction than comorbid disease or impairment measures (Fairhall, Sherrington, Kurrle, Lord, and Cameron, 2011) and that, as the probability of depression increased, so did the likelihood of participation restriction in older people (Wilkie, Peat, Thomas, and Croft, 2007). Therefore, findings support the use of an emotion model to predict participation in this individual.

## 4.6 Participant 4 Results

### *4.6.1 Descriptive Statistics*

Participant 4 was a 64 year old female with both rheumatoid and osteoarthritis affecting her wrists, knees, and feet. This participant reported that pain, joint stiffness, and fatigue were their most prominent symptoms affecting A. Questions about SEA and OEA asked specifically about these symptoms in this participant's survey.

Cronbach's alpha indicated that scales of I ($\alpha = 0.70$), SEA ($\alpha = 0.89$), OEA ($\alpha = 0.83$), SEP ($\alpha = 0.76$), anxiety ($\alpha = 0.69$), depression ($\alpha = 0.64$), and mood ($\alpha = 0.63$) had acceptable to high internal reliability in this participant. Table 4.22 shows either mean(standard deviation) or median(range) scores, depending on normality, for each variable in participant 4 and the lag applied each variable during the prewhitening process.

Table 4.22 *Mean(standard deviation)[a] or median(range)[b] score and lag applied to each variable from Participant 4*

| **Variable** | **Mean(sd)[a] / Median(range)[b]** | **Applied Lag** |
|---|---|---|
| Activity (A; vector magnitude) | 571414(706094)[b] | 7 |
| Impairment (I) | 3.00(5.00)[b] | 5 |
| Participation (P) | 35.10(12.03)[a] | None |
| Activity Self-Efficacy (SEA) | 5.00(5.50)[b] | None |
| Activity Outcome Expectancy (OEA) | 3.79(1.07)[a] | 1 |
| Participation Self-Efficacy (SEP) | 4.50(4.00)[b] | None |
| Participation Outcome Expectancy (OEP) | 4.00(7.00)[b] | 5 |
| Mood | 6.75(5.00)[b] | 1, 4 |
| Anxiety | 2.50(5.00)[b] | 1 |
| Depression | 1.00(4.00)[b] | 1 |

*Note: [a] = mean(standard deviation); [b] = median(range); None = no significant autocorrelation present in data series; higher scores = higher levels of activity, more positive participation scores (scale of 1 – 121), greater impairment (scale of 0 – 10), higher self-efficacy (scale of 0 – 10), more negative outcome expectancies (scale of 0 – 10), more anxiety (scale of 0 – 10), more depression (scale of 0 – 10), and more positive mood (scale of 0 – 10).*

Figure 4.7 presents the daily activity, participation, impairment, SEA, OEA, SEP, OEP, mood, anxiety, and depression scores over the 60 day study period. Day to day variability was evident in al 10 time plots.

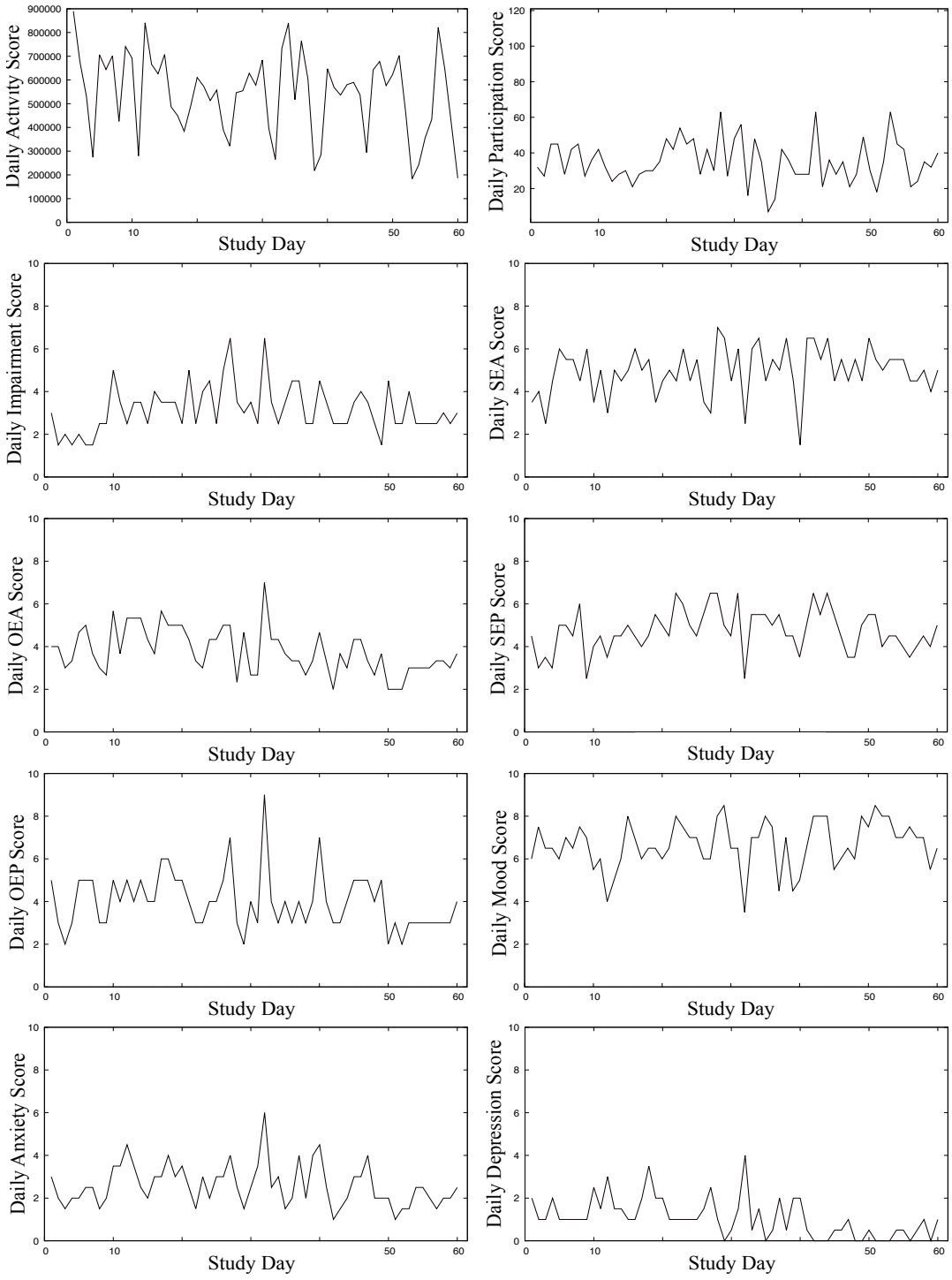


**Figure 4.7** ***Time plots of daily scores for all variables from Participant 4***

*4.6.2 Cross-Correlations – The Integrated ICF / SCT Model and Activity*

Variability could be seen in all data series (Figure 4.7), allowing for time series analysis. The three largest activity-related cross-correlations between each pair of variables as indicated by the integrated ICF / SCT model (Figure 4.2) are shown in Table 4.23.

Five of the six theoretically possible activity-related cross-correlations involving activity, impairment, and cognitions about walking (i.e. SEA, OEA) exceeded the 95% confidence interval. All of these five cross-correlations involved psychological constructs. Only one, however, met the 0.4 criterion for meaningful effects (i.e SEA and OEA).

This cross-correlation was found at a lag of one, indicating that participant 4 had more self-efficacy towards activity one day prior to having more positive outcome expectancies about activity ($r$ = -0.50).

Four further cross-correlations exceeding the 95% confidence level were found at negative lags, suggesting that changes in self-efficacy and outcome expectancies about activity followed changes in activity, while changes in impairment followed changes in self-efficacy and outcome expectancies regarding activity. However, these associations did not meet the 0.4 effect size criterion and should, therefore, be interpreted with caution.

Table 4.23 *Activity-related cross-correlations of interacting ICF and SCT model components for Participant 4*

| | | First Variable | | |
|---|---|---|---|---|
| | | **I** | **SEA** | **OEA** |
| **Second Variable** | **A** | -0.21 (0.15) lag -6<br>-0.18 (0.14) lag -3<br>-0.17 (0.14) lag 5 | -0.34 (0.14) lag -5*<br>0.30 (0.14) lag -1*<br>-0.12 (0.14) lag -2 | 0.30 (0.15) lag -6*<br>-0.24 (0.14) lag -2<br>0.12 (0.15) lag -7 |
| | **SEA** | -0.32 (0.14) lag -5*<br>-0.22 (0.14) lag -2<br>0.21 (0.14) lag 5 | | |
| | **OEA** | 0.36 (0.14) lag -4*<br>-0.26 (0.14) lag 6<br>-0.23 (0.14) -6 | **-0.50 (0.13) lag 1*§**<br>0.20 (0.13) lag -3<br>0.18 (0.14) lag 5 | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; I = impairment; A = activity; SEA = self-efficacy for activity; OEA = outcome expectancy for activity*

*4.6.3 Cross-Correlations – The Integrated ICF / Emotion Model and Activity*

Variability could be seen in all data series (Figure 4.7), allowing for time series analysis. The three largest activity-related cross-correlations between each pair of variables as indicated by the integrated ICF / emotion model (Figure 4.3) are shown in Table 4.24.

Three of seven theoretically possible cross-correlations between activity, impairment, and emotional constructs (i.e. mood, anxiety, depression) exceeded the 95% confidence interval. All three involved emotional constructs. However, only one met the 0.4 effect size criterion (i.e. I and anxiety).

The cross-correlation meeting both criteria for meaningful effects was found at a negative lag of four, indicating that participant 4 experienced greater impairment four days following higher levels of anxiety ($r = 0.43$).

Impairment also exceeded the 95% level of confidence at a lag of zero and at a negative lag, suggesting that changes in impairment were concurrent with changes in mood, but followed changes in depression for this individual. However, these cross-correlations failed to meet the 0.4 criterion for meaningful effects and so, should be interpreted with caution.

Table 4.24 *Activity-related cross-correlations of interacting ICF and emotion model components for Participant 4*

| | | **First Variable** | | | |
|---|---|---|---|---|---|
| | | **I** | **Mood** | **Anx** | **Dep** |
| **Second Variable** | **A** | -0.21 (0.15) lag -6<br>-0.18 (0.14) lag -3<br>-0.17 (0.14) lag 5 | -0.25 (0.14) lag 4<br>0.22 (0.15) lag 7<br>0.15 (0.14) lag 0 | 0.27 (0.14) lag -5<br>-0.25 (0.14) lag -2<br>-0.24 (0.14) lag 4 | -0.18 (0.14) lag 4<br>0.18 (0.14) lag 0<br>0.18 (0.14) lag -5 |
| | **Mood** | -0.39 (0.14) lag 0*<br>0.18 (0.14) lag -2<br>0.16 (0.14) lag 6 | | | |
| | **Anx** | **0.43 (0.14) lag -4*§**<br>-0.29 (0.14) lag -6<br>0.13 (0.14) lag -2 | | | |
| | **Dep** | 0.37 (0.14) lag -4*<br>-0.20 (0.14) lag 2<br>-0.19 (0.14) lag -6 | | | |

*Note: Figures in **BOLD** indicate cross-correlations that exceeded 95% confidence intervals and met or exceeded the effect size criterion of 0.4; * denotes cross-correlations that exceeded 95% confidence intervals; § denotes cross-correlations that met or exceeded the effect size criterion of 0.4; I = impairment; A = activity; Anx = anxiety; Dep = depression*

*4.6.4 Cross-Correlations – The Integrated ICF / SCT Model and Participation*

Variability could be seen in all data series (Figure 4.7), allowing for time series analysis. The three largest participation-related cross-correlations between each pair of variables as indicated by the integrated ICF / SCT model (Figure 4.2) are shown in Table 4.25.

Only two of seven theoretically possible cross-correlations involving participation, ICF constructs (i.e. impairment, activity), and cognitions about participation (i.e. SEP, OEP) exceeded the 95% level of confidence, but none met the 0.4 criterion for meaningful effect sizes.

One cross-correlation exceeding the 95% confidence interval was found at lag zero, suggesting that participant 4 experienced changes in self-efficacy for participation concurrently with changes in participation. The other was found at lag five, indicating that changes in self-efficacy for participation occurred five day prior to changes in outcome expectancies about participation in this individual. However, as these associations did not meet the 0.4 effect size criterion, they should be interpreted with caution.

Table 4.25 *Participation-related cross-correlations of interacting ICF and SCT model components for Participant 4*

| | | **First Variable** | | | |
|---|---|---|---|---|---|
| | | **I** | **A** | **SEP** | **OEP** |
| **Second Variable** | **P** | 0.25 (0.14) lag 5<br>-0.23 (0.14) lag 6<br>0.20 (0.14) lag 2 | 0.17 (0.14) lag 1<br>0.15 (0.15) lag 6<br>-0.15 (0.14) lag -5 | 0.31 (0.13) lag 0*<br>0.19 (0.13) lag 3<br>0.14 (0.14) lag -5 | 0.21 (0.14) lag 5<br>-0.20 (0.14) lag -5<br>-0.16 (0.14) lag -2 |
| | **SEP** | | -0.25 (0.14) lag -3<br>-0.20 (0.15) lag -7<br>0.15 (0.15) lag 7 | | |
| | **OEP** | | 0.25 (0.14\0 lag -4<br>-0.20 (0.15) lag 6<br>-0.15 (0.14) lag 0 | -0.36 (0.14) lag 5*<br>0.29 (0.14) lag -5*<br>0.28 (0.14) lag 1* | |

*Note: * denotes cross-correlations that exceeded 95% confidence intervals; I = impairment; A = activity; P = participation; SEP = self-efficacy for participation; OEP = outcome expectancy for participation*

*4.6.5 Cross-Correlations – The Integrated ICF / Emotion Model and Participation*

Variability could be seen in all data series (Figure 4.7), allowing for time series analysis. The three largest participation-related cross-correlations between each pair of variables as indicated by the integrated ICF / emotion model (Figure 4.3) are shown in Table 4.26.

None of the eight theoretically possible cross-correlations involving participation, ICF constructs (i.e. impairment, activity), or emotional constructs (i.e. mood, anxiety, depression) exceeded the 95% confidence interval.

Table 4.26 *Participation-related cross-correlations of interacting ICF and emotion model components for Participant 4*

| | | **First Variable** | | | | |
|---|---|---|---|---|---|---|
| | | **I** | **A** | **Mood** | **Anx** | **Dep** |
| **Second Variable** | **P** | 0.25 (0.14) lag 5<br>-0.23 (0.14) lag 6<br>0.20 (0.14) lag 2 | 0.17 (0.14) lag 1<br>0.15 (0.15) lag 6<br>-0.15 (0.14) lag -5 | -0.25 (0.14) lag 5<br>0.21 (0.14) lag -3<br>0.17 (0.14) lag -1 | -0.22 (0.14) lag -6<br>0.20 (0.14) lag -7<br>-0.18 (0.13) lag 3 | -0.17 (0.14) lag -6<br>0.16 (0.14) lag -7<br>0.13 (0.14) lag 4 |
| | **Mood** | | -0.25 (0.14) lag -4<br>0.22 (0.15) lag -7<br>0.15 (0.14) lag 0 | | | |
| | **Anx** | | 0.27 (0.14) lag 5<br>-0.25 (0.14) lag 2<br>-0.24 (0.14) lag -4 | | | |
| | **Dep** | | -0.18 (0.14) lag -4<br>0.18 (0.14) lag 0<br>0.18 (0.14) lag 5 | | | |

*Note: I = impairment; A = activity; P = participation; Anx = anxiety; Dep = depression*

*4.6.6 Regression Analyses – Activity*

Table 4.27 displays the results of the regression analyses assessing the utility of the ICF, SCT and emotion model for the prediction of activity.

Neither the ICF, SCT, nor emotion models alone were predictive of activity. Namely, impairment did not predict activity; self-efficacy and outcome expectancy towards activity did not predict activity; mood, anxiety, and depression did not predict activity.

Table 4.27 *Forced entry regression analyses testing the predictive effects of the ICF only, SCT only, and emotions only on activity in Participant 4*

| **Variable** | **B(SE B)** | ***β*(*t*-value)** | **adj. $R^2$(F)** |
|---|---|---|---|
| ***ICF predicting A*** | | | |
| I | -11324.10(18437.71) | -0.09(-0.61)*ns* | -0.01(0.38)*ns* |
| ***SCT predicting A*** | | | |
| SEA | -11800.46(18399.35) | -0.09(-0.64)*ns* | |
| OEA | 8191.18(19554.21) | 0.06(0.42)*ns* | 0.03(0.25)*ns* |
| ***Emotion model predicting A*** | | | |
| Mood | 20774.85(19183.54) | 0.15(1.08)*ns* | |
| Anxiety | -5881.57(39342.31) | -0.04(-0.15)*ns* | |
| Depression | 35278.80(43414.03) | 0.22(0.81)*ns* | -0.001(0.98)*ns* |

*Note: SEB = standard error of B; A = activity; I = impairment; SEA = self-efficacy for activity; OEA = outcome expectancies for activity*

*4.6.7 Regression Analyses – Participation*

Table 4.28 displays the results of the regression analyses assessing the utility of the ICF, SCT and emotion model for the prediction of participation. Applying a lag of seven data points to the activity series meant that regression analyses including activity excluded the first seven data points of each series in the model. To allow for the results of regressing participation onto SCT constructs and emotions alone to be directly compared with the results of regressing participation onto ICF constructs, the first seven data points were removed prior to analyses of models that did not include activity (i.e. SCT constructs alone, emotions alone).

Neither the ICF nor emotion model alone were predictive of participation. That is, impairment did not predict participation; mood, anxiety, and depression did not predict participation. The SCT model alone did predict participation. Specifically, high self-efficacy and more negative outcome expectancies towards participation were predictive of more participation.

Table 4.28 *Forced entry regression analyses testing the predictive effects of the ICF only, SCT only, and emotions only on participation in Participant 4*

| **Variable** | **B(SE B)** | ***β*(*t*-value)** | **adj. $R^2$(F)** |
|---|---|---|---|
| ***ICF predicting P*** | | | |
| I | 1.24(1.63) | 0.11(0.76)*ns* | |
| A | -3.33(0.00) | -0.04(-0.27)*ns* | -0.03(0.35)*ns* |
| ***SCT predicting P*** | | | |
| SEP | 4.58(1.69) | 0.36(2.72)* | |
| OEP | 0.90(1.25) | 0.10(0.72)*ns* | 0.12(4.36)* |
| ***Emotion model predicting P*** | | | |
| Mood | -1.70(1.71) | -0.14(-1.00)*ns* | |
| Anxiety | -0.29(3.50) | -0.02(-0.08)*ns* | |
| Depression | 0.97(3.86) | 0.07(0.25)*ns* | -0.04(0.37)*ns* |

*Note: SEB = standard error of B; P = participation; I = impairment; SEP = self-efficacy for participation; OEP = outcome expectancies for participation; * p < 0.05; ** p < 0.01; *** p < 0.001*

*4.6.8 Participant 4 Discussion*

All data series for participant 4 were judged to have enough variability for within-person analyses of the effects of changes in one variable on changes in another. The only model tested in the present study that predicted behaviour in participant 4 was that of SCT constructs (i.e. self-efficacy, outcome expectancies) predicting participation. This model accounted for 12% of the variance in participation behaviour. Consistent with findings from participants 1 and 3, none of the presently tested models predicted activity in participant 4.

Meaningful changes in activity-related self-efficacy were found to precede changes in outcome expectancies by one day; increases in self-efficacy towards activity occurred prior to more positive outcome expectancies about activity. Both the temporal ordering and the direction of this relationship support the pathway between self-efficacy and outcome expectancies as part of the framework of SCT. Changes in impairment were found to follow changes in anxiety; increased impairment followed increases in anxiety. The appraisal model of emotion would explain this finding through the proposed circular process of situation appraisal, emotional response, behaviour in which a situation could be affected by a preceding emotion via the resulting behaviour (Smith and Ellsworth, 1985).

Cognitive constructs derived from SCT (i.e. self-efficacy, outcome expectancies) predicted participation in participant 4. However, only the relationship between self-efficacy towards participation and participation behaviour was independently significant within the cognitive model. Previous research has found that self-efficacy is usually more predictive of behaviour than outcome expectancies (Johnston and Dixon, 2014). While this has generally been found in relation to activity, the present study extends this finding to the prediction of participation behaviour in this particular individual.

Although the lack of effect of cognitive models on activity may be due to a lack of correspondence between cognitive measures and behavioural measures (Ajzen and

Fishbein, 1977; Rhodes, Matheson, and Blanchard, 2006; Sutton, 1998), a weak predictive validity of cognitions on objectively measured behaviour (i.e. accelerometer) (Dixon, et al., 2012; Hobbs, et al., 2013; McEachan, Conner, Taylor, and Lawton, 2011; Quinn, Johnston, and Johnston, 2013), or a lack of salience of activity-related cognitions for this participant (Fazio, Powell, and Williams, 1989; Petkova, Ajzen, and Driver, 1995), these factors don't explain the absence of any predictive validity of emotion on activity or participation. In fact, only two theoretically possible pairs of variables were significantly associated to a meaningful degree (i.e. SEA and OEA; I and anxiety). Therefore, it is likely that there were other factors affecting this individual's behaviour that were not included in the present study. For example, past exercise behaviour has been found to predict current exercise behaviour in people with arthritis (Iversen, Fossel, Ayers, Palmsten, Wang, and Daltroy, 2004). Further, decreased mobility has been associated with the use of passive strategies when coping with pain and with reduced social networks (Evers, Kraaimaat, Geenen, and Bijlsma, 1998). Another study found that fatigue, a common symptom of rheumatoid arthritis (Hewlett, et al., 2005) and perceived benefits and barriers to exercise predicted exercise behaviour (Neuberger, Aaronson, Gajewski, Embretson, Cagle, Loudon, and Miller, 2007). Perceived barriers to physical activity have also been found to mediate the effect of self-efficacy on activity engagement, in addition to outcome expectancies (Ayotte, Margrett, and Hicks-Patrick, 2010). Factors such as illness cognitions (Scharloo, et al., 1998), fear of falling (Jamison, Neuberger, and Miller, 2003), and pain avoidance (Evers, Kraaimaat, Geenen, Jacobs, and Bijlsma, 2003) have all been associated with behaviour in arthritis and so, there are many factors that could either have influenced cognitions and emotions to affect behaviour in this individual or were important factors in explaining this individual's activity behaviour while the cognitions and emotions as measured in the present study were not. Future research might set out to replicate these findings and determine whether, in individuals for which cognitions and emotions do not predict activity, there are measurement issues, confounding effects on activity, or a completely different set of factors important to that person's activity behaviour.

## 4.7 Conclusions

The present study tested the predictive utility of ICF constructs (i.e. impairment, activity), SCT constructs (i.e. self-efficacy, outcome expectancies), emotions (i.e. mood, depression, anxiety), and integrated ICF / SCT and ICF / emotion models on activity and participation behaviour in a series of four n-of-1 studies. Activity was significantly predicted in only one participant (i.e. participant 2) and only by the emotion model. However, participation was predicted by at least one model in each of the four participants. SCT constructs predicted participation in three individuals (i.e. participants 1, 2, and 4) and emotions predicted participation in two individuals (i.e. participants 1 and 3). Integrating ICF constructs with SCT constructs was predictive of participation in one individual (i.e. participant 1); integrating ICF constructs with emotional variables was also predictive of participation in one individual (i.e. participant 1).

The lack of a relationship between impairment, SCT constructs, emotional variables and activity could be explained by a number of factors. This may be a demonstration of the weakness of self-report measures in predicting objective measures of activity, a finding that has been reported previously (Hobbs, et al., 2013). Meta-analytic findings suggest that, of 105 studies testing the effects of Theory of Planned Behaviour (Ajzen, 1991) cognitions (i.e. intention, perceived behavioural control, attitude) on activity, those that used an objective measure of activity found cognitions to explain an average of 12% of its variance, while those that use self-report measures of activity found cognitions to explain nearly 26% of its variance (McEachan, et al., 2011). However, Ajzen and Fishbein (1977) assert that both cognitive measures and behavioural measures should at least include the same action (e.g. walking) and target (e.g. treadmill) components, but ideally should also include the same context (e.g. at the gym) and time elements (e.g. every day this week) (Ajzen, 2006). Cognitive measures in the present study were not specific, instead asking generally about confidence in walking or socialising (i.e. self-efficacy) and expectations about how walking or socialising will affect symptoms of arthritis (i.e. outcome expectancies). Further, by nature it is not possible to match the target,

action, time, or context elements of a cognitive measure to the objective measure used in this study, as the objective measure of behaviour was simply an activity count. Therefore, it may be that using cognitions to predict objectively measured behaviour provides an underestimation of the true relationships between cognitions and behaviour. Certainly, doing so is outwith the realm of the proposals of the models from which they are derived (Ajzen and Fishbein, 1977, McEachan, et al., 2011). Or, it may be that cognitions don't have strong relationships with actual behaviour, but only an individual's perceptions of their own behaviour (McEachan, et al., 2011), which are subject to bias at the time of recall (Armitage and Conner, 2011).

Alternatively, integrated biobehavioural models might simply be better at predicting activity limitations than they are at predicting activity (Johnston and Dixon, 2014). Previous research has found that impairment integrated with psychological cognitions was highly predictive of activity limitations, while cognitions were more predictive of activity behaviour (i.e. the healthy version of activity limitations) when impairment was excluded from the model (Johnston and Dixon, 2014). The present study included self-efficacy and outcome expectations in relation to both activity and participation to allow for tests of the models on each outcome (i.e. activity and participation). Behavioural constructs were measured towards the healthy version of the ICF (i.e. activity rather than activity limitation; participation rather than participation restriction) because self-efficacy is more easily conceptualised in a positive direction (i.e. how confident do you feel?… rather than how unsure do you feel?...) and therefore, physical activity and participation should correspond more closely with self-efficacy measures than activity limitations and participation restrictions would (Ajzen, 1985; Ajzen and Fishbein, 1977; McEachan, et al., 2011). In contrast, impairment and outcome expectancies were both measured towards the disability version of the model. Outcome expectancies in this study were measured in relation to the presence of disease symptoms (eg. "pain will make walking / socialising difficult today") as activity and participation in the presence of chronic disease were the subject of interest. However, the presence of specific disease symptoms was only considered important to these participants in relation to engaging

in activity, while participation was described as being affected by arthritis more generally. Future research might determine whether these findings are replicable. Also, determining whether body structure and function is a better predictor of activity behaviour compared to impairment; body structure and function and activity being components of the healthy version of the ICF (WHO, 2002) framework, would aid in answering questions surrounding the model's utility in predicting activity rather than activity limitations.

Although integrated models of disability have been tested in various forms, including versions that use SCT constructs and versions that use TPB constructs (Dixon, et al., 2012; Dixon, et al., 2008; Quinn, et al., 2012), the focus has been on the prediction of activity and activity limitations. To date, the ability of the integrated model to account for participation or participation restrictions in individuals has not been evaluated. In part, participation has been excluded from previous research testing integrated ICF / behavioural models due to the absence of a suitable measure of participation and questions concerning whether the ICF's (WHO, 2002) activity and participation constructs are empirically distinct (Hemmingsson and Jonsson, 2005; Jette, Haley, and Kooyoomjian, 2003). However, activity and participation constructs have been found to be distinct using Discriminant Content Validity methods (Dixon, Johnston, McQueen, and Court-Brown, 2008), a process that establishes the content and discriminant validity of items used to measure theoretical constructs (Johnston, Dixon, Hart, Glidewell, Schröder, and Pollard, 2014). Activity and participation have also been reported as separate entities by mobility restricted participants (Dixon and Johnston, 2008; Pollard, Dixon, Dieppe, and Johnston, 2009). Therefore, there is support for the inclusion of both activity and participation as distinct constructs in integrated biobehavioural models of disability (Dixon and Johnston, 2008; Johnston, et al., 2014; Pollard, at al., 2009). While activity can be measured objectively without difficulty, measuring participation objectively can be more challenging. The ICF recommendation is to measure observed participation (Hemmingsson and Jonsson, 2005). However, this is problematic not only because of the difficulties involved in observing a person's daily life over any length of time, but also because activity and participation are both defined as having a 'capacity' component and a

'performance' component where 'capacity' accounts for a person's ability to participate and 'performance' accounts for observable engagement in participation (Perenboom and Chorus, 2003). It has been argued that the 'capacity' component of participation should account for a person's subjective experience of participation (Perenboom and Chorus, 2003; Ueda and Okawa, 2003) and this cannot be measured through observation (Hemmingsson and Jonsson, 2005). In the present study, two simple questions were used as measures of 'capacity' to participate and 'performance' of participation in an effort to account for subjective experience of participation. These two measures were viewed as distinct components of participation that mutually influence the overall experience of participation for an individual and so, scores from each question were multiplied to create a weighted participation score. While this measure of participation did allow for both capacity and performance components, as well as subjective experience, to be accounted for as part of the overall participation construct, it is possible that this measure may have been too simplistic. Determining whether 'capacity' and 'performance' require equal weighting as part of the overall participation score was outwith the scope of the present study. Future research might usefully focus on developing clear measures and methods of fully conceptualising participation in both group and N-of-1 studies as well as determining the most meaningful method of weighting 'capacity' to participate against 'performance' of participation (Perenboom and Chorus, 2003; Seekins, Ipsen, and Arnold, 2007), especially given that the present study found both impairment and psychological constructs to be better predictors of self-reported participation behaviour than of objectively measured activity behaviour. These findings also suggest that participation could be more amenable to change through cognitive or emotional interventions than activity behaviour, as participation in all four individuals in the present study was associated with either cognitions, emotions, or both, while activity behaviour was only predicted by emotions in one individual. Participation behaviour should therefore, not be overlooked in future research simply because it is difficult to define.

The findings of the present study suggest that cognitions and emotions are better at explaining behaviour than impairment. Integrating SCT cognitions or emotional

variables with the ICF might help to predict participation, depending on the individual. Within emotion models, anxiety did not independently predict behaviour in any participant in the present study, while mood and depression quite often did. This may be due to the way that anxiety was measured, but it may also be that anxiety does not adequately fit within the emotional or biobehavioural model as proposed here. One factor similar in concept to anxiety, but specifically theorised to affect behaviour in musculoskeletal disorders is 'fear-avoidance' or 'pain avoidance', which occurs when a person who has chronic pain develops fears about injury and anxiety about the source of the threat of injury (Leeuw, Goossens, Linton, Crombez, Boersma, and Vlaeyen, 2007). This is conceptualised within the Fear-Avoidance Model (Vlaeyen and Linton, 2000) and includes anxiety, fear, depression, and catastrophising as emotional components, plus avoidance, escape, and disuse as behavioural components (Leeuw, et al., 2007). All three of these behavioural components refer to activity behaviour and so, this model and its emotional components are compatible with ICF constructs. Further, fear-avoidance has been shown to be a strong predictor of physical activity in disability (Al-Obaidi, Nelson, Al-Awadhi, and Al-Shuwaie, 2000; Elfving, Andersson, and Grooten, 2007; Philips, 1987; Waddell, Newton, Henderson, Somerville, and Main, 1993) and may also affect self-efficacy (Philips, 1987). Additionally, perceived benefits and barriers to a behaviour (Gecht, et al., 1996; Neuberger, Aaronson, Gajewski, Embretson, Cagle, Loudon, and Miller, 2007; Neuberger, Kasal, Smith, Hassanein, and DeViney, 1994) characteristics of a person's social network (Litt, Kleppinger, and Judge, 2002; McNeill, Kreuter, and Subramanian, 2006; Seeman, Berkman, Charpentier, Blazer, Albert, and Tinetti, 1995) and the transtheoretical model's (Prochaska and DiClemente, 1983) 'readiness to change' (Litt, Kleppinger, and Judge, 2002; Daley and Duda, 2006) have all been found to affect behaviour. Introducing cognitive, emotional, social, or environmental factors into integrated models of disability outside of those tested here could increase the predictive validity of the models or explain variance in behaviour in individuals for which self-efficacy, outcome expectancies, depression, anxiety, or mood do not adequately explain behaviour.

Using an N-of-1 design in the present study has illustrated the differences in factors important to activity and participation behaviour within individuals. In primary care, this type of study could be conducted prior to treating an individual with arthritis, allowing health care providers to identify factors that could effectively be intervened upon to make meaningful changes in behaviour, or to determine whether the factors most important to the individual's behaviour have yet to be identified (Davidson, et al., 2014). This could potentially be cheaper than referring patients to interventions without first conducting such an investigation and later finding that the intervention was ineffective. Future research might focus on refining survey instruments, better defining model constructs, and increasing the breadth of the evidence base using N-of-1 methods across a range of individuals. Future N-of-1 research might usefully extend tests of the integrated model to include a participation outcome, as it is one of three central components of the ICF (Hemmingsson and Jonsson, 2005; Jette, Haley, and Kooyoomjian, 2003; Perenboom and Chorus, 2003). Finally, adding factors that could be important to activity or participation behaviour to integrated models could illuminate issues of unexplained variance in disability behaviour.

## Chapter 5: General Discussion

This thesis set out to evaluate the existing evidence base for self-management interventions through systematic review and meta-analyses, to test the effects of goal-setting and action planning (i.e. the 'taking action' SM component) on PA, and model disability behaviour (i.e. activity; participation) by integrating ICF constructs (i.e. impairment) with SCT constructs (i.e. self-efficacy; outcome expectancies) and with emotional variables (i.e. mood; anxiety; depression).

### *5.1 Summary of Thesis*

#### *Chapter 2*

Chapter 2 of this thesis describes a systematic review of the SM literature published between 1984 and 2012 and a narrative review update of the SM literature published between 2013 and 2017. Studies were included if they were an RCT of adults (i.e. 18+ years) with formally diagnosed RA or OA, published in English, with a usual care control group, testing an intervention that included at least one of the five components of SM as described by Lorig and Holman (2003). After screening, 85 met inclusion criteria for review. However, five were not available. Therefore, 80 studies were included in the original systematic review and 36 were included in the narrative review update. For the purposes of meta-analyses, only studies including one or more of the three most common outcomes were included to ensure sufficient power to calculate effects on each: pain, disability, and mental health. Of the 80 studies originally reviewed, data from 19 were not available and two did not measure pain, disability, or mental health and so, 59 studies were included in the meta-analysis. Systematic review indicated that SM interventions have positive effects on disability, pain, and mental health outcome regardless of intervention content. Positive effects on pain and mental health persisted up to six months, while positive effects on disability remained at the longest follow-up period observed (i.e. 21 months). Study quality was found to be good and attrition rates were acceptable even amongst studies with the highest attrition rates (Altman, 2000; Fewtrell, et al., 2008). However, while WHO has published core measure sets for RA and OA (Dreinhofer,

et al., 2004; Stucki, et al., 2004), there is no consensus on the best ways of measuring outcomes in RA and OA. This lack of consensus was apparent in the presently reviewed studies, with 31 different measures employed to assess pain, 95 measures assessing disability, and 38 measures assessing mental health. Further, intervention content was often not described in enough detail for replication and none of the studies reviewed included a definition of self-management. However, it was possible to identify previously described self-management components (Lorig and Holman, 2003) within interventions and meta-analyse their individual effects. Overall, meta-analyses found that SM interventions effectively improved pain, disability, and mental health outcomes in participants with arthritis. While there were an insufficient number of studies testing only one SM component to reliably test the effects of every component individually, meta-regressions were able to show that different components produce different effects depending on the target outcome, with individual effects of 'decision-making' on pain and 'problem-solving' on mental health. There was no effect of the number of SM components included in interventions, suggesting that SM interventions that do not include all five SM components can be just as beneficial to behavioural and health outcomes as those that do include all five.

*Chapter 3*

Chapter 3 of the present thesis described a series of randomised, controlled N-of-1 trials of a goal-setting and action planning intervention on PA. These behaviour change techniques are commonly employed together (Kahn, et al., 2002; Scobbie, Dixon, and Wyke, 2010; Shilts, Horowitz, and Townsend, 2004), are sometimes referred to as 'specific goal-setting' (Abraham and Michie, 2008; Shilts, Horowitz, and Townsend, 2004), and form the basis of one of Lorig and Holman's (2003) five SM components (i.e. 'taking action'). More than half of the studies included in the present thesis' meta-analysis included a 'taking action' component. In the current study, delivered to a group of participants with chronic pain and a group of participants without chronic pain, the effect of goal-setting and action planning on the behaviour of individuals and on behaviour at the group level was tested. Testing effects of the intervention on PA in individuals addressed a gap in the literature of

behaviour change intervention research (Sniehotta, et al., 2012). As attention to pain has been found to affect behaviour (McCracken, 1997) and because pain is an issue of salience for those who have chronic joint pain (Gooberman-Hill, et al., 2007; ten Klooster, et al., 2007), the intervention also included a 'pain report' condition, under which participants were either asked to report their pain levels or were not asked to report pain levels daily. This allowed for the identification of any effects of attention to pain on PA as well as for the control of those effects in analyses of intervention effects. Each participant was individually randomised to the intervention goal condition (i.e. walking goals) for half of the study period (i.e. 60 days) and the control goal condition (i.e. diet goals) for half of the study period. Each participant was also randomised to report pain for half of the days spent in the intervention goal condition (i.e. 15 days) and half of the days spent in the control goal condition (i.e. 15 days). Individual analyses revealed an effect of goal-setting and action planning on PA in only one participant (i.e. healthy group) who had higher PA levels on days spent in the intervention goal condition (i.e. walking goals) in comparison to days spent in the control goal condition (i.e. diet goals). Reporting pain affected PA in five participants, with four (i.e. one pain group, three healthy group) having lower PA levels on days when they were asked to report pain and one (i.e. healthy group) who had higher PA levels on days that they were asked to report pain in comparison to those that they were not asked about pain. Time trends were included in individual analyses to control for cumulative intervention effects and any non-stationarity of the data series. Significant effects of time were found in 12 participants, with three (in the healthy group) increasing PA levels over the course of the study period and 9 (five pain group participants, four healthy group participants) decreasing PA levels over time. Group analyses indicated that the effect of goal-setting and the effect of pain reporting on PA did not differ between groups (i.e. pain group v healthy group). The pain group did report significantly worse health (AIMS2-SF), greater disability (HAQ), and higher levels of pain (VAS) than the healthy group at both baseline and post-intervention. The pain group reported significantly improved health post-intervention compared to baseline, but there were no significant changes in disability or pain levels. There were no significant changes in health, disability, or pain in the healthy group at post-intervention.

*Chapter 4*

Chapter 4 of the present thesis described a series of longitudinal N-of-1 studies designed to facilitate the modelling of disability behaviour using both medical and psychological models of behaviour. Previously, integrating psychological model constructs with ICF model constructs has been found to significantly add to the predictive validity of the overall disability model on behaviour (Dixon, et al., 2008; Dixon, et al., 2012; Johnston and Dixon, 2014; Schröder, et al., 2007; Quinn, et al., 2012; Quinn, Johnston and Johnston, 2013). To date, much of this research has been conducted in groups and has mainly focussed on predicting activity or activity limitations. Further, while there are sound theoretical frameworks modelling the effects of emotion on behaviour (Baumeister, et al., 2010; Smith and Ellsworth, 1985), the existing body of research has not integrated emotional variables with ICF constructs. The effects of emotional appraisal and SCT cognitions on behaviour are theorised to occur on an individual level (Bandura, 2001; Ellsworth and Scherer, 2003). The present study was, therefore, designed to measure impairment as proposed by the ICF, cognitions from SCT (i.e. self-efficacy, outcome expectancies), and emotional variables (i.e. mood, anxiety, depression) within individuals and model their effects on ICF behaviours (i.e. activity, participation). The aim of this study was to quantify the effects of each model alone (i.e. biological, cognitive, emotional), the effects of an integrated ICF / SCT model, and the effects of an integrated ICF / emotion model on objectively measured activity in each participant. Six participants with self-reported RA or OA were recruited from the community. One participant withdrew from the study and one participant was excluded due to corrupted objective data. Therefore, four participants were included in analyses. Participants were asked to complete a questionnaire each morning and each evening daily for 60 days. They were also asked to wear ActiGraph (ActiGraph Corp, 2014) accelerometers during waking hours daily throughout the 60 day study period. Results of regression analyses showed that activity behaviour was only predicted by emotions and only in one participant. Participation behaviour, however, was predicted by one or more models in each of the four participants. SCT constructs alone predicted participation behaviour in the greatest number of participants (i.e.

three), while emotions alone predicted participation behaviour in two of four participants.

*5.2 Implications and Future Research*

The present review and meta-analysis was the first to clearly define each intervention component that makes up a full SM programme and therefore, the first to stipulate the exact intervention content that would qualify for inclusion in a review and meta-analysis of SM interventions. To allow future reviews to also include clear inclusion criteria based on intervention content, complex interventions need to be reported with absolute precision (Boutron, et al., 2008). The recent series of BCT taxonomy iterations (Abraham and Michie, 2008; Michie, et al., 2013) provide a valuable outline for systematically identifying effective behaviour change techniques within SM interventions (Michie, Hyder, Walia, and West, 2011; Michie, Whittington, Hamoudi, Zarnani, Tober, and West, 2012), creating a framework for designing and implementing behaviour change within SM interventions (Michie, van Stralen, and West, 2011), training investigators to apply the taxonomy to the both the design and evaluation of SM interventions (Abraham, Wood, Johnston, Francis, Hardeman, Richardson, and Michie, 2015; Wood, et al., 2014), and a shared language for reporting behaviour change interventions that could facilitate more accurate literature syntheses (Johnston, 2014; Michie, Wood, Johnston, Abraham, Francis, and Hardeman, 2015). Results from a recent study suggest that training investigators to use this taxonomy had more positive effects on the reporting of within-group studies than that of between-group studies (Wood, Hardeman, Johnston, Francis, Abraham, and Michie, 2016). Further research is needed to determine the mechanism of this effect (Wood, et al., 2016). These taxonomies have largely been developed in aide of giving clear definitions of behavioural intervention techniques to enable more uniform, replicable reporting of methods in health behaviour research (Michie, Johnson, and Johnston, 2015). Another group aimed to taxonomise behavioural intervention techniques in aide of intervention development, rather than intervention reporting (Kok, Gottlieb, Peters, Mullen, Parcel, Ruiter, Fernández, Markham, and Bartholomew, 2016). These discussions represent a wider shift towards stricter

methods of development, execution, and communication of behavioural interventions and their results (Kok, et al., 2016; Michie, Johnson, and Johnston, 2015). These are certainly positive developments in the field of behavioural psychology and could have implication for the wider social scieneces. The finding of the present meta-analysis that individual SM components may affect target outcomes differently lends further support to the taxonomisation of SM techniques just as behaviour change techniques have been taxonomised (Michie, et al., 2013). This would allow for more clearly defined SM intervention protocols and in turn, the identification and quantification of specific, individual effects of intervention components and combinations of intervention components (Michie, et al., 2013). An evidence base that enables an intervention provider to prescribe specific intervention components to specific populations based on disease or in individuals based on target outcomes and personal circumstances could valuably inform tailored interventions in personalised medicine (Davidson, et al., 2014; Michie, et al., 2013). Additionally, published core outcome sets direct researchers to essential disease-related target outcomes; this alone aids in meta-analysing sets of studies. However, there is no clear guidance on core measures to match each of these outcomes. Outcome Measures in Rheumatology Clinical Trials (OMERACT) calls the HAQ a 'gold standard' measure of disability and lists recommended measures of pain, mental health, fatigue, and self-efficacy, but many of these are only included as subscales of questionnaires (Richards and De Wit, 2016). It is not clear whether there are 'gold standard' measures for pain, mental health, or any other core RA or OA outcome as set out by OMERACT (Richards and De Wit, 2016). This lack of guidance on measuring core outcomes in RA and OA means that it is difficult to integrate findings across studies of interventions on arthritis due to the large variety of measures reported for each type of outcome. Therefore, although SM interventions seem to have positive effects on pain, disability, and mental health regardless of the type or number of SM components included, method of outcome measurement, or number of treatment sessions, it is unclear whether particular SM components are more effective than others or whether certain SM components are more pertinent to certain target outcomes. There is a lack of studies that clearly define each SM component involved in an intervention or that test one SM component at a time. This

field of research could benefit from studies that break the standard SM intervention down into its component parts and test their effects in individuals, as individuals are the unit of interest in real-world treatment settings.

The present series of randomised, controlled N-of-1 trials demonstrated that goal-setting and action planning as an established component of many behavioural interventions, can be tested in individuals using robust methods. Results highlighted the importance of identifying the mechanisms of effect in more complex interventions (Artinian, et al., 2010; Dombrowski, et al., 2012) and of taking care when extrapolating results of group studies on behavioural interventions to individual applications (Clay, 2010; Davidson, et al., 2014). While the present meta-analysis of SM interventions and others previously found that interventions including goal-setting and action planning have positive effects on health and behavioural outcomes (Conn, et al., 2008; Dombrowski, et al., 2012; Greaves, et al., 2011), the present series of randomised, controlled N-of-1s found very little support for an intervention involving goal-setting and action planning alone to change PA behaviour. Indeed, a previous meta-regression found that, while certain behaviour change techniques, such as self-monitoring, did have individual effects on target outcomes, goal-setting did not (Dombrowski, et al., 2012; Greaves, et al., 2011). However, to determine whether the results of the present randomised controlled series of N-of-1s are replicable and whether there are effects of goal-setting and action planning outside of more complex interventions, more research needs to be carried out testing the effects of this SM component alone. Future research might usefully seek to test the individual effects of each of the five SM components described by Lorig and Holman (2003). Testing the individual effects of each established behavioural intervention component as well as the effects of combinations of components could help to determine which components affect particular outcomes, which components affect outcomes alone, and which groups of components interact to affect outcomes. Employing these tests using N-of-1 designs could aid in the application of more personalised treatment in primary care settings by identifying differences in intervention effects between individuals (Davidson, et al., 2014). It may be advantageous to select combinations of behaviour change

components to include together in tests of behavioural interventions with the use of existing theoretical frameworks. Doing so would allow for conclusions about effect mechanisms to be grounded in theory and to guide next steps in research (Johnston and Dixon, 2014).

The present series of longitudinal N-of-1 studies tested the utility of impairment, cognitions, and emotions in predicting disability behaviour. Results showed that psychological models effectively predicted participation behaviour, but not activity and between the two psychological models, cognitions explained more variance in participation than emotions did. That activity could not be predicted may be due to a lack of correspondence between self-report measures of cognitions, emotions, and objectively measured activity. Psychological models have been found to explain more variance in self-report activity than in objectively measured activity in the past (Hobbs, et al., 2013; McEachan, et al., 2011). This might occur because self-report measures of cognitions cannot be designed to match an objective measure of movement only according to target, action, time, and context as proposed by Ajzen and Fishbein (1977), leading to the suggestion that cognitive models are only able to predict perceived behaviour and not actual behaviour (McEachan, et al., 2011). However, previous research has also found cognitions to be stronger predictors of activity limitations than of activity, even when both were measured by self-report (Dixon, et al., 2012). It might be useful for future researchers to investigate whether carefully aligning psychological measures with behavioural measures to ensure adequate agreement, including positive wording (e.g. how easy…) when predicting healthy behavioural outcomes (e.g. activity) and negative wording (e.g. how difficult…) when predicting disability outcomes (e.g. activity limitations) improves the predictive validity of cognitions on behaviour. The present series of longitudinal N-of-1s employed a multiplicative measure of participation behaviour involving one 'capacity' item and one 'performance' item. Doing so was expected to account for individuals' perceived experience of participation in a way that observation only cannot (Hemmingsson and Jonsson, 2005; Perenboom and Chorus, 2003). Results suggest that all models were more predictive of participation than of activity and future research should set out to determine whether these findings are replicable. It

would be useful to evaluate the presently used measure of participation and its scoring method for reliability and validity as it is brief and easy to use. Within emotion models, mood and depression were most strongly associated with behaviour. In future, emotional models of behaviour in individuals with chronic pain or musculoskeletal disorders might focus on fear of pain and fear avoidance (Vlaeyen and Linton, 2000) as a useful framework with which to integrate biological and cognitive factors related to behaviour. Doing so might help to provide more disease-specific context to emotional factors affecting behaviour in chronic disease and identify specific mechanisms of effect on behaviour (Leeuw, et al., 2007). In the present series of longitudinal N-of-1s, cognitions explained more variance in participation than any other model. However, integrating cognitions and emotions to form more complex models including other factors known to affect disability, such as social network size (McNeill, et al., 2007), 'readiness to change' (Daley and Duda, 2006), and perceived behavioural barriers and benefits (Neuberger, et al., 2007) could account for some of the remaining unexplained variance in participation. The present test of a goal-setting and action planning intervention and the present series of longitudinal model testing studies employed N-of-1 designs. The results of these studies showed that it is feasible and appropriate to test behavioural interventions and behavioural models on an individual level and that models of behaviour theorised on an individual basis show intraindividual variability.

N-of-1s methods have been used more extensively in other fields of medicine and psychology (Gabler, Duan, Vohra, and Kravitz, 2011; Norcross and Wampold, 2011; Perdices and Tate, 2009; Punja, Bukutu, Shamseer, Sampson, Hartling, Urichuk, and Vohra, 2016; Smith, 2012), but their application to health behaviour change is more limited (McDonald and Davidson, 2016; McDonald, et al., 2017). A 2016 systematic review identified 36 health behaviour studies using various N-of-1 designs conducted since 2000 (McDonald, et al., 2017). Whilst 36 is not a large number of studies for a 16 year period, there is increasing interest in N-of-1 methods in health psychology as evidenced by the N-of-1 special interest group in the European Health Psychology Society (EHPS, 2016) and an N-of-1 network within the British Psychological Society (BPS) Division of Health Psychology in the UK (BPS, 2017). The use of N-

of-1 designs could help to keep the field health psychology and its repertoire of intervention methods abreast with the wider healthcare community as many move toward personalised or "precision" medicine (Schork, 2015). An expanded CONSORT statement provides an outline for designing N-of-1 trials and guidelines for reporting their outcomes (Shamseer, Sampson, Bukutu, Schmid, Nikles, Tate, Johnston, Zucker, Shadish, Kravitz, Guyatt, Altman, Moher, Vohra, and the CENT group, 2015; Vohra, Shamseer, Sampson, Bukutu, Schmid, Tate, Nikles, Zucker, Kravitz, Guyatt, Altman, Moher, and the CENT group, 2015). Advances in technology and the conceptualisation of novel research methods and tools has introduced cost-effective ways of conducting N-of-1 studies and of delivering personalised behavioural interventions (McDonald, et al., 2017). Objective measures of PA range in both price and accuracy. Cost is considered a significant barrier to conducting N-of-1 trials, with costs arising from intervention development, recruitment, data collection, and researcher or physician time (Davidson, et al., 2014). However, while a tailored intervention tested using a group design was found to be more expensive than a non-tailored intervention, it was also found to be more cost-effective in terms of price per minute of increased PA engagement (Larsen, Gilmer, Pekmezi, Napolitano, and Marcus, 2015). If individualised interventions can produce more positive, cost-effective outcomes than standardised interventions, it may be that individualised interventions tested using N-of-1 designs can produce such outcomes as well. Many data collection tools employed in N-of-1 trials can be implemented at low-cost or no-cost, such as daily diaries, email responses, online surveys, and technology existing in participants' own mobile phones (McDonald, et al., 2017). It would be useful for future research to take advantage of these methods to continue developing the evidence base for individualised behavioural medicine.

### *5.3 Strengths and Limitations of Thesis*

The present thesis included a novel systematic review and meta-analysis of self-management interventions that was the first to give a clear definition of each component of self-management and to attempt to individually quantify the effects of each component. Similarly, the present series of randomised controlled N-of-1s

testing a goal-setting and action planning intervention replicated Sniehotta, et al.'s (2012) novel test of goal-setting and self-monitoring in individuals, but extended this design to include a chronic pain group and a healthy group as well as to test the effects of attention to pain on PA. The present series of longitudinal N-of-1s, employed to test integrated models of disability behaviour, replicated a previous test of an integrated ICF (WHO, 2002) / SCT (Bandura, 1989) model, but using an N-of-1 design to reflect the ICF and SCT models' theorised individual applications. Further, this study extended the existing literature integrating the ICF with psychological models in this method to test an integrated ICF / emotions model.

In an effort to include a range of studies using varying types and number of SM components, the present meta-analysis showed heterogeneity between studies. Future research might overcome this limitation by focussing on analysing only full SM interventions including all five SM components until such time that the evidence base testing individual SM components is large enough to meta-analyse their effect individually in separate reviews. Although time trends in the present series of randomised, controlled N-of-1s were primarily included in the analyses to control for non-stationarity of data series and to account for cumulative intervention effects, significant effects of time indicated decreases in PA in the majority of participants for which such effects were found. This may compliment the finding from the present meta-analysis suggesting that lengthier intervention periods were associated with negative effects on target outcomes. Or, participants might experience an initial increase in motivation upon receipt of an activity monitor, followed by an overall decrease in motivation as has been found previously in adolescents (Kerner and Goodyear, 2017).

Finally, this thesis focussed on individual models of disability to predict individuals' behaviour. The N-of-1 studies included in this thesis were found to be feasible in identifying individual behaviour patterns and the applied models fit the data well. However, individual models of disability do not fully account for social factors associated with disability and participation (Bircher and Kuruvilla, 2014). Participation was tested as part of the individual models of disability behaviour in the present thesis because participation and participation restriction do possess

individual features as part of their conceptualisation (Salter, et al., 2005; WHO, 2002). However, participation as part of the ICF (WHO, 2002) is not fully explained by individual factors and so, an individual model likely does not account for all aspects of participation behaviour (Oliver, 2013). For the purposes of behavioural research, individual models are likely best applied when group studies suggest that results are highly heterogenous between individuals (Davidson, et al., 2014). Social models are more useful in driving major societal and environmental changes (Levitt, 2017) and while both individual and social models of disability are important to the comprehensive definition of disability behaviour, researchers should choose appropriate models according to study design and the level of the outcome of interest (e.g. individual, group, population). Future research might seek to determine whether it is more valuable to combine individual and social models of disability or to continue applying each in isolation depending on study requirements.

### *5.4 Conclusion*

People with chronic disease have to manage their condition, as by definition chronic illness is not amenable to cure. SM interventions have helped to improve health and behavioural outcomes in arthritis, but it is unclear whether all five SM components are necessary to achieve positive outcome or whether individual SM components and combinations of SM components produce different effects in individuals. The present thesis found some evidence that SM components have different effects depending on the target outcome, but further research and taxomisation of SM components individually and in combination is necessary. No evidence was found to support delivering goal-setting and action planning (i.e. the 'taking action' SM component) alone to increase PA in healthy individuals or in those with chronic pain. Future research is needed to determine whether these results are replicable. Cognitions and emotions predicted participation behaviour in individuals with arthritis but not objectively measured activity. While the WHO (2002) ICF model posits that impairment is related to behaviour, the present thesis only found weak relationships between impairment and behaviour. Cognitive models, followed by emotions, explained the greatest amount of variance in participation behaviour.

Future research should continue to test behavioural models and interventions in individuals to account for individual variability and compliment the theories' asserted individual applications (Zahn and Ottenbacher, 2001; Westmeyer, 2003).

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## Appendices

### Appendix 1 – Information Extracted from Each Study Included in Systematic Review

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Allen, et al. (2010) (US) | 172, 60 (10), 9%F<br><br>171, 60 (10), 6%F | eligible patients of the Durham Veterans Affairs Medical Center were mailed introductory letters and then phoned for further eligibility assessment and consent | 12 months | OA Self-Management<br><br>Control | 12 monthly phone calls | I | mail-delivered |
| Appelbaum, et al., 1988 (US) | 9, 62 (9), 11%F<br><br>9, 63(9), 11%F | referred through either Rheumatology or Rehabilitation Medical Services at the Albany, NY Veterans Administration Medical Center | PT, 18 months from PT | Treatment<br><br>Control | 2 sessions/week for 4 weeks + 1 session/week for 2 weeks | NR | doctoral psychology student |
| Arnold, et al., 2010 (Can) | 28, 73(5), 71%F<br><br>26, 74(8), 77%F<br><br>25, 76(6), 64%F | NR | PT | Aquatics & Education<br><br>Aquatics Only<br><br>Control | 2 (30 min.) aquatic sessions/week + 1 (30 min.) education session/week for 11 weeks<br><br>2 (45 min.) aquatic sessions/week for 11 weeks | G<br><br>G | aquatic fitness instractors and physical therapist<br><br>aquatic fitness instructors |

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|---|---|---|---|---|---|---|---|
| Barlow, et al., 2000□(UK) | 311, 57(13), 85%F<br><br>233, 59(12), 83%F | recruited by Arthritis Care's (charity) trainers through the Arthritis Care Branch Network, information places in GP practices and rheumatology departments, and public service announcements in local media | 4 months, 12 months<br><br>4 months | ASMP<br><br>Control | 1 (2 hr.) session/week for 6 weeks | G | pairs of lay-leaders trained by Arthritis Care and guided by a manual |
| Beaupre, et al., 2004□(Can) | 65, 67(7), 60%F<br><br>66, 67(6), 50%F | from the current TKA waiting list | 2 weeks | Treatment<br><br>Control | 3 sessions/week for 4 weeks | G | community physical therapy clinic |
| Bell, et al., 1998□(Can) | 76, 58(11), 78%F<br><br>74, 54(15), 82%F | referred to selected offices of the Consultation and Therapy Service of the Arthritis Society, Ontario, Canada | PT | Treatment<br><br>Control | at least 4 sessions (at least 3 hrs. TOTAL over all sessions) over 6 weeks | I | physical therapist from the Consultation and Therapy Services (CTS) of the Arthritis Society, Ontario, Canada |
| Berge, et al., 2004□(UK) | 19, 72(6), 63%F<br><br>21, 71(6), 79%F | recruited from the hospital THR waiting list | 6 weeks from PT | Pain Management<br><br>Control | 8 sessions (2-3 hrs.) over 6 weeks | G | clinical psychologist, occupational therapist, and physiotherapist |

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| Blixen, et al., 2004 (US) | 16, 72(6), 44%F<br><br>16, 70(6), 31%F | recruited from the arthritis/rheumatology clinics of 2 Midwestern hospitals over 3 mo. | 3 months, 6 months | Self-Management<br><br>Control | 1 phone call (45 min.)/week for 6 weeks | I | advanced practice nurse |
| Bradley, et al., 1987 (US) | 17, 48 (14), 76%F | from the Section on Rheumatology of the Bowman Gray School of Medicine | 6 months | Cognitive Behavioural Therapy | NR | 1 I<br>1 G | a staff member from the Section on Medical Psychology |
| Brus, et al., 1998 (Neth) | 25, 59(15), 92%F<br><br>30, 59(9), 70%F | selected by their rheumatologists during a visit to "our" outpatient clinic | 3 months from baseline, 6 months from baseline | Treatment<br><br>Control | 6 sessions (duration unreported) | G | NR |
| Buszewicz, et al., 2006 (UK) | 406, 68(8), 63%F<br><br>406, 69(9), 63%F | recruited from UK general practices in areas where the voluntary organisation "Arthritis Care" provided the "challenging arthritis" intervention | 4 months, 12 months | Treatment<br><br>Control | 1 session (2.5 hrs.)/week for 6 weeks | G | voluntary organisation, “Arthritis Care” |
| Cadbury, 1997 (UK) | 105, 62, 75%F<br><br>65, 65, 69%F | General practices in the Merton, Sutton and Wandsworth Health | 12 months from baseline | Treatment<br><br>Control | 1 (1 hr.) session/week for 4 weeks | G | NR, provided at general practitioner’s surgery |

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|---|---|---|---|---|---|---|---|
| Cohen, et al., 1997 (US) | 24, 66, 78%F<br><br>28<br><br>34 | recruited via public service announcements, letters to internal medicine and family practice physicians, and notices sent to senior citizen clubs, churches, and the public affairs department of a teaching hospital in the vicinity of Chapel Hill, NC | 6 – 8 weeks PT<br>6 – 8 weeks PT | Pro-led SM<br><br>Lay-led SM<br><br>Control | 6 weeks<br><br>6 weeks | G<br><br>G | health professional<br>lay person |
| Cronan, et al., 1997 (US) | 97, 70(6), 70.1%<br><br>87, 70(6), 56.3%F<br><br>89, 69(6), 65.2%F<br><br>90, 69(6), 64.4%F | letters sent to 3000 randomly selected Health Management Organization (HMO) members | 1 year, 2 years | Education<br><br>Social Support<br><br>Combination<br><br>Control | 1 (2hr.) session/week for 10 weeks + 1 (2hr.) session/month for 10 months | G<br><br>G<br><br>G | professional healthcare educators<br><br>no staff present - led by weekly task assignments<br><br>educational sessions led by professional healthcare educators |
| Crotty, et al., 2009 (Aus) | 75, 68(11), 60%F<br><br>77, 67(11), 61% | patients who had an initial consultation with an orthopaedic surgeon concerning the potential hip or knee replacement and who were then added to the waiting list for joint replacement surgery were invited to take part in the study | 6 months from baseline | Treatment<br><br>Control | at least 1 interview + monthly phone calls (study duration NR) + optional self-management courses 1 session (2.5 hrs.)/week for 6 weeks + optional joint replacement courses 1 session (2.5 hrs.)/week for 2 weeks | I | research nurse and volunteer peer support educators |

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| DeVellis, et al., 1988 (US) | 51, 51 (14), 73%F<br><br>50, 52 (15), 70%F | from the North Carolina Memorial Hospital rheumatology clinic | 2 weeks from PT | Treatment<br><br>Control | psychosocial interview prior to randomisation, problem-solving intervention (1 session) 2 – 4 weeks later | I | patient educator with a master's degree in public health education |
| Evers, et al., 2002 (Neth) | 30, 54(10), 70%F<br><br>29, 54(13), 72%F | NR | 6 months from PT, 1 year from PT | CBT<br><br>Control | 2 sessions (1 hr.)/week for 10 weeks + 1 booster session 1 month later | NR | 2 therapists trained in the treatment modules and supervised by a cognitive-behaviour supervisor |
| Freeman, et al., 2002 (UK) | 32, 51 (11), 85%F<br><br>22 | from 2 rheumatology clinics | 3 months 'following attendance', 6 months 'following attendance' | CBT Arthritis Education<br><br>Didactic Arthritis Education | 4 weeks (8 hours total)<br><br>4 weeks (8 hours total) | G<br><br>G | NR<br><br>NR |
| Fries, et al., 1997 (US) | 375, 64(1), 71%F<br><br>434, 63(1), 73%F | from an HMO in Seattle, WA (Group Health), 3 CA rheumatology practices, and a general health education program (Healthtrac) | 6 months | Treatment<br><br>Control | 6 month intervention (session information unreported) | I | computer generated |

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| Frost, et al., 2005□(US) | 13,<br>66(5), 85%F<br><br>11,<br>66(7), 64%F | identified from within the University of Pittsburgh Medical Center health system based on medical records review using the above criteria. Patients who meet the criteria were approached by a physician, therapist, or clinical staff member of a UPMC facility regarding participation in the study | 2 months from baseline | Treatment<br><br>Control | 1 (1 hr.) session + 3 bimonthly phone calls (15-30 min. each) over 2 months<br><br>1 (15 min.) session + 3 bimonthly phone calls (15 min. each) over 2 months | I<br><br>I | researcher<br><br>researcher |
| Gallagher, et al., 1997□(US) | 363, 69(6), 64.2%F<br><br>over all groups | letters explaining the study and inviting people to participate were sent to 3,000 recipients randomly selected from a large HMO membership list of 50,450 people who were 60 or older | 1 year from baseline, 2 years from baseline, 3 years from baseline | Social Support<br><br>Education<br><br>Combination<br><br>Control | 1 (1 hr.) session/week for 10 weeks + 1 (1hr.) session/month for 10 months<br><br>1 (1 hr.) session/week for 10 weeks + 1 (1hr.) session/month for 10 months<br><br>1 (2 hr.) session/week for 10 weeks + 1 (2hr.) session/month for 10 months | G<br><br>G<br><br>G | NR<br><br>NR<br><br>NR |
| Gerber, et al., 1987□(US) | 18,<br>57(range 33-84), 88%F<br><br>10,<br>51(range 33-73), 90%F | patients from the occupational therapy departments at NIH and three Multipurpose Arthritis Centers (MAC) | 3 months from PT | Treatment<br><br>Control | 2 (2 hr.) sessions/week for 8 weeks<br><br>1 (1-2 hr.) session/fortnight for 8 weeks | optional | therapist<br><br>therapist |

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| Germond, et al., 1993 (South Africa) | 14, 49 (9), 100%F | from the outpatient clinics of 2 hospitals in Cape Town | PT | Stress and Pain Management Training<br><br>Usual Care | 2 (2 hr.) sessions/week for 8 weeks<br><br>2 (1-2 hr.) session/month for 2 months | G<br><br>NR | NR<br><br>NR |
| Giraudet-Le Quintrec, et al., 2007 (France) | 104, 55(12), 86%F<br><br>104, 54(14), 85%F | medical records were screened and they were contacted directly through their rheumatologist or by mail | 6 months from baseline | Education<br><br>Control | 1 (6 hr.) session/week for 8 weeks + 1 (4 hr.) booster session 6 months later | G | rheumatologist, rehabilitation specialist, dietician, social assistant, 2 nurses, 2 physiotherapists, and 2 occupational therapists |
| Goeppinger, et al., 1989 (US) | 121, 64 (11), 87%F<br><br>100<br><br>153 | recruited face to face, by articles in the local newspapers and church bulletins, through public service announcements and interviews given by staff to area television and radio stations, by posters in stores and post offices, from physicians practices and referral from other health service providers, and through word-of-mouth from other participants | 4 months | Home Study<br><br>Small Group<br><br>Control | 6 sessions, duration NR<br><br>6 sessions, duration NR | I<br><br>G | mail-delivered<br><br>led by persons trained in presentation of the standardised curriculum |

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| Goeppinger, et al., 2009□(US) | 458, 54(12), 85%F<br><br>463, 53(12), 86%F | phase targeted recruitment strategy in an effort to reach both Spanish and English speakers, including African-Americans; state health departments, radio, internet, flyers, tv, etc. | 4 months from baseline | Treatment<br><br>Control | no sessions (mail-delivered) (study duration NR) | I | mail delivered paper and audio materials |
| Hammond, et al., 2001□(UK) | 65, 49(11), 82%F<br><br>62, 52(10), 71%F | recruited from 2 hospitals | 6 months, 12 months | Joint Protection<br><br>Control | 4 (2 hr.) sessions (study duration NR)<br><br>4 (2 hr.) sessions (study duration NR) | G<br><br>G | rheumatology occupational therapist<br><br>nursing, medical, occupational therapy, and physiotherapy staff |
| Hammond, et al., 1999 (UK) | 17, 55(9), 83%F (over all groups)<br><br>18, 55(9), 83%F (over all groups) | NR | PT, 12 weeks from baseline | Treatment<br><br>Control | 1 (2 hr.) session/week for 4 weeks + 1 optional home visit within 2 weeks post-treatment | G | rheumatology occupational therapist |
| Hammond, et al., 2004 (UK) | 162, 54 (14), 75%F<br><br>164, 57 (14), 70% | recruited from 11 hospitals in the former North Thames Regional Health Authority | 6 months, 12 months, 24 months | Occupational Therapy<br><br>Control | 4 one hr. individual treatments and 1 two hr. group arthritis education program over 6-8 weeks | 4 I<br>1G | senior occupational therapists, trained in delivering this program |

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|---|---|---|---|---|---|---|---|
| Hansson, et al., 2010 (Sweden) | 61, 62(9), unreported<br><br>53, 63(10), unreported | referred to the patient education program for osteoarthritis by their GP, orthopaedic specialist, physiotherapist, or occupational therapist | 6 months | Treatment<br><br>Control | 1 (3 hr.) session/week for 5 weeks | G | physiotherapist, occupational therapist, and orthopaedic specialist |
| Helliwell, et al., 1999 (UK) | 43, median 55(range 23-71), 63%F<br><br>34, median 57(range 28-78), 71%F | from routine out-patient clinic appointments | PT, 12 months from baseline | Treatment<br><br>Control | 1 (2 hr.) session/week for 4 weeks | G | non-medical health professional |
| Heuts, et al., 2005 (Neth) | 132, 51(5), 59%F<br><br>141, 52(5), 60%F | from academic registration networks of primary care practices and by local advertisements. Two morbidity registration networks in the Netherlands representing about 77 general practitioners collaborated in this study. Additionally, letters were sent to 309 other general practices in Limburg, which resulted in 15 more general practitioners willing to refer patients. | 3 months, 21 months | Treatment<br><br>Control | 6 (2 hr.) sessions (study duration NR) | G | physiotherapists |

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|---|---|---|---|---|---|---|---|
| Hewlett, et al., 2011 (UK) | 65, 61(11), 75.4%F<br><br>62, 58(12), 71%F | recruited from rheumatology departments in two teaching hospitals in Bristol, UK, approached in person (consecutive patients attending clinic) or by letter (via departmental RA databases, randomly mailed in batches of 40) | 12 weeks from PT (4 weeks from booster session) | Treatment<br><br>Control | 1 (2 hr.) session/week for 6 weeks + 1 (1 hr.) session 2 months later | G<br><br>G | clinical psychologist and specialist occupational therapist<br><br>rheumatology specialist nurse |
| Hill, et al., 2001 (UK) | 51, median 63(range 22-74), 100%F<br><br>49, median 62(range 34-79), 100%F | from the outpatient clinic at Leeds General Infirmary | 24 weeks from baseline | Treatment<br><br>Control | 7 (30 min.) sessions over 6 months | I<br><br>I | rheumatology nurse practitioner<br><br>rheumatology nurse practitioner |
| Hopman-Rock, et al., 2000 (Neth) | 56, 65(5), 78%F<br><br>49, 65(6), 88%F | by announcements in newspapers and on television in the area around the research centre | PT, 6 months | Treatment<br><br>Control | 1 (2 hr.) session/week for 6 weeks | G | occupational therapist, general practitioner, physical therapist, and peer educator |
| Hughes, et al., 2004 (US) | 80, 74(7), unreported<br><br>70, 74(6), unreported | recruited by newsletter, announcements in the local media, and presentations to local senior groups | 2 months from baseline, 6 months from baseline | Treatment<br><br>Control | 3 (1.5 hr.) sessions/week for 8 weeks | G | physical therapists |

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|---|---|---|---|---|---|---|---|
| Hurley, et al., 2007 (UK) | 132, 68 (range 51-84), 71%F<br><br>146, 66 (50-91), 71%F<br><br>140, 67 (51-89), 69%F | patients who had consulted a primary care physician were given specific written info about the intervention they would receive. Those interested called the investigators and received a verbal explanation of the trial | 6 months from PT<br><br>6 months from PT | Group Treatment<br><br>Individual Treatment<br><br>Control | 2 session/week for 6 weeks<br><br>2 session/week for 6 weeks | G<br><br>I | physiotherapist<br><br>physiotherapist |
| Kaplan, et al., 1981 (US) | 11, 46(range 29-63), 100%F<br><br>17, 51(range 23-63), 100%F | women regularly attending the Rheumatology Clinics of Milwaukee County General Hospital were selected for the study from a large group of approximately 100 patients with RA who were invited to participate | PT | Treatment<br><br>Control | 1 (1 - 2 hr.) session/week for 15 weeks<br><br>3 (2.5 hr.) sessions over 15 weeks | G<br><br>G | rheumatologist, occupational therapist, medical social worker, patient counselor, and psychiatrist<br><br>rheumatologist, occupational therapist, medical social worker |

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| Keefe, et al., 2004 (US) | 18, 60(12), 50%F<br><br>16, 60(9), 38%F<br><br>20, 60(9), 65%F<br><br>18, 58(14), 61%F | recruited from rheumatology clinics and advertisements placed in newspapers | PT | Spouse-Assisted Coping Skills<br><br>Exercise<br><br>Combination<br><br>Control | 1 (2 hr.) session/week for 12 weeks<br><br>3 (30 min.) aerobic sessions/week + 2 (30 min.) strength training sessions/week for 12 weeks<br><br>1 (2 hr.) session/week for 12 weeks + 3 (30 min.) aerobic sessions/week + 2 (30 min.) strength training sessions/week for 12 weeks | G<br><br>G<br><br>G | PhD level psychologists<br><br>PhD level psychologists and BA or above physiologist<br><br>BA or above exercise physiologists |

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| Keefe, et al., 1990<br>(US) | 99,<br>64(11), 72%F<br><br>over all groups | from clinics of the Division of Rheumatology and Immunology at Duke University Medical Center | PT | Pain Coping Skills<br><br><br><br><br><br><br>Education<br><br><br>Control | 1 (1.5 min.) session/week for 10 weeks | G<br><br><br><br><br><br><br>G | psychologist with group CBT pain management experience and nurse with arthritis education experience<br><br>psychologist with group CBT pain management experience and nurse with arthritis education experience |
| Kirwan, et al., 2005<br>(UK) | 30,<br>56(CI 53, 60), 63.3%F<br><br>28,<br>57(CI 53, 61), 75%F | hospital outpatients were invited to take part | 4, 8, 12, 24, and 36 weeks from baseline | Treatment<br><br><br><br>Control | 1 (2.5 hr.) session/week for 4 weeks + 1 (2.5 hr.) session 4 weeks later | G | psychologist, specialist rheumatology nurse, occupational therapist, physiotherapist, pharmacist, and rheumatologist |

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|---|---|---|---|---|---|---|---|
| Kovar, et al., 1992 (UK) | 52, 70(9), 77%F<br><br>50, 68(11), 90%F | recruited from a broad population base that included private patients who had a scheduled appointment with a cooperating physician at The Hospital for Special Surgery, a major referral center for patients with musculoskeletal and rheumatic diseases located at the New York Hospital-Cornell Medical Center; patients seen in the outpatient rheumatology and orthopaedic clinics of the hospital; and patients identified through the New York Chapter of the Arthritis Foundation and various community based sites in the vicinity of the hospital | PT | Treatment<br><br>Control | 3 (1.5 hr.) sessions/week for 8 weeks | G | physical therapist |
| Kraaimaat, et al., 1995 (Neth) | 77, 57(13), 68%F<br><br>over all groups | rheumatologists of 4 hospitals in the center of the Netherlands selected 512 patients who met inclusion criteria. These patients were invited by letter to participate in the study | PT, 6 months | CBT<br><br>OT<br><br>Control | 1 (2 hr.) session/week for 10 weeks<br><br>1 (2 hr.) session/week for 10 weeks | G<br><br>G | rheumatologist and clinical psychologists<br><br>rheumatologist and occupational therapists |

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| Laforest, et al., 2008<br>(Can) | 65, 77(10), 90%F<br><br>48, 79(10), 91%F | recruited from the local community health service centers (CLSCs), which are part of the Quebec health and social services network. All 29 Montreal CLSCs were invited to participate, and 15 CLSCs agreed to participate. | PT | Treatment<br><br>Control | 1 (1 hr.) session/week for 6 weeks<br>(the first session of 6 was 1.5 hrs.) | I | healthcare professional |
| Lindroth, et al., 1997<br>(Sweden) | 49, 54(15), 90%F<br><br>47, 56(12), 85%F | all rheumatologists working in Malmo were asked to refer all patients with RA who came to their clinic | 3 months, 12 months | Treatment<br><br>Control | 1 (2.5 hr.) session/week for 8 weeks | G | doctor, nurse, physiotherapist, occupational therapist, social worker, and dietician |
| Lorig, et al., 1986<br>(US) | NR, 70(9), 72%F<br><br>NR, 62(14), 69%F<br><br>NR, 62(12), 79%F | recruited by use of public service announcements | 4 months from baseline | Lay-Led<br><br>Pro-Led<br><br>Control | 1 (2 hr.) session/week for 6 weeks<br><br>1 (2 hr.) session/week for 6 weeks | G<br><br>G | 2 lay-leaders<br><br>rheumatologist and physical therapist |
| Lorig, et al., 1985<br>(US) | 129, 67(12), 83%F<br><br>61, NR(NR), NR | by public service announcements in the mass media, from a community clinic, and from senior citizen centers | 4 months from baseline | Treatment<br><br>Control | 6 sessions (duration NR) over 4 months | G | 2 trained lay-leaders |

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| Lorig, et al., 1989 (US) | 64, NR (NR), 84%F<br><br>over all groups | through public service announcements in newspapers, on radio, and on television in the SF Bay area | 4 months from baseline | Treatment<br><br>Control | 1 (2 hr.) session/week for 6 weeks | G | 2 trained lay-leaders |
| Lorig, et al., 2004 (US) | 522, 62(range 20-90), 77%F (over all groups)<br><br>568, 62(range 20-90), 77%F (over all groups) | potential participants in the Arthritis, Rheumatism, and Aging Medical Information System (ARAMIS) databank centers in Wichita, Kansas; Nashville, Tennessee; Saskatoon, Canada; and Pittsburgh, Pennsylvania and who had OA or RA were invited by the databank centers to participate in the first trial | 1 year, 2 years, and 3 years from baseline | Treatment<br><br>Control | 4 sessions (duration NR) over 12 - 18 months | I | self-administered mail-delivered |
| Lorig, et al., 1999 (US) | 561 (314 with arthritis), 66(range 40-90), 65%F this group's information is for all disease groups, but only arthritis data analysed here<br><br>207, 65(range 40-89), 64%F | recruited using public services announcements in the mass media,<br>referrals from flyers left in physicians' offices and community clinics, posters at senior citizen centers, announcements in health maintenance organization (HMO)<br>patient newsletters, and referrals from county government employers | 6 months from baseline | Treatment<br><br>Control | 1 (2.5 hr.) session/week for 7 weeks | G | lay leaders |

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| Lundgren, et al., 1999 (Sweden) | 37, 57 (28-70), 81%F<br><br>31, 57 (34-68), 71%F | from the rheumatology unit at the Rehab Centre, Vanersborg | PT, 6 months from PT, 12 months from PT | Treatment<br><br>Control | 2 (30 min.) sessions/week for 10 weeks | NR | physical therapist supervised, taped instructions |
| Martire, et al., 2007 (USA) | 89, 68 (8), 72%F<br><br>99, 69 (7), 74%F<br><br>54, 68 (8), 72%F | recruited through the rheumatology clinics affiliated with the University of Pittsburgh Medical Center from 2000 to 2003 | 1 month from PT, 6 months later | Patient Education<br><br>Couples Education<br><br>Control | 1 (2 hr.) session/week for 6 weeks, plus 5 monthly booster sessions<br><br>1 (2 hr.) session/week for 6 weeks, plus 5 monthly booster sessions | G<br><br>G | an individual who was trained by staff of the Arthritis Foundation to lead the Arthritis Self-Management Program |
| Masiero, et al., 2007 (Italy) | 46, 54(10), 81%F<br><br>39, 52(12), 82%F | recruited via invitation to participate from the outpatients of the University of Padova rheumatology department | 8 months | Treatment<br><br>Control | 4 (3 hr.) sessions over 12 weeks | G | physiatrist, rheumatologist, physiotherapist, occupational therapist |
| Mazzuca, et al., 2004 (US) | 111, 62 (13), 74%F<br><br>75, 62 (12), 71%F | recruited from the membership of a large HMO with multiple care sites in the Greater Indianapolis Area between April and December 1999 | 3 months, 6 months, 12 months from PT | Treatment<br><br>Control | 1 (30-60 min.) session, 4 (5-10 min.) phone calls, follow-up visit 10 weeks from baseline; 18 week total intervention duration | I | nurse |

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| Multon, et al., 2000 (US) | 44, 58 (11), 41%F<br><br>42<br><br>44 | recruited from a midwestern Department of Veterans Affairs hospital, a university medical center, and a private rheumatology practice. | PT, 3 months, 15 months from PT | Stress Management Attention<br><br>Attention Control<br><br>Control | 1 (1.5 hr.) session/week for 10 weeks, 1 session every 3 months for 15 months<br><br>1 (1.5 hr.) session/week for 10 weeks, 1 session every 3 months for 15 months | I<br><br>I | 3 counselors with masters degrees in psychology and were well trained in CBT |
| Neuberger, et al., 1993 (US) | 53, 53(14), 66%F<br><br>over all groups | outpatients seen at a 500 bed teaching hospital | 3 - 16 weeks from PT | Group 1<br><br>Group 2<br><br>Group 3<br><br>Control | 4 (20 - 25 min.) sessions (study duration NR)<br><br>4 (20 - 25 min.) sessions (study duration NR)<br><br>4 (20 - 25 min.) sessions (study duration NR) | I<br><br>I<br><br>I | self-administered<br><br>self-administered and investigator<br><br>self-administered and investigator or nurse<br><br>investigator |
| Nour, et al., 2006 | 65, 77 (10), NR<br><br>48, 79 (10), NR | recruited over a one-year period through 15 Local Community Health Service Centers located in a large urban center | PT | Treatment<br><br>Control | 1 (1 hr.) session/week for 6 weeks | I | a practitioner |

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| Nuñez, et al., 2006a (Spain) | 51, 73(6), 76%F<br><br>49, 69(7), 65%F | referral from the Orthopedic Surgery Department to the study's TEFR Unit | 6 months from PT | Treatment<br><br>Control | 1 (30 min.) session at week 1 + 1 (1.5 hr.) session/week at weeks 3 and 4 + 1 (30 min.) session at 3 months | 2 G<br>2 I | trained health educator |
| Nuñez, et al., 2006b (Spain) | 22, 55(16), 36%F<br><br>21, 51(17), 29%F | referred from the outpatient clinic of the Rheumatology department of the Hospital Clinic, a tertiary care center in Barcelona, Spain | 6 months PT | Treatment<br><br>Control | 4 (30 min.) sessions and 2 (2 hr.) sessions/3 months for 1 year | 2 G<br>4 I | trained health educator |
| O'Brien, et al., 2006 (UK) | 21, 62(10), 71%<br><br>24, 57(8), 75%F<br><br>22, 60(13), 73%F | via the multidisciplinary clinical team and were then screened by telephone by the research physiotherapist | PT | Strengthening and Mobilsing<br><br>Mobilising<br><br>Control | 4 sessions (15 - 30 min.) over 6 months<br><br>4 sessions (15 - 30 min.) over 6 months<br><br>1 (30 min.) session | I<br><br>I<br><br>I | musculoskeletal therapist<br><br>musculoskeletal therapist<br><br>musculoskeletal therapist |
| Oermann, et al., 1986 (US) | 15, 47(range 23-68), "mostly female"<br><br>15, 58(range 30-80), "mostly female" | from a rheumatology clinic associated with Wayne State University | PT | Treatment<br><br>Control | 7 units (duration unreported) for an average of 4 weeks | I | self-instruction |

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| Parker, et al., 1988 (US) | 83, 61(8), unreported<br><br>over all groups | from a midwestern Veterans Administration hospital | PT | CBT<br><br>Attention Control<br><br>Control | 24 (1 hr.) sessions over 1 week + plus<br><br>support groups every 1 - 3 months for 1 year<br><br>24 (1 hr.) sessions over 1 week + plus support groups every 1 - 3 months for 1 year | G<br><br>G<br><br>G | NR<br><br>NR<br><br>NR |
| Parker, et al., 1984 (US) | 11, 55 (11), 0%F<br><br>11, 56 (10), 0%F | from a Veterans Administration hospital | PT, 3 months | Treatment<br><br>Control | 7 hrs. (number of sessions NR) | G | rheumatology patient educator, rheumatologist, occupational |
| Parker, et al., 1995 (US) | 47, 60 (median), NR<br><br>49, 59 (median), NR<br><br>45, 60 (median), NR | from a a midwestern Department of Veterans Affairs hospital | PT, 3 months, 15 months from PT | Stress Management<br><br>Attention Control<br><br>Control | 1 (1.5 hr.) session/week for 10 weeks, 1 maintenance session every 3 months for 15 months | I | counselors with masters' degrees in psychology and trained in CBT |

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| Peterson, et al., 1993<br>(US) | 91, 69(NR), NR | recruited from cooperating physicians at the Hospital for Special Surgery, outpatient rheumatology and orthopedic clinics at the hospital, and volunteers from various community-based sites in the vicinity of the hospital | PT | Treatment<br><br>Control | 3 (1.5 hr.) sessions/week for 8 weeks | G | trained interventionist or guest speaker |
| Petkova, et al., 2009<br>(Bulg) | 43, 46 (3), 67%F<br><br>43, 45(3), 58%F | registered as arthritis patients at St. Ivan Rilski University Multiple Profile Hospital for Active Treatment, Sofia, Bulgaria | 4 months from baseline | Treatment<br><br>Control | 1 session (duration unreported)/month for 4 months | NR | pre-graduation pharmacists |
| Pradhan, et al., 2007 (US) | 63, NR | recruited through advertisements in Baltimore newspapers, presentations to rheumatologists, presentations at community health fairs, and informational flyers widely distributed through the Maryland Chapter of the Arthritis Foundation | 2 months, 6 months from PT | G | 1 full day 'retreat', 1 (2.5 hr.) session/week for 7 weeks, 3 refresher sessions over 4 months | G | 3 certified MBSR teachers taught the classes, all trained through the Center for Mindfulness at the University of Massachusetts Medical School |

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| Radojevic, et al., 1992<br>(US) | 59, 54(NR), 76%F<br><br>over all groups | recruited to participate from the department of rheumatology at a major university medical center and from private rheumatologists in the San Diego area | PT, 2 months | BTFS<br><br><br><br>BT<br><br><br><br>EFS<br><br>Control | 1 (1.5 hr.) session/week for 4 weeks + 2 weeks of home practice<br><br>1 (1.5 hr.) session/week for 4 weeks + 2 weeks of home practice<br><br>1 (1.5 hr.) session/week for 4 weeks + 2 weeks of home discussion | G<br><br><br><br>G<br><br><br><br>G | 3 research assistants who were doctoral candidates in clinical psychology<br><br>3 research assistants who were doctoral candidates in clinical psychology<br><br>therapists |
| Ravaud, et al., 2009<br>(France) | 146, 64(8), 100%M<br><br>181, 65(8), 100%M | recruited rheumatologists by mail, sending them an invitation to participate in the trial. Each rheumatologist had to include the first two patients who complied with the inclusion criteria | PT, 8 months from PT | Treatment<br><br><br>Control | 3 sessions (duration NR) over 1 month<br><br>3 sessions (duration NR) over 1 month | I<br><br>I | rheumatologist |
| Riemsma, et al., 1997 (Neth) | 69, 57 (10), 67%F<br><br>75, 59 (10), 66%F<br><br>72, 58 (9), 65%F | from outpatient clinics of the 5 rheumatologists of the Medisch Spectrum Twente, Enschede, and the Twenteborg Ziekenhuis, Almelo | 1 month, 13 months form PT<br><br>1 month, 13 months form PT | Treatment<br><br>Attention Control<br><br>Control | number of sessions NR, 6 months intervention duration<br><br>number of sessions NR, 6 months intervention duration | I<br><br>I | rheumatologists, GPs physiotherapists, and visiting nurses |

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| Rogers and Wilder, 2009 (US) | 46, 75 (7), 87%F | recruited from the greater Clearwater, Florida community through newspaper announcements, presentations at senior centers, and word of mouth | PT, 4 months from PT | Treatment<br><br>Control | 1 session in lab to teach proper techiniques, done at home daily (10-15 min.) for 4 months | I | principle investigator |
| Scholten, et al., 1999 (Austria) | 68, 48(6), 79%F<br><br>over all groups | NR | 2 weeks, 6 weeks, and 52 weeks from baseline | Treatment<br><br>Control | 9 sessions (duration NR) over 2 weeks | G | rheumatologists, orthopaedists, physicotherapists, psychologists, and social workers |
| Sharpe, et al., in press (Aus) | 25, 58(15)<br><br>26, 58(13)<br><br>27, 55(13)<br><br>26, 54(11)<br><br>78%F (over all groups) | recruited through their routine out-patient appointments or contacted the researchers in response to an article in the Arthritis Foundation Newsletter | 6 months from PT | CBT<br><br><br><br>BT<br><br><br><br>CT<br><br>Control | 1 (1 hr.) session/week for 8 weeks<br><br>1 (1 hr.) session/week for 8 weeks<br><br>1 (1 hr.) session/week for 8 weeks | I<br><br><br><br>I<br><br><br><br>I | 5 psychologists with postgraduate training specialising in CBT<br><br>5 psychologists with postgraduate training specialising in CBT<br><br>5 psychologists with postgraduate training specialising in CBT |

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| Sharpe, et al., 2001<br>(Aus) | 23, 54(14), 70%F<br><br>22, 57(13), 73%F | from rheumatology clinics at three hospitals in or near London | PT, 6 months from PT | Treatment<br><br>Control | 1 (1 hr.) session/week for 8 weeks | I | 2 psychologists |
| Stamm, et al., 2002<br>(Austria) | 20, NR(NR), NR<br><br>20, NR(NR), NR | from 2 Austrian rheumatology outpatient clinics | PT | Treatment<br><br>Control | 1 (45 min.) session<br><br>1 (20 min.) session | I<br><br>I | occupational therapist<br><br>occupational therapist |
| Taal, et al., 1993<br>(Neth) | 27, 50(range 27-64), 74%F<br><br>30, 50(range 24-64), 73%F | from a nationwide Standard Diagnosis Registration system | 4 months and 14 months from baseline | Treatment<br><br>Control | 1 (2 hr.) session/week for 5 weeks | G | nurses specialising in rheumatic diseases, physiotherapists, and social workers |
| Victor, et al., 2005<br>(UK) | 120, 62(11), 75%F<br><br>73, 65(11), 69%F | general practices referring patients to the Rheumatology Department at St George's Hospital were enrolled into the study | 1 month, 1 year | Treatment<br><br>Control | 4 (1 hr.) sessions (study duration NR) | G | 2 research nurses |
| Wetstone, et al., 1985 (US) | 18, 50 (13), 83%F<br><br>17, 52 (13), 82%F | recruited from the patients that were followed by the faculty at University of Connecticut School of Medicine | 2-6 weeks from baseline | Treatment<br><br>Control | 1-4 sessions (mean duration 24 min.), intervention duration NR | I | research assistant |

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| Wetzels, et al., 2008<br>(Neth) | NR, 76(7), 76%F<br><br>NR, 73(6), 75%F | from 9 family practices in the Netherlands | 3 months from PT | Treatment<br><br>Control | 3 sessions (home visit was 30 min.; other session durations NR) over 3 months | I | rheumatology nurse |
| Yip, et al., 2007<br>(China) | 88, 66(1), 84%F<br><br>94, 64(1), 84%F | recruited in the specialist out-patient clinic of the Orthopaedic Department of a local hospital, the general outpatient clinic of a local hospital and the Telehealth clinic | PT, 4 months from PT | Treatment<br><br>Control | 1 (2 hr.) session/week for 6 weeks | G | registered nurses trained in small group leadership and basic principles on self-management and a lay-person Tai Chi tutor |

*Note: N = number of participants; sd = standard deviation; PT = posttreatment; I = individual; G = group*

## Appendix 2 – Information Extracted from Each Study Included in Narrative Review Update

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Allen, et al., 2017 (US) | 128, 64 (9), 73%F<br><br>140, 63 (10), 76%F<br><br>140, 63 (9), 76%F<br><br>129, 64 (10), 71%F | identified from electronic medical records at Duke University Health System's community-based primary care clinics | PT, 6 months | Treatment<br><br>Provider<br><br>Patient-Provider<br><br>Control | 1 year (6 bimonthly phone calls + 6 monthly phone calls) | I | counselor |
| Bossen, et al., 2013 (Neth) | 100, 61 (6), 60%F<br><br>99, 63 (5) 70%F | through advertisements in Dutch newspapers and online on health-related websites | 3 months, 12 months | Treatment<br><br>Control | 9 weeks | I | online |
| Bozic, et al., 2013 (US) | 61, NR NR<br><br>62, NR NR | identified from the clinic schedules of patients referred to medical centers at the University of California and Stanford University | PT, 6 weeks | Treatment<br><br>Control | NR, mail-delivered information + question-listing telephone consultation<br><br>leaflet from GP office (DM) | I | health coach |

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Breedland, et al., 2011 (Neth) | 19, 45 (12), 63%F<br><br>15, 52 (9) 80%F | eligible patients referred by a rheumatologist to a rehabilitation center in the Netherlands were invited to take part | PT, 6 months | Treatment<br><br>Control | 8 weeks (1.5 hours twice weekly exercise + once weekly 1 hour education sessions) | G | physical therapist, psychologist, occupational therapist, dietician, social worker |
| Broderick, et al., 2014 (US) | 129, 68 (9), 74%F<br><br>128, 66 (10), 79%F | from community primary care and rheumatology practices in New York, Virginia, and North Carolina. Advertisements were posted in waiting rooms and doctors informed eligible patients about the study | PT, 6 months, 12 months | Treatment<br><br>Control | 10 weeks (1 session per week) | I | nurse practitioner |
| Callahan, et al., 2014 (US) | 172, 68 (1), 87%F<br><br>167, 70 (1), 80%F | recruited through community contacts (eg. family practice offices, rheumatology clinics, community centres, and health departments), local radio, and print advertisements | PT | Treatment<br><br>Control | 20 weeks (1 hour long session per week) | G | trained instructors recruited from community-based health roles |
| Clarke, et al., 2017 (UK) | 16, 66 (7), 25%F<br><br>15, 67 (11), 67%F | eligible patients who participated in previous research and expressed interest in future research as well as eligible patients attending clinics at Nottingham University Hospitals and Sherwood Forest Hospitals NHS Trusts were invited | 2 months, 4 months | Treatment<br><br>Control | 6 weeks (weekly 1 hour sessions) | G | clinical psychologist |

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Coleman, et al., 2012 (Aus) | 71, 65 (8), 80%F<br><br>75, 65 (9), 69%F | recruited from primary care general practices in Perth, Australia | PT, 6 months | Treatment<br><br>Control | 6 weeks (weekly 2.5 hour sessions) | G | healthcare professionals |
| Conn, et al., 2013 (US) | 52, 54 (8), 79%F<br><br>52, 53 (10), 79%F | eligible patients attending Grady Hospital Arthritis Clinic in Georgia, USA were recruited | 6 months, 12 months, 18 months | Treatment<br><br>Control | 6 weeks (weekly 2 hour sessions) | G | instructor identified by the Georgia Chapter of the Arthritis Foundation |
| Dziedzic, et al., 2018 (UK) | 288, 67 (11), 58%F<br><br>237, 68 (10), 62%F | general practices using the EMIS (electronic health records system) were invited to take part | PT, 3 months, 6 months, 12 months | Treatment<br><br>Control | 3 months (4 GP visits) | I | GPs and practice nurses trained as part of the provider intervention component of this study |
| El Miedany, et al., 2012 (Egypt) | 74, 53 (10), 72%<br><br>73, 53 (10), 74%F | NR | 3 months, 6 months, 9 months, 12 months | Treatment<br><br>Control | NR | I | healthcare professional |

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Feldthusen, et al., 2016 (Sweden) | 36, 54 (9), 89%F<br><br>34, 53 (11), 88%F | recruited from the Swedish Rheumatology Quality Register of the participating hospital | PT, 6 months | Treatment<br><br>Control | 12 weeks | I | physical therapist |
| Fergusen, et al., 2015 (UK) | 10, 51 (14), 100%F<br><br>8, 46 (17), 100%F | approached by the psychologist during clinics at a hospital rheumatology outpatient clinic in England | PT | Treatment<br><br>Control | 6 weeks (weekly 50 minute sessions) | I | psychologist |
| Ferwerda et al., 2017 (Neth) | 62, 55 (11), 61%F<br><br>71, 57 (9), 66%F | recruited from rheumatology departments at on academic and 3 nonacademic hospitals in the Netherlands | PT, 3 months, 6 months, 9 months, 12 months | Treatment<br><br>Control | 9 – 65 weeks (online, individually tailored / prescribed intervention modules) | I | psychologists |

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Forss, et al., 2017 (Sweden) | 51, NR<br><br>49, NR<br><br>83%F overall | referred by their general practitioner, orthopaedic specialist, physiotherapist, or occupational therapist to the patient education programme in Primary Health Care in Sweden | 6 months | Treatment<br><br>Control | 5 weeks (weekly 3 hour sessions) | G | NR |
| Helminen, et al., 2015 (Finland) | 55, 65 (7), 71%F<br><br>56, 63 (7), 68%F | NR | 3 months, 12 months | Treatment<br><br>Control | 6 weeks (weekly 2 hour sessions) | G | psychologist, physiotherapist |
| Laforest, et al., 2012 (Can) | 36, 77 (11), 86%F<br><br>29, 77 (10), 97%F<br><br>48, 79 (10), 90%F | recruited from local Community Health Services Centers in Canada | 2 months, 10 months | Treatment<br><br>Treatment + Social Support<br><br>Control | 6 weeks (weekly 1 hour sessions)<br><br>6 weeks + 6 months support (6 weekly sessions, plus bimonthly phone calls for 2 months followed by monthly phone calls for 4 months) | I<br><br>I | trained healthcare practitioner<br><br>trained healthcare practitioner |

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Lee, et al., 2012 (Korea) | 150, 64 (9), 93%F<br><br>140, 68 (9), 89%F | recruited from 47 community health posts in Korea | PT | Treatment<br><br>Control | 6 weeks (weekly 2 hour sessions) | G | community health practitioners |
| Manning, et al., 2014 (UK) | 52, 53 (16), 85%F<br><br>56, 57 (15), 68%F | recruited from the rheumatology clinics and physiotherapy departments of 4 public hospitals in England | 3 months, 9 months | Treatment<br><br>Control | 14 weeks (biweekly sessions for 2 weeks + 12 weeks home exercise) | G | trained physiotherapists |
| Meade, et al., 2015 (Aus) | 78, 31 (4), 100%F<br><br>66, 30 (5), 100%F | through online advertising including a Google ad campaign, social media, media releases, website content, and relevant arthritis websites as well as print advertising including general practitioner newsletters, posters, and flyers distributed to rheumatology clinics | PT | Treatment<br><br>Control | 2 weeks | I | email |
| Moe, et al., 2013 (Norway) | 390, 63 (8), 86%F overall | from a specialist rheumatology outpatient clinic | 4 months | Treatment<br><br>Control | 3.5 hours plus consultation following group session on same day | G | dietist, nurse, occupational therapist, pharmacist, physical therapist, rheumatologist |

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Murphy, et al., 2016 (USA) | 64, 64 (8), 61%F<br><br>66, 64 (8), 62%F<br><br>63, 66 (9), 62%F | recruited through public advertisements (e.g. newspaper, online, radio, flyers) and through flyers at clinics in the University hospital and Veterans Administration | PT, 6 months | Tailored Activity Pacing<br><br>Activity Pacing<br><br>Usual Care | 10 weeks weeks (1 hour session followed by two 30-45 minute sessions every 7-10 days) | I<br><br>I | occupational therapists |
| Pisters, et al., 2010 (Netherlands) | 97, 65 (7), 75%F<br><br>103, 65 (8), 79%F | recruited by participating physiotherapists and by articles about the study in local newspapers | 3 months, 9 months, 15 months, 5 years | Treatment<br><br>Control | 12 weeks (18 initial sessions + 5 booster sessions) | I | physical therapists |
| Pot-Vaucel, et al., 2016 (France) | 28, 58 (11), NR<br><br>26, 62 (10), NR | from the rheumatology department of Nantes university hospital in France | 6 months | Treatment<br><br>Control | 6 months (diagnostic interview + 3 sessions + final evaluation) | I, G | patient therapeutic educator |

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Poulsen, et al., 2013 (Denmark) | 39, 66 (7), 38%F<br><br>43, 66 (9), 45%F<br><br>36, 63 (9), 47%F | referred to the study by medical practitioners in Denmark and contacted by phone by the principal investigator | 6 weeks, 3 months, 12 months | Education<br><br>Education and Manual Therapy<br><br>Control | 6 weeks (personal interview, 3 group education sessions, personal follow-up)<br><br>6 weeks (personal interview, 3 group education sessions, personal follow-up + two 15-20 minute manual therapy sessions per week) | I, G<br><br>I, G | physiotherapist<br><br>physiotherapist, chiropractor |
| Rini, et al., 2015 (USA) | 58, 69 (8), 79%F<br><br>55, 67 (11), 82%F | recruited from the Johnston County Osteoarthritis Project in North Carolina, USA | PT | Treatment<br><br>Control | 8 weeks (one module per week) | I | online programme |
| Saraboon, et al., 2015 (Thailand) | 40, 67 (6), 93%F<br><br>40, 68 (7), 93%F | recruited from 8 communities in Muang Nakhon Phanom Municipality, Thailand | 8 weeks, 6 months, 12 months | Treatment<br><br>Control | 6 weeks (3 consecutive days of 2 hour sessions + follow-up sessions every 2 weeks for 6 weeks following the initial workshops | G | NR |

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Saw, et al., 2016 (South Africa) | 35<br><br>39<br><br>61 (6), 81%F overall | recruited from hip/knee arthroplasty waiting lists at Tygerberg and Helen Joseph Hospitals in South Africa | PT, 6 weeks, 4.5 months | Treatment<br><br>Control | 6 weeks (weekly 2 hour sessions) | G | physiotherapists |
| Schlenk, et al., 20ll (USA) | 26, 63 (10), 96%F | recruited from rheumatology practices, an arthritis disease registry, and self-referral | PT | Treatment<br><br>Control | 6 months (6 weekly sessions + 9 biweekly phone counseling sessions) | NR | physical therapist, nurse |
| Shigaki, et al., 2013 (USA) | 54, 50 (12), 93%F<br><br>52, 49 (12), 92%F | recruited through online Google ads, craiglist, RA-relevant discussion boards, and through local rheumatology clinics | PT, 9 months | Treatment<br><br>Control | 10 weeks (online access to programme + weekly phone calls from counselor) | I, G | online, CBT counselor |
| Skou, et al., 2016 (Denmark) | 50, 65 (9), 52%F<br><br>50, 67 (9), 50%F | recruited from 2 specialised, public outpatient clinics at Aalborg University Hospital in Denmark | PT, 3 months, 6 months, 12 months, 2 years | Treatment<br><br>Control | 3 months (2 one hour education sessions + biweekly one hour exercise sessions and 4 weekly one hour dietary advice sessions over one month + an 8 week transition period to home exercise) | NR | physiotherapist |

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Somers, et al., 2012 (USA) | 60, 58 (11), 67%F | recruited through the Rheumatology, Orthopedic Surgery, Internal Medicine, Family Medicine, and Pain Management clinics at Duke University Medical Center, through flyers posted in the community and from advertisements in local newspapers | PT, 6 months, 12 months | Pain Coping Skills Training | 1 year (weekly 1 hour sessions for 12 weeks followed by bimonthly sessions for 12 weeks + 6 monthly maintenance calls) | G | psychologists |
| | 59, 58 (11), 80%F | | | Behavioural Weight Management | same as PCST + three 1.5 hour exercise sessions per week for the first 12 weeks | G | psychologists |
| | 62, 57 (9), 92%F | | | PCST + BWM | | | |
| | 51, 58 (10), 78%F | | | Control | | | |

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Sperber, et al., 2013 (USA) | 172 | recruited from the primary care unit at Durham VA Medical Center in North Carolina, USA | PT | OA intervention | 1 year (written and audio intervention materials + monthly telephone calls to review key points) | I | health educator |
| | 172 | | | Attention Control | 1 year (materials regarding hypertension and cholesterol + monthly telephone calls to review these topics) | I | health educator |
| | 171<br><br>60 (10), 7%F overall | | | Control | | | |
| Thomsen, et al., 2016 (Denmark) | 10, 65 (9), 60%F<br><br>10, 54 (14), 60%F | recruited from the rheumatology outpatient clinic at Rigshospitalet, Glostrup in Denmark | PT | Treatment<br><br>Control | 16 weeks (3 motivational counseling sessions during the first 10 weeks, goal prompts via text message for 16 weeks) | I | nurses, researchers |

| Author, Year (Country) | N, Age(sd), Gender | Recruitment | Follow-Up | Groups | Duration | Indiv (I) Gp (G) | Delivered by |
|---|---|---|---|---|---|---|---|
| Thomsen, et al., 2017 (Denmark) | 75, NR NR<br><br>75, NR NR | recruited from the Danish National Board of Health Biological Therapies | PT | Intervention<br><br>Control | 16 weeks (3 motivational counseling sessions during the first 10 weeks, goal prompts via text message for 16 weeks) | I | nurses, researchers |
| Yousefi, et al., 2015 (Iran) | 100, 43 (19), 86%F<br><br>106, 47 (11), 90%F | recruited from a community-based rheumatology clinic in Iran | 5 months, 8 months, 12 months, 15 months | Intervention<br><br>Control | 8 weeks (weekly 2.5 hour sessions) | G | NR |

*Note: N = number of participants; sd = standard deviation; PT = posttreatment; I = individual; G = group*

**Appendix 3 – Randomised, Controlled N-of-1s Advertisement for Pain Group Participants**

University of Strathclyde
Humanities & Social Sciences

## Do you have joint pain in your hips or knees?

## Are you interested in making some changes to your physical activity levels?

We are looking for adults in or around Central Scotland aged 18 years or older who suffer from long-term joint pain in the hips or knees to take part in a research study. We ask that volunteers are physically able to walk and have a mobile phone that sends and receives text messages. You will be asked to participate for 60 days and will not be required to make any significant changes to your daily routine. If you are interested in taking part, please contact Tiffany who will be happy to discuss the study with you in more detail and send you further information by post:

by text at **07706 761 541**
or
by email at **tiffany.hamilton-barclay@strath.ac.uk**

**Appendix 4 – Randomised, Controlled N-of-1s Participant Information Sheet for Chronic Pain Group**

# Participant Information Sheet

**Name of department:** School of Psychological Sciences and Health
**Title of the study:** The effect of joint pain on exercise-related goal-setting

**Introduction**
My name is Tiffany Hamilton-Barclay and I am a postgraduate research student at the University of Strathclyde. This research is being done as part of the department of psychology in the School of Psychological Sciences and Health. I can be contacted via email at tiffany.hamilton-barclay@strath.ac.uk or by phone on 0141 548 4391.

**What is the purpose of this investigation?**
How physically active we are varies over time and between people. Sometimes we are active and other times we are not active; some people are very active and others less so. At the moment we do not fully understand these differences. In this study we are interested in trying to identify the factors that predict how active an individual is each day.

**Do you have to take part?**
No, you don't have to take part, and participation in this study is voluntary. You may withdraw from this study at any time without giving a reason. If you decide to take part in this project, you will be asked to wear an activity monitor every day for 60 days. The activity monitor is about the size of a small box of matches and is worn at the waist. You will also receive a text each morning asking you to make a personal goal for the day. The goal might be an activity goal or a healthy diet goal. You will also be asked to text the researcher each morning and each evening indicating how much joint pain you are experiencing.

**What will you do in the project?**
If you would like to take part in this project you will be asked to meet with me (Tiffany) at a time and place that is convenient for you. This will allow you to answer a health questionnaire that normally takes about 20 minutes complete. I will also show you how to use an activity monitor – a small device that measures walking; it is about the size of a small box of matches and clips to your belt or waistband. A similar meeting will be arranged for the end of the study so that the activity monitor can be returned and so that you can ask any questions that you might have once you've finished the study.

Over the course of 60 days (2 months), you will receive a text message each morning asking you to do 3 things:
- text the researcher to tell them your current pain level
- make a goal about walking or about eating fruit and vegetables that day (the text message will say which type of goal we'd like you to make)
- wear the activity monitor

You will also receive a text message each evening asking you to give your average pain level throughout the day. Once you have completed the study, you will be reimbursed £15 for the cost of sending and receiving these text messages.

**Why have you been invited to take part?**
You have been invited to take part because we are looking for adults who suffer from hip pain, knee pain, or both. However, it is important that you are physically able to stand and walk for 10 minutes at a time (even if you don't usually do it and even if you need to use a walking aid). It is also important that you have a mobile phone that you can use for texting the researcher during the study.

**What are the potential risks to you in taking part?**
There are no potential hazards or risks associated with taking part in this study. All changes to diet and physical activity will be set by yourself – you will not be asked to meet any specific changes. This study will merely ask you to give some of your time. If you have any concerns about participating affecting your health, please check with your GP before starting the study.

**What happens to the information in the project?**
The information you supply will remain confidential and will be securely stored on a password protected computer. The data will be stored securely for a period of 5 years and then destroyed. The University of Strathclyde is registered with the Information Commissioner's Office who implements the Data Protection Act 1998. All personal data on participants will be processed in accordance with the provisions of the Data Protection Act 1998.

Thank you for reading this information – please ask any questions if you are unsure about what is written here.

**What happens next?**
If you are happy to be involved in this project, you will be asked to sign a consent form to confirm this. If you do not want to be involved, I thank you very much for your time – there is nothing more that will be asked of you. All participants will receive information explaining the ideas behind this study. We plan to submit the results for publication in a scientific journal.

**Researcher Contact Details:**
Tiffany Hamilton-Barclay
School of Psychological Sciences and Health
University of Strathclyde
Graham Hills Building
40 George Street
Glasgow, G1 1QE
Telephone: 0141 548 4391
Email: tiffany.hamilton-barclay@strath.ac.uk

**Chief Investigator Details:**
Dr. Diane Dixon
School of Psychological Sciences and Health
University of Strathclyde
Graham Hills Building
40 George Street
Glasgow, G1 1QE
Telephone: 0141 548 2571
Email: diane.dixon@strath.ac.uk

This investigation was granted ethical approval by the University of Strathclyde ethics committee. If you have any questions/concerns, during or after the investigation, or wish to contact an independent person to whom any questions may be directed or further information may be sought from, please contact:

Secretary to the University Ethics Committee
Research & Knowledge Exchange Services
University of Strathclyde
Graham Hills Building
50 George Street
Glasgow, G1 1QE
Telephone: 0141 548 3707
Email: ethics@strath.ac.uk

**Appendix 5 – Randomised, Controlled N-of-1s Advertisement for Healthy Group Participants**

University of Strathclyde
Humanities & Social Sciences

## Are you interested in taking part in research on joint pain in physical activity?

We are looking for adults in or around Central Scotland aged 18 years or older to take part in a research study. We ask that volunteers are physically able to walk and have a mobile phone that sends and receives text messages. You will be asked to participate for 60 days and will not be required to make any significant changes to your daily routine. If you are interested in taking part, please contact Tiffany who will be happy to discuss the study with you in more detail and send you further information:

by email at **tiffany.hamilton-barclay@strath.ac.uk**

**Appendix 6 – Randomised, Controlled N-of-1s Participant Information Sheet for Healthy Group**

# Participant Information Sheet

**Name of department:** School of Psychological Sciences and Health
**Title of the study:** The effect of joint pain on exercise-related goal-setting

**Introduction**
My name is Tiffany Hamilton-Barclay and I am a postgraduate research student at the University of Strathclyde. This research is being done as part of the department of psychology in the School of Psychological Sciences and Health. I can be contacted via email at tiffany.hamilton-barclay@strath.ac.uk or by phone on 0141 548 4391.

**What is the purpose of this investigation?**
How physically active we are varies over time and between people. Sometimes we are active and other times we are not active; some people are very active and others less so. At the moment we do not fully understand these differences. In this study we are interested in trying to identify the factors that predict how active an individual is each day.

**Do you have to take part?**
No, you don't have to take part, and participation in this study is voluntary. You may withdraw from this study at any time without giving a reason. If you decide to take part in this project, you will be asked to wear an activity monitor every day for 60 days. The activity monitor is about the size of a small box of matches and is worn at the waist. You will also receive a text each morning asking you to make a personal goal for the day. The goal might be an activity goal or a healthy diet goal. You will also be asked to text the researcher each morning and each evening indicating how much joint pain you are experiencing.

**What will you do in the project?**
If you would like to take part in this project you will be asked to meet with me (Tiffany) at a time and place that is convenient for you. This will allow you to answer a health questionnaire that normally takes about 20 minutes complete. I will also show you how to use an activity monitor – a small device that measures walking; it is about the size of a small box of matches and clips to your belt or waistband. A similar meeting will be arranged for the end of the study so that the activity monitor can be returned and so that you can ask any questions that you might have once you've finished the study.

Over the course of 60 days (2 months), you will receive a text message each morning asking you to do 3 things:
- text the researcher to tell them your current pain level
- make a goal about walking or about eating fruit and vegetables that day (the text message will say which type of goal we'd like you to make)
- wear the activity monitor

You will also receive a text message each evening asking you to give your average pain level throughout the day. Once you have completed the study, you will be reimbursed £15 for the cost of sending and receiving these text messages.

**Why have you been invited to take part?**
You have been invited to take part because we are looking for healthy adults. It is important that you are physically able to stand and walk for 10 minutes at a time (even if you don't usually do it and even if you need to use a walking aid). It is also important that you have a mobile phone that you can use for texting the researcher during the study.

**What are the potential risks to you in taking part?**
There are no potential hazards or risks associated with taking part in this study. All changes to diet and physical activity will be set by yourself – you will not be asked to meet any specific changes. This study will merely ask you to give some of your time. If you have any concerns about participating affecting your health, please check with your GP before starting the study.

**What happens to the information in the project?**
The information you supply will remain confidential and will be securely stored on a password protected computer. The data will be stored securely for a period of 5 years and then destroyed.

The University of Strathclyde is registered with the Information Commissioner's Office who implements the Data Protection Act 1998. All personal data on participants will be processed in accordance with the provisions of the Data Protection Act 1998.

Thank you for reading this information – please ask any questions if you are unsure about what is written here.

**What happens next?**
If you are happy to be involved in this project, you will be asked to sign a consent form to confirm this. If you do not want to be involved, I thank you very much for your time – there is nothing more that will be asked of you. All participants will receive information explaining the ideas behind this study. We plan to submit the results for publication in a scientific journal.

**Researcher Contact Details:**
Tiffany Hamilton-Barclay
School of Psychological Sciences and Health
University of Strathclyde
Graham Hills Building
40 George Street
Glasgow, G1 1QE
Telephone: 0141 548 4391
Email: tiffany.hamilton-barclay@strath.ac.uk

**Chief Investigator Details:**
Dr. Diane Dixon
School of Psychological Sciences and Health
University of Strathclyde
Graham Hills Building
40 George Street
Glasgow, G1 1QE
Telephone: 0141 548 2571
Email: diane.dixon@strath.ac.uk

This investigation was granted ethical approval by the University of Strathclyde ethics committee.

If you have any questions/concerns, during or after the investigation, or wish to contact an independent person to whom any questions may be directed or further information may be sought from, please contact:

Secretary to the University Ethics Committee
Research & Knowledge Exchange Services
University of Strathclyde
Graham Hills Building
50 George Street
Glasgow, G1 1QE
Telephone: 0141 548 3707
Email: ethics@strath.ac.uk

**Appendix 7 – Randomised, Controlled N-of-1s Consent Form**

## Consent Form

**Name of department:** School of Psychological Sciences and Health

**Title of the study:** The effect of joint pain on exercise-related goal-setting: an N-of-1 randomised controlled trial

- I confirm that I have read and understood the information sheet for the above project and the researcher has answered any queries to my satisfaction.
- I understand that my participation is voluntary and that I am free to withdraw from the project at any time, without having to give a reason and without any consequences.
- I understand that any information recorded in the investigation will remain confidential and no information that identifies me will be made publicly available.
- I consent to being a participant in the project

| | |
|---|---|
| I<br>(PRINT NAME) | Hereby agree to take part in the above project |
| Signature of Participant: | Date |

## Appendix 8 – Randomised, Controlled N-of-1s Demographic Information Sheet

### Participant Information

Name_____

Age_____

Gender_____

Mobile Phone Number_____

Do you know what the cause of your hip or knee pain is? If so, please describe.

Do you have any illnesses or health problems that you think might affect this study? If so, please give details below.

Do you use pain relieving medication regularly?

# Appendix 9

## Arthritis Impact Measurement Scales 2 (AIMS2-SF)

| During the past four weeks … | All Days | Most Days | Some Days | Few Days | No Days |
|---|---|---|---|---|---|
| 1. How often were you physically able to drive a car or use public transportation? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. How often were you in a bed or chair for most of the day? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Did you have trouble doing vigorous activities such as running, lifting heavy objects, or participating in strenuous sports? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Did you have trouble either walking several blocks or climbing a few flights of stairs? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. Were you unable to walk unless assisted by another person or by a cane, crutches or walker? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6. Could you easily write with a pen or pencil? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7. Could you easily button a shirt or blouse? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8. Could you easily turn a key in a lock? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9. Could you easily comb or brush your hair? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10. Could you easily reach shelves that were above your head? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11. Did you need help to get dressed? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12. Did you need help to get out of bed? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13. How often did you have severe pain from your arthritis? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14. How often did your morning stiffness last more than one hour from the time you woke up? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15. How often did your pain make it difficult for you to sleep? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16. How often have you felt tense or high strung? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | |
|---|---|---|---|---|---|
| 17. How often have you been bothered by nervousness or your nerves? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18. How often have you been in low or very low spirits? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19. How often have you enjoyed the things you do? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20. How often did you feel like a burden to others? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 21. How often did you get together with friends or relatives? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 22. How often were you on the telephone with close friends or relatives? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 23. How often did you go to a meeting of a church, club, team, or other groups? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 24. Did you feel that your family or friends were sensitive to your personal needs? | ☐ | ☐ | ☐ | ☐ | ☐ |

**If you are unemployed, disabled, or retired, stop here.**

| | | | | | |
|---|---|---|---|---|---|
| 25. How often were you unable to do any paid work, house work or school work? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 26. On the days you did work, how often did you have to work a shorter day? | ☐ | ☐ | ☐ | ☐ | ☐ |

# Appendix 10 – HAQ-20

**Please circle the ONE best answer for your abilities over the PAST WEEK.**

AT THIS MOMENT, are you able to:

DRESSING & GROOMING

1. Dress yourself, including shoelaces and buttons?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

2. Shampoo your hair?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

ARISING

3. Stand up from an armless straight chair?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

4. Get in and out of bed?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

EATING

5. Cut your meat?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

6. Lift a full cup or glass to your mouth?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

7. Open a new milk carton?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

WALKING

8. Walk outdoors on flat ground?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

9. Climb up five steps?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

Please check any AIDS OR DEVICES that you usually use for any of the above activities:

☐ Devices used for dressing (button hook, zipper pull, etc.)

☐ Built up or special utensils

☐ Crutches

☐ Cane

☐ Wheelchair

☐ Special or built up chair

☐ Walker

Please check any categories for which you usually need HELP FROM ANOTHER PERSON:

☐ Dressing and grooming

☐ Arising

☐ Eating

☐ Walking

**Please circle the ONE best answer for your abilities over the PAST WEEK.**

AT THIS MOMENT, are you able to:

HYGIENE

10. Wash and dry your body?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

11. Take a bath in a bathtub?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

12. Get on and off the toilet?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

REACH

13. Reach and get down a 5-pound object (such as a bag of sugar) from just above your head?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

14. Bend down to pick up clothing from the floor?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

GRIP

15. Open car doors?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

16. Open previously opened jars?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

17. Turn taps on and off?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

ACTIVITIES

18. Run errands and shop?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

19. Get in and out of a car?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

20. Do chores such as hoovering or gardening?

| without ANY difficulty | with SOME difficulty | with MUCH difficulty | UNABLE to do |
|---|---|---|---|

Please check any AIDS OR DEVICES that you usually use for any of the above activities:

☐ Raised toilet seat
☐ Bathtub seat
☐ Bathtub bar
☐ Long-handled appliances in the bathroom
☐ Long-handled appliances for reach
☐ Jar opener (for jars previously opened)

Please check any categories for which you usually need HELP FROM ANOTHER PERSON:

☐ Hygiene
☐ Gripping and opening things
☐ Reach
☐ Errands and chores

# Appendix 11 – Randomised, Controlled N-of-1s Baseline and Follow-Up Pain Scale

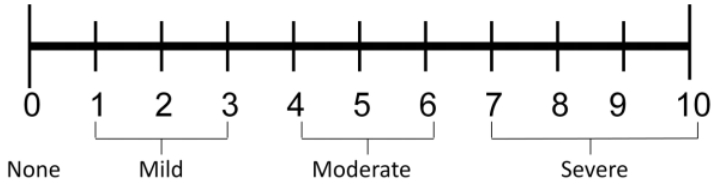
University of Strathclyde
Humanities & Social Sciences

**Please indicate the intensity of your current, best, and worst pain levels over the past 24 hours on a scale of 0 (no pain) to 10 (worst pain imaginable).**

Current _____

Best _____

Worst _____



**Appendix 12 – Randomised, Controlled N-of-1s Debriefing Sheet**

## Debriefing form

**School of Psychological Sciences and Health**

**The effect of joint pain on exercise-related goal-setting: an N-of-1 randomised controlled trial**

---

Thank you for taking part in this study about the effect of goal-setting on physical activity. This study is trying to find out whether setting a personal walking goal effects physical activity differently depending on how much pain a person is experiencing.

For the purposes of this study, you completed 2 different types of goal-setting. On some days, you made a goal about walking. Other days, you made a goal about eating fruit and vegetables. We expected you to walk more on days when you set a walking related goal compared to days on which you set a fruit and vegetable related goal. We also expected that you would walk less on days when your joint pain was high compared to on days when your joint pain was lower.

Feel free to contact me or my supervisor if you have any questions.

**Thank you very much for taking part.**

Tiffany Hamilton-Barclay
School of Psychological Sciences and Health
University of Strathclyde
Graham Hills Building
40 George Street
Glasgow, G1 1QE
Email: tiffany.hamilton-barclay@strath.ac.uk

Dr. Diane Dixon (Supervisor)
School of Psychological Sciences and Health
University of Strathclyde
Graham Hills Building
40 George Street
Glasgow G1 1QE
Email: diane.dixon@strath.ac.uk
Phone.: 0141 548 2571

# Appendix 13 – Longitudinal N-of-1s Advertisement

**Do you suffer from chronic joint pain in you knee or hip?**

We are looking for volunteers in Scotland aged 18 years or older with chronic knee and/or hip pain who are able to walk, have access to the internet, and are interested in participating in a research study.
The study will last for 8 weeks and will involve answering questionnaires about how you feel and how active you've been.

If you would like to find out more about participating,
please contact Tiffany at tiffany.hamilton-barclay@strath.ac.uk

## Appendix 14 – N-of-1s Participant Information Sheet

**Participant Information Sheet**

**Name of Department:** School of Psychological Sciences and Health

My name is Tiffany Hamilton-Barclay and I am a postgraduate research student at the University of Strathclyde. This research is being done as part of the department of psychology in the School of Psychological Sciences and Health. I can be contacted via email at tiffany.hamilton-barclay@strath.ac.uk or by phone on 0141 548 4391.

**Title of the study:** Understanding mobility in chronic joint pain

*You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being carried out and what it will involve. Please take the time to read the following information sheet carefully.*

**What is the purpose of this investigation?**

Arthritis is a long-term condition that can affect the way a person lives their life. In particular joint pain can affect how active a person is. In this study we are trying to understand the relationship between joint pain and activity. In addition, we are interested in better understanding how personal views about health and mood affects a person's day-to-day activity levels.

**Do you have to take part?**

No, you don't have to take part, and participation in this study is voluntary. You may withdraw from this study at any time without giving a reason. However, data cannot be withdrawn once your information is anonymised.

**What will you do in the project?**

This study involves completing a questionnaire and an interview that assesses physical health, psychological well-being, and physical activity. The researcher will meet you at a location of your choice to do this. You will be asked to wear an accelerometer (a small device about the size of a matchbox) each day to record your activity levels and to answer some questions online once each morning and once each evening throughout the

study. This device is worn on a belt around your waist and shouldn't affect your daily routine in any way. You will also be asked to complete the original questionnaire again at the end of the study. You will be shown all the questions you will be asked to answer before you finally decide whether or not you wish to participate in the study.

**Why have you been invited to take part?**

You have been invited to take part because we are interested in adults who have chronic joint pain of the hip or knee.

**What happens to the information in the project?**

The information you supply will remain confidential and will be securely stored on a password protected computer. All the data will be securely destroyed five years after the study is completed.

**The University of Strathclyde is registered with the Information Commissioner's Office who implements the Data Protection Act 1998. All personal data on participants will be processed in accordance with the provisions of the Data Protection Act 1998.**

**Thank you for reading this information – please ask any questions if you are unsure about what is written here.**

**What happens next?**

If you would like to take part in this project you will first be asked to complete a consent form. Next, you will be asked to complete a questionnaire. You will then be given an accelerometer, which you will be asked to wear every day for 8 weeks. You will also be asked to go online twice each day and answer a series of questions. There are no right or wrong answers to these questions; it is your personal experience and beliefs that are of interest. At the end of the first week the researcher will contact you to make sure you are happy with participating in the study and to check that the equipment is working properly. After 8 weeks the researcher will meet with you again to collect your accelerometer, give you the first questionnaire one more time, and answer any questions you may have about the study. You are free to contact the researcher or her supervisor at any time.

**If you do not wish to take part thank you very much for your interest and for taking the time to read this information sheet.**

This investigation was granted ethical approval by the University of Strathclyde Ethics Committee.

If you have any questions/concerns, during or after the investigation, or wish to contact an independent person to whom any questions may be directed or further information may be sought from, please contact:

Secretary to the University Ethics Committee
Research & Knowledge Exchange Services
University of Strathclyde
Graham Hills Building
50 George Street
Glasgow
G1 1QE
Telephone: 0141 548 3707
Email: ethics@strath.ac.uk

**Researcher Contact Details:**
**Student Investigator:**
Tiffany Hamilton-Barclay
School of Psychological Sciences and Health
University of Strathclyde
Graham Hills Building
40 George Street
Glasgow
G1 1QE
Telephone: 0141 548 4391
Email: tiffany.hamilton-barclay@strath.ac.uk

**Supervisor:**
Dr. Diane Dixon
School of Psychological Sciences and Health
University of Strathclyde
Graham Hills Building
40 George Street
Glasgow
G1 1QE
Telephone: 0141 548 2571
Email: diane.dixon@strath.ac.uk

## Appendix 15 – N-of-1s Consent Form

**Consent Form**

**Name of department:** School of Psychological Sciences and Health

**Title of the study:** Understanding pain and mobility in osteoarthritis

- I confirm that I have read and understood the information sheet for the above project and the researcher has answered any queries to my satisfaction.
- I understand that my participation is voluntary and that I am free to withdraw from the project at any time, without having to give a reason and without any consequences.
- I understand that any information recorded in the investigation will remain confidential and no information that identifies me will be made publicly available.
- I consent to being a participant in the project

□ I consent to being audio recorded during the interview
(you may still participate even if you do not wish to be audio recorded)

| | |
|---|---|
| I (PRINT NAME) | Hereby agree to take part in the above project |
| Signature of Participant: | Date |

**Title of the study:** Understanding pain and mobility in arthritis

*The University of Strathclyde is a charitable body, registered in Scotland, number SC015263*

Last updated: May 2011

## Appendix 16 – N-of-1s Demographic Information Sheet

### Participant Information

Name_____

Age_____

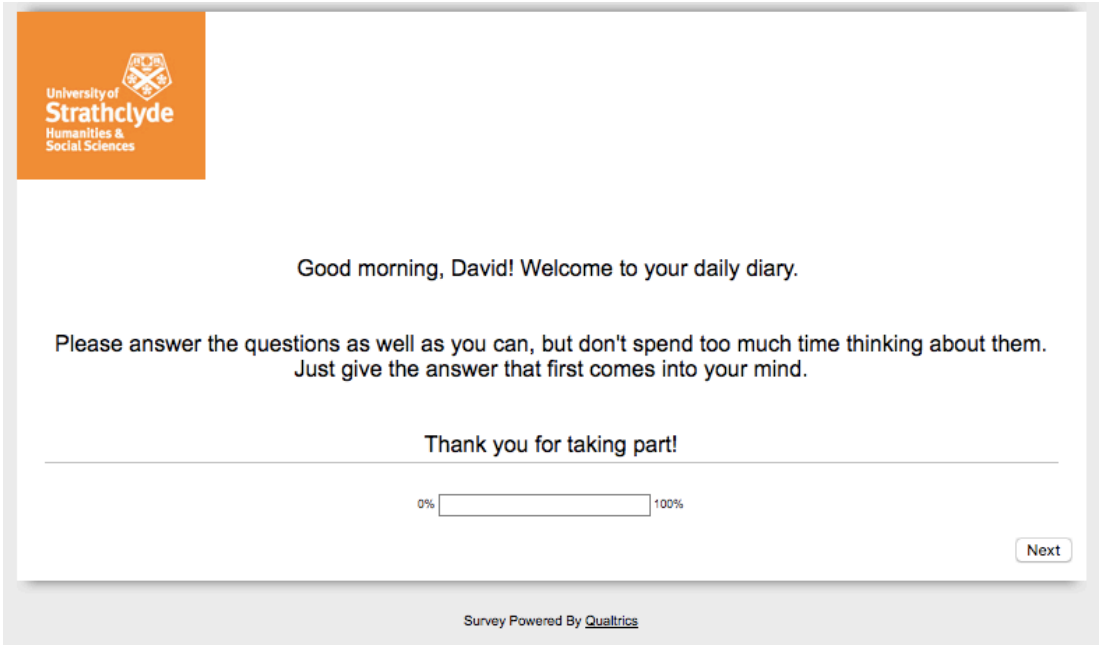
Gender_____

Email Address_____

Do you have any illnesses or health problems that you think might affect this study? If so, please give details below.

Do you use pain relieving medication regularly?

## Appendix 17 – N-of-1s Morning Qualtrics Survey Example



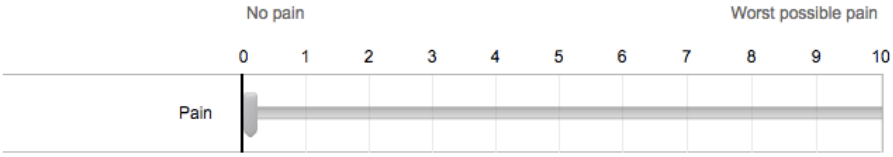
University of Strathclyde
Humanities & Social Sciences

Questions about 'symptoms' are asking about sensations that you feel are signs of your osteoarthritis or would otherwise not be experienced by the average, healthy person.
(Examples: pain, stiffness, swelling, fatigue, etc.)

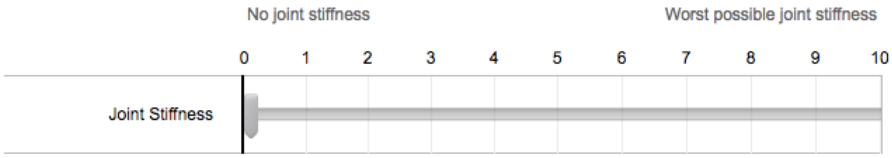
Which symptom is causing you the most trouble today?

- ○ pain
- ○ stiffness
- ○ fatigue

What is your pain like today?




What is your joint stiffness like today?




0% 100%

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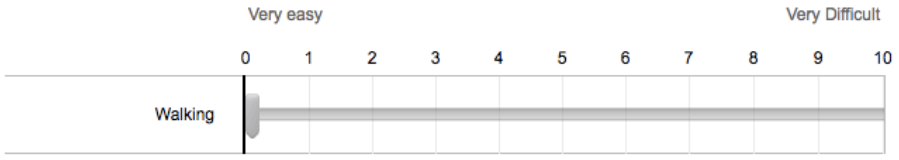
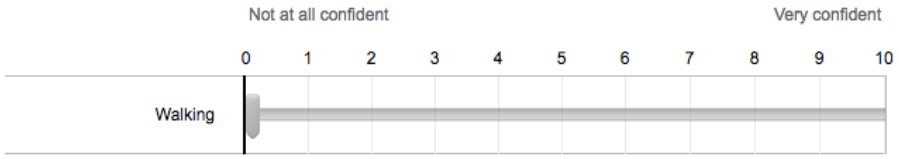
University of Strathclyde
Humanities & Social Sciences

Questions about 'symptoms' are asking about sensations that you feel are signs of your osteoarthritis or would otherwise not be experienced by the average, healthy person.
(Examples: pain, stiffness, swelling, fatigue, etc.)

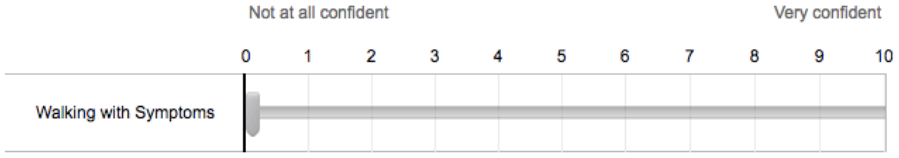
How difficult or easy do you find walking today?



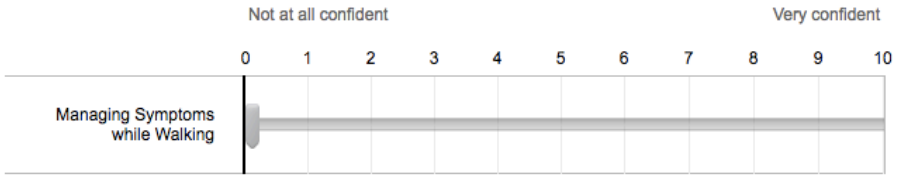

How confident do you feel about walking today?




How confident do you feel about walking while your symptoms are present today?




How confident do you feel about managing your symptoms while walking today?





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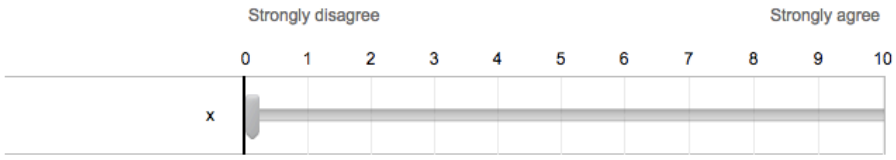
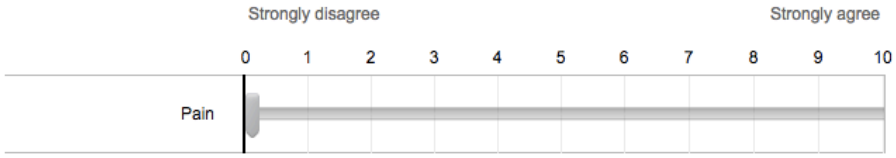
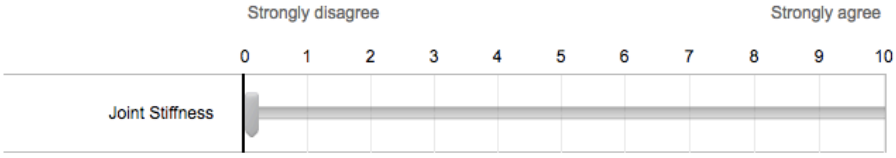
Walking today will make my fatigue worse.




Walking today will be painful.




Walking today will make my joints stiffer.





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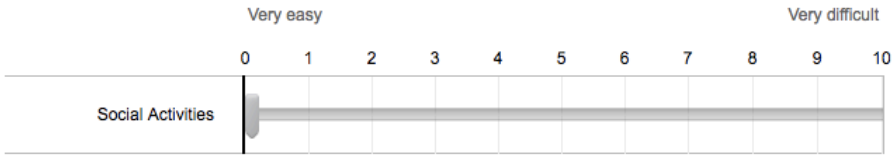
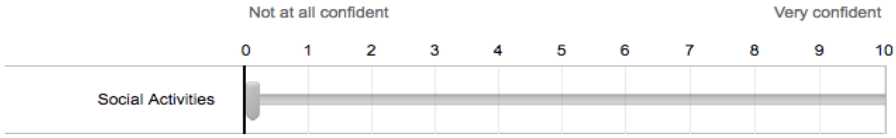
Questions about 'symptoms' are asking about sensations that you feel are signs of your osteoarthritis or would otherwise not be experienced by the average, healthy person.
(Examples: pain, stiffness, swelling, fatigue, etc.)

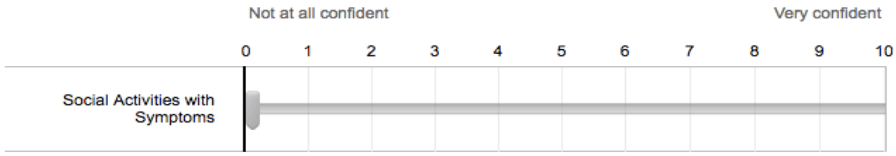
How difficult or easy do you find it to take part in social activities today?



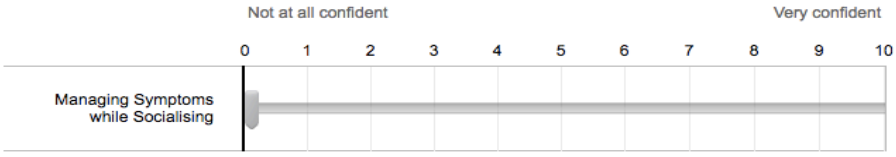

How confident are you that you can take part in social activities while you are experiencing symptoms today?



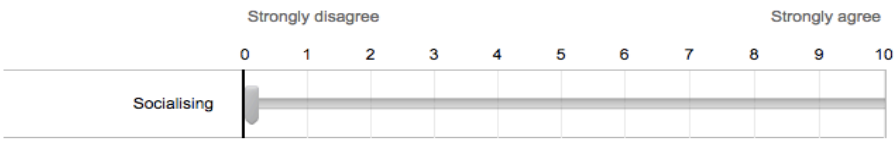

How confident are you that you can take part in social activities while your symptoms are particularly bad today?




How confident do you feel about managing your symptoms while taking part in social activities today?




Socialising today will be difficult.





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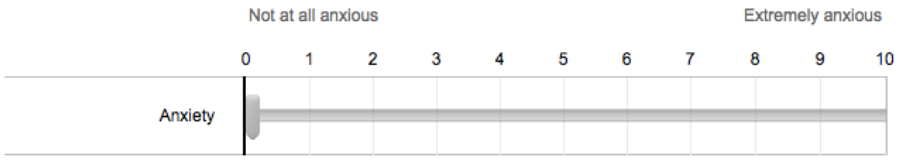
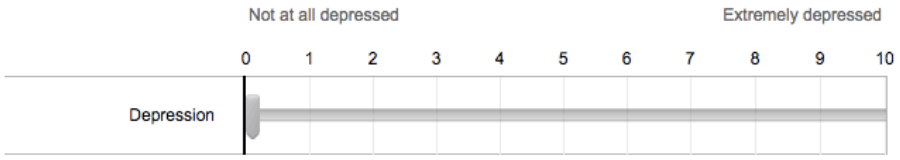
University of Strathclyde Humanities & Social Sciences

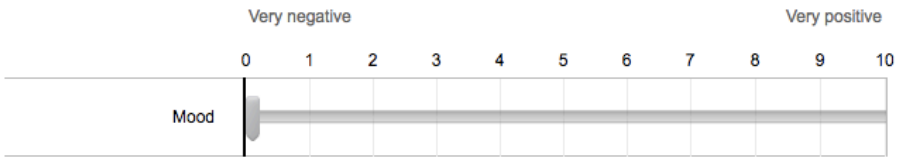
How anxious are you now?




How depressed do you feel now?




How is your mood now?





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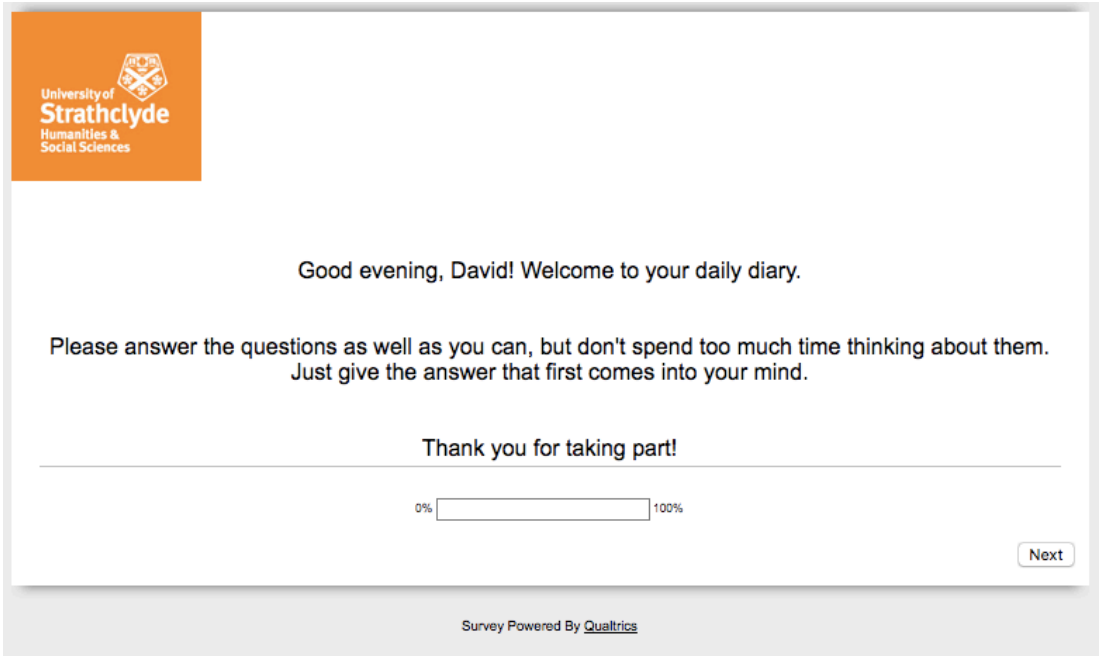
University of Strathclyde Humanities & Social Sciences

We thank you for your time spent taking this survey.
Your response has been recorded.

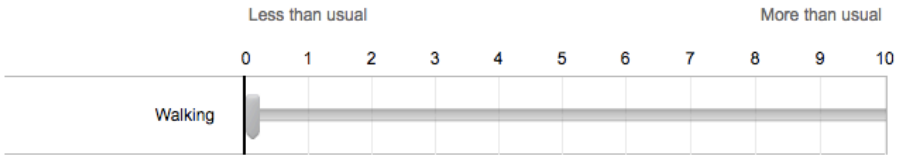

Survey Powered By Qualtrics

## Appendix 18 – N-of-1s Evening Qualtrics Survey Example

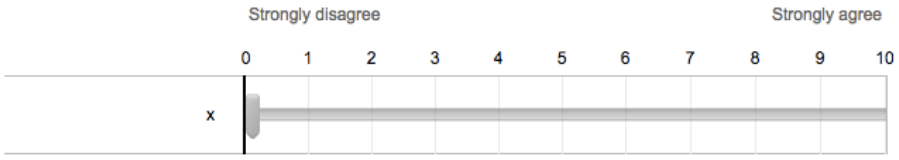


University of Strathclyde
Humanities & Social Sciences

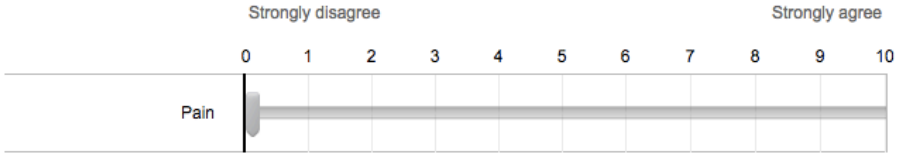
How much walking did you do today?



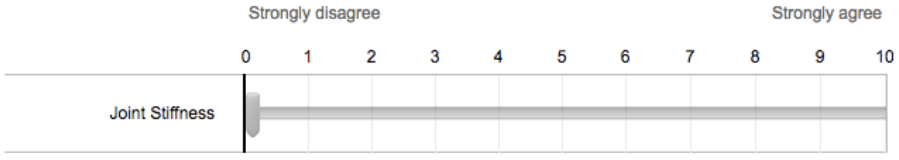

Walking today made my fatigue worse.




Walking today was painful.




Walking today made my joints stiffer.





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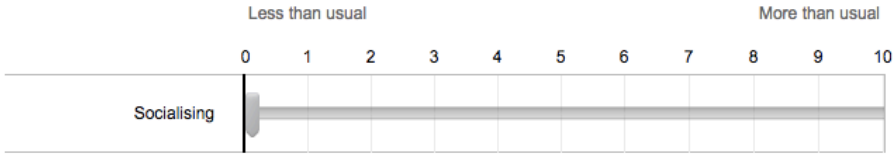
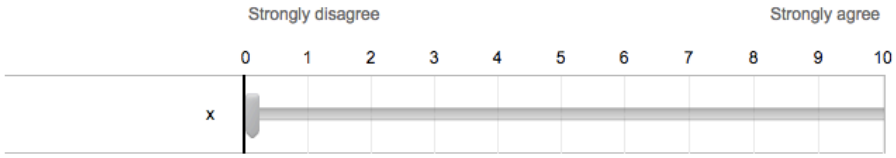
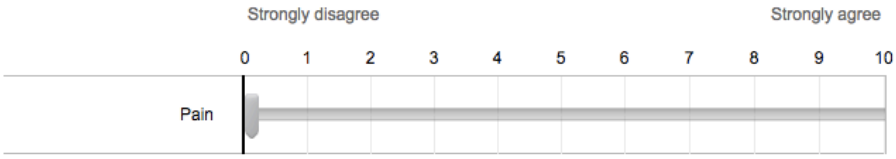
How much socialising did you do today?



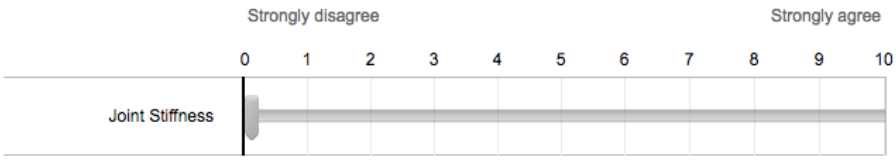

My social activities made my fatigue worse today.




My social activities made my pain worse today.




My social activities made my joints stiffer today.





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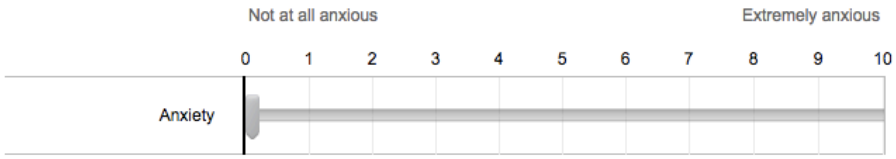
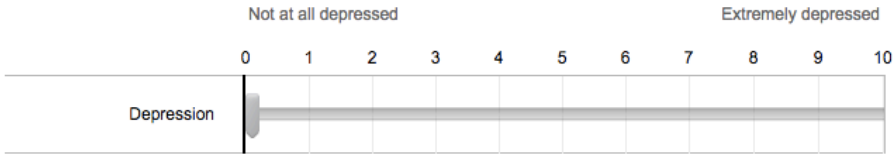
Humanities & Social Sciences

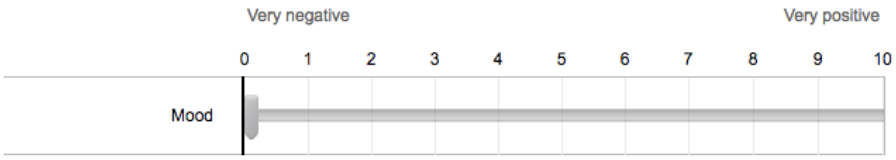
How anxious were you today overall?




How depressed did you feel today overall?




How was your mood today overall?





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Humanities & Social Sciences

We thank you for your time spent taking this survey.
Your response has been recorded.


Survey Powered By Qualtrics

**Appendix 19 – N-of-1s Debriefing Sheet**

## Debriefing form

**School of Psychological Sciences and Health**

Understanding pain and mobility in arthritis

---

Thank you for taking part in this study about arthritis, pain and mobility. This study is trying to understand more about the relationship between pain and mobility in people with arthritis. We are interested to understand how pain affects how active people with arthritis are. At the moment we have some information about this from studies that have compared activity in people with osteoarthritis with people who do not have arthritis. We have less information about how joint pain and stiffness affects mobility and activity on a day-to-day basis in people with arthritis. Also, we are interested in understanding how beliefs and mood affect activity. We do know that a person's beliefs, for example how confident the person is in their ability to be active, can affect how active they are. Also, we know that a person's mood can affect how active they are, for example, we tend to be more active when we are in a positive mood compared to when we are in a negative mood. However, it is not clear whether our mood makes us more active or whether being more active makes us more positive. This study collected information about pain, activity, mood and beliefs every day. This information will enable us to examine the day-to-day relationship between pain, activity, mood and beliefs to answer these kinds of questions.

If you have any concerns about your mood or your arthritis, please contact your general practitioner and/or look for more information from the following organisations:

**Arthritis Care**
http://www.arthritiscare.org.uk/Home
0808 800 4050
Unit 25A
Anniesland Business Park
Glasgow
G13 1EU

**Arthritis Research UK**
http://www.arthritisresearchuk.org/
Copeman House
St Mary's Gate
Chesterfield
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**The Scottish Association for Mental Health**
http://www.samh.org.uk/
SAMH Information Service
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Please feel free to contact me or my supervisor if you have any questions. Thank you for taking part.

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